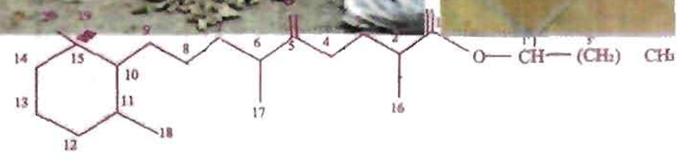
ISBN 81 - 86872 10 - 8

Biodiversity Conservation & Utilization of Spices Medicinal & Aromatic Plants

IISR PUB-32

Proceedings of the National Symposium on Spices, Medicinal & Aromatic Plants - Biodiversity, Conservation & Utilization

10 to 12 August 1998, Calicut



ISBN 81 - 86872 10 - 8

Biodiversity Conservation &Utilization of Spices, Medicinal & Aromatic Plants

Editors

B. Sasikumar
B.Krishnamoorhty
J. Rema
P.N. Ravindran
K.V. Peter

IISR PVB - 32

Proceedings of the Golden Jubilee National Symposium on Spices, Medicinal and Aromatic Plants - Biodiversity, Conservation and Utilization

10-12 August 1998 Calicut

ICAR
Indian Institute of Spices Research ,
Calicut - 673 012
Kerala , India

Published by

Director,
Indian Institute of Spices Research,
Calicut, 673012
Kerala, India.

Editors

B. Sasikumar
B.Krishnamoorthy
J. Rema
P.N. Ravindran
K.V. Peter

Cover

A. Sudhakaran & B.Sasikumar

Citation

Sasikumar .B, Krishnamoorhty. B, Rema. J, Ravindran P.N, and Peter.K.V, (Eds.) 1999 . Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants. Indian Institute of Spices Research, Calicut, Kerala

December 1999

Printed at
Premeela Press
Calicut
Phone: 722 889

Tel . Off. 91-11-3382534
Res. 91-11-6241196
Fax 91-11-3382534/3387293
Telex 031-62249 ICAR-IN
E-Mail spg@icar.delhi.nic.in

ICAR
DR. S. P. GHOSH
Dy Director General
(Horticulture)

भारतीय कृषि अनुसंधान परिषद्
कृषि भवन, डा. राजेन्द्र प्रसाद रोड, नई दिल्ली-110001
INDIAN COUNCIL OF AGRICULTURAL RESEARCH
Krishi Bhawan, Dr Rajendra Prasad Road, New Delhi - 110001

December 27, 1999

FOREWORD

India has very rich diversity of spices, medicinal and aromatic plants. Indian spices occupied a unique position in Western as well as continental cuisine. Our traditional medical system of Ayurveda has been well recognised throughout the world.

India is the center of origin and diversity for major spices like black pepper and cardamom; a major center of diversity and an important production center for ginger, turmeric and seed spices. Black pepper, long pepper and ginger are also used as important ingredients in many Ayurvedic preparations. Over exploitation and the destruction of forest wealth is leading to the depletion of these medicinal plants in natural habitat and many may be on the brink of extinction. Often we may not even aware of the extent of threat to the medicinal plant wealth, and we do not know which one is endangered or which one is going to become extinct. Again plants such as neem, *Phyllanthus amarus, Gymnema*, turmeric etc. shot into international fame recently due to the changed international scenario on intellectual property right on genetic resources and foreign companies bagged patents on them.

In order to effectively counter any attempt of biopiracy of valuable germplasm of spices, medicinal and aromatic plants of India, the first and foremost step needed is stock taking of our assets. Accurate documentation and identification of biodiversity of spices, medicinal and aromatic plants will definitely be the important step in this direction.

This publication, "Biodiversity, Conservation and Utilization of Spices, Medicinal and Aromatic Plants" forms the proceedings of the National Symposium on Spices, Medicinal and Aromatic Plants – Biodiversity, Conservation and Utilization, organized by the Indian Institute of Spices Research in collaboration with Indian Society for Spices at Calicut during 10-12 August, 1999. I am sure, that the publication will be very useful to all those who are involved in R&D activities and policy planning and farming of these groups of plants. I compliment the IISR and ISS for organizing this timely Symposium and for bringing out the proceedings timely. I compliment the editors for the good work done.

S.P. Ghosh

(S.P. GHOSH)
Dy. Director General(Hort.)

PREFACE

Realising the importance and relevance of biodiversity of spices, medicinal and aromatic plants in the light of WTO conditions and regulations, the Indian Institute of Spices Research has organised a Golden Jubilee National Symposium with the focal theme on Spices, Medicinal and Aromatic Plants - Biodiversity, Conservation & Utilization at Calicut during 10-12 August, 1998 in collaboration with the Indian Council of Agricultural Research (ICAR), New Delhi. The Symposium was co-sponsored by the Indian Society for Spices, Calicut.

This publication 'Biodiversity, Conservation and Utilization of Spices, Medicinal and Aromatic Plants' is the proceedings of the above National Symposium. A total of 50 papers presented in the Symposium covering four technical sessions, viz., i) Biodiversity of spices and their conservation ii) Biodiversity of medicinal and aromatic plants and their conservation iii) Ethnobotany, ethnomedicine and folk medicines and iv) Development, futurology and intellectual property rights, are included in this proceedings. Two panel discussions were also held during the Symposium.

The editors are grateful to the Indian Council of Agricultural Research (ICAR) New Delhi and the Indian Institute of Spices Research, Calicut for organising the above Symposium. We are also grateful to Dr. S P Ghosh, Dy. Director General (Hort.), ICAR, New Delhi, for kindly writing the foreword for the publication. Thanks are also due to Dr. S. Edison, Director, Central Tuber Crops Research Institute, Thiruvananthpuram, the then President of the Indian Society for Spices, Calicut, for his keen interest in the Symposium and the Indian Society for Spices.

We also acknowledge the financial assistance given by M/s Aryavaidyasala, Kottakal; M/s Chemind Chemicals, Calicut, Sri. Ravi, C.S. Scientific Instruments, Chennai; M/s Krishna Agencies, Calicut; M/s Towa Optics, Madras; Saveer, New Delhi and State Bank of India, Calicut. Finally the editors earnestly request to bear with for any inadvertent act of omission.

The editors express their appreciation to M/s Premeela Press, Calicut for bringing out the proceedings in an attractive form.

Editors

CONTENTS

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. i-iv, 1999

Presidential address

S. P. GHOSH
Deputy Director General (Horticulture) ICAR, New Delhi - 110 001

I am extremely happy to be here at Calicut, the city of spices, to preside over the Golden Jubilee National Symposium on Spices, Medicinal & Aromatic Plants. I feel privileged to be among the galaxy of scientists who are devoted to the focal area of biodiversity in spices, medicinal and aromatic plants.

India has a long tradition in perfumery, probably dating back to the pre-Vedic period of Aryan civilization (Ca. 4000 years). There are innumerable references in our ancient literature about the use of perfumes by kings, queens and courtesans. But the blossoming of the Indian perfumery took place during the Mughal period.

Among the many hundreds of medicinal and aromatic plants, only a few are being grown commercially, while the others are still collected from wild plants. The indiscriminate exploitation had led many plants to the point of extinction. Our forests are the largest repository of Medicinal Aromatic Plants (MAPs) and it is our bounden duty to preserve and conserve them. The loss of forest habitat in an alarming way all over the world is a matter of deep concern of the future of mankind.

At the same time the sustainable utilisation of forests and MAP biodiversity is essential for human existence. It is essential that we in India initiate a concerted attempt for biodiversity prospecting (or bioprospecting) for meeting the challenges to health care in the years to come. Bioprospecting integrates the systematic research of new sources of economically valuable products (such as chemicals, genes from micro and higher organisms) with biotechnology issues. It has the two fundamental goals of making sustainable use of genetic resources and their conservation, and helping the socioeconomic development of biodiversity rich countries. The newly constituted committee for bioprospecting at the Dept. of Biotechnology, will function as a catalyst for the speedy realisation of these twin goals.

In the whole process the greatest emphasis should be given to germplasm. The combined market world for pharmaceuticals, agrochemicals and seeds is over 200 billion annually, and genetic resources provide the starting material for a significant portion of this market. Till today it is estimated that the returns from potential new drugs developed from the biodiversity found in tropical forests exceed US$ 100 billion in value to society as a whole; but unfortunately nothing has so far trickled down to the society that owns the biowealth. The new genetic engineering technology, promises an even brighter future for biodiversity prospecting.

The biodiversity convention envisions harmonious links between conservation, intellectual property right, environmental protection, research, development and economic advancement for developing countries. But the system is complex, and we must be ever vigilant.

Let me dwell on spices for a moment. Ours is known as the Land of Spices from time immemorial. We produce annually spices worth around Rs. 7000 crores in the country, many of them form part and parcel of our daily food. We exported in 1997-98 spices and spices products worth over Rs. 1350 crores, a valuable addition to our national exchequer. But more than that the spices cultivation forms the economic main stay of many thousands in our country. The requirements of all major spices will increase year after year and decade after decade. To cite an example, in the case of black pepper, the requirement for 2050 AD is estimated to be around 280,000 tonnes annually, double of the present world production.

Here, I would like to add a comment made by the Parliamentary Sub Committee constituted to review R & D in spices. (I quote) "we have descended from such high pedestal to a much low level in production and quality of spices. Instead of improving upon our ancient performance, we have lagged behind others". It is high time the causes of such a decline are found and lapses made good.

India is a vast country having very rich resources in spices, medicinal and aromatic plants. At this point of time, when we stand at the threshold of a new millennium, we should have an introspection on whether we were safeguarding our MAP resources and exploiting them in a sustainable way. What have we done to preserve our rich heritage and the indigenous traditions in medicine? The past decade has seen many efforts especially by certain voluntary organizations for the revitalization of the old traditions. But we have touched only the tip of an iceberg. I hope the experts assembled here may ponder over it.

In this context the following suggestion I would like to put across for your consideration.

1. Efforts on nation wide by all concerned organizations to document the indigenous knowledge.
2. Evaluation of the effectiveness of the common indigenous medical treatment and their standardization.
3. Integration of traditional and modern medicines should be encouraged as in the case of China.
4. Rural farmers should be encouraged in the cultivation of medicinal and

aromatic plants as a means of cash income generation.

5. Rural people should be trained in the proper use of traditional medicine.

By the beginning of the next century the predicted global market for MAP will be around $20 billion and for spices it will be around US$2 billion annually. The vast genetic resources combined with the infrastructure available in the country if properly used can put India on the top of the world countries in production and export of spices and MAP. Our national agenda for future development should have the following components.

1. Identification of potential and promising species-this includes (i) potential species which have the potential for developing into commercial crops (ii) promising species-which have already attained status of commercial exploitation.
2. Germplasm-survey, documentation, conservation, characterization. The genetic erosion of Spices, Medicinal and Aromatic Plants (SMAP) is very fast due to variety of causes. A resource mapping of the country, identification of ideal locations for *in situ* conservation, establishment of conservatories and strengthening the existing agencies (such as NBPGR, CIMAP, IISR, etc.) for ex situ conservation etc. have to be undertaken. Wherever necessary molecular characterization should be taken up.
3. Crop improvement - selection and breeding has been limited in SMAP. Active breeding programme should be initiated to increase production, productivity, quality, and for developing resistance to biotic stress conditions.
4. Use of biotechnology-modern techniques have to be adopted for solving various spices specific problems. Marker assisted breeding programme is the need of the day.
5. Net working-all the organizations involved in SMAP R&D activity should be effectively linked and a national SMAP information network should be evolved. This also involves the following aspects:

1. compilation and publication of SMAP directory
2. manpower development-especially in the areas of MAP taxonomy, conservation, breeding,biotechnology and commercial utilization.
3. a bimonthly or quarterly Newsletter for effective information spread among the various organizations and end uses.
4. a national level SMAP workshop once in every two years to take stock of the situation and to formulate strategies.
5. formation of an apex committee including the representatives of the various agencies such as CSIR, ICAR, Spices Board, ICMR etc. to review and monitor the progress.

I hope the experts assembled here will take note of some of the points raised and will deliberate on the them to evolve practical programmes and recommendations. All over the world people have become highly quality conscious-especially so in the western world. Commercialisation of production, and productivity enhancement should go hand in hand with quality enhancement as well. Concerted effort should be made by all concerned form the primary grass root producer to the exporter and R & D agencies to keep up the motto of quality. This is more important in the case of consumable spices and spice products. Efficient and imaginative research on post harvest technology and product development should be undertaken, so as to make SMAP cultivation stable and attractive.

I hope that this meet will discuss the pros and cons of the various aspects of biodiversity and conservation of SMAP in all its dimensions. In fact the spirit of conservation should be inculcated in the common people from the grass root level among the students, the working class and especially in the women folk. The realization should come that conservation of nature is conservation of our own life.

Now, Ladies and Gentlemen let me stop. I wish you happy stay here at Calicut and fruitful three-days of deliberations.

Thank you.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants pp. v-vii, 1999

Inaugural address

K. N. SHYAMASUNDARAN NAIR
Vice Chancellor, Kerala Agricultural University, Vellanikkara-680 654

Let me first express my grateful thanks to Dr. K.V. Peter, Director, Indian Institute of Spices Research, Calicut for the honour bestowed upon me by giving an opportunity to inaugurate this Golden Jubilee National Symposium on Spices, Medicinal and Aromatic Plants - Biodiversity, Conservation & Utilization at the Regional Science Centre, Calicut.

Ours is a legendary land-the land of spices, precious stones, ivory and Maharajas; of course all of them except spices vanished during the passage of time. It was in search of spices that the foreign powers reached the Indian subcontinent and the shores of Kerala. India has a 2000 years old history of foreign trade, sustained mainly by the spices trade till recently. It was exactly five hundred years ago in 1498 May 20th, Vasco da Gama landed near this very same city of Calicut. It was this event that opened up the door of colonisation which eventually culminated in the fomidable British Raj. It is only in the fitness of things that this Symposium on Spices, Medicinal and Aromatic Plants is held in Calicut, the city that welcomed Gama 500 years ago innocently to the best of traditions without realising the consequences.

The International Trade Centre (ITC) Geneva, has put the current trade in spices at 400,000-450,000 tonnes valued at US $ 1.5-2.0 billion annually. Over the years the spices trade showed an annual compound growth rate of 3.6% in quantity and 8.4% in value. Among these, pepper accounts for 34%, chillies 22%, seed spices 17%, tree spices 14% and others 17%. In India, the annual production and trading in spices is to the tune of about Rs. 6000 crores, and we export currently spices worth about 5.85% (about Rs. 1300 crores) of the export earnings from agricultural products. The spices cultivation, production and marketing are the main economic stay of millions of people of our country.

Estimate put the trade in raw drugs and phytochemicals in India around US$ 600 million (i.e. about Rs. 2,400 crores). A large number of aromatic and medicinal crops are being grown in diverse situations throughout this vast country. It is indeed a herculian task to collect information on them-unfortunately in our age gathering information is very costly. Yet we know that India is the world's largest producer of sandalwood oil, lemongrass oil, jasmine and tuberose concretes leaving apart spices oils and oleoresins in which India has always been the major producer. But sadly our share in international trade of flavours and fragrances is less than 1%. It is sad because our country has vast resources-natural resources, scientific man power and infrastructure under the various organizations such as CSIR, ICAR, SAUs, NGOs of various hues and dimensions, but what is lacking is perhaps the will, to which I will come a bit late.

One of the most beautiful contributions of the ancient India is the concept of living in oneness with nature-the entire edifice of ancient medicine and culture is based on the fundamental identity between humans and nature, man is considered as a microcosm of the macrocosm, both being constituted by the same *Panchabhuta* (the five fundamental elements). Over the many centuries man has become more and more greedy, jealous, egoistic and for making profit he started cutting the base of the very tree of nature underneath of which he was living safely and happily. Though we have not been successful in many areas, we have been extremely successful in cutting down our forests, in killing our wild life, in exterminating almost everything that nature has bestowed on us. We do it again and again with a vengeance, with an Iagoan 'motiveless malignity'. Human settlements, human encroachments and human vandalism degraded and deformed the environment-whether it is the Himalayas or the Western Ghats. We have disregarded the spirit of nature conservation and love which our ancient *Rishis* have demonstrated for others to emulate.

The theme of this symposium is of cardinal importance, for the very existence of our communities - biodiversity mapping, assessment, conservation and characterization of the important and unique ones along with sustainable utilization. The most basic thing in this area is the comprehensive documentation of the genetic resources of aromatic and medicinal plants together with the documentation of the local knowledge and practices-*to record the unrecorded*-before such knowledge is lost for ever. This of course is a massive exercise in which all R & D organizations, universities, teachers and student community should get involved. I feel that the CSIR, Ministry of Environment & Forests and ICAR should jointly from an apex body to plan and implement such a massive exercise on a war footing.

It is an irony that the foreign companies are taking patents on our medicinal plants. It only shows that we do not know what we have. The Western Ghats is one of the 12 biodiversity hot spots on earth and we have done pretty little to understand this biodiversity, except for a few doctoral theses on a few plant types. Bioprospecting for useful biochmicals is a need of the hour and all our efforts including those of the research students of our universities should be diverted to this area. I hope that this symposium will make some useful recommendation to this effect to all concerned.

I would like to conclude with these lines from the Mandukya Upanishad Karika of Gaudapada.

"Asparsa yogo vai nama

Sarva - sattva - sukh hitah

A vivado aviruddhasca

Desitah tani namamyaham"

"I salute this philosophy that has taught the well known asparsa-yoga or the yoga non-separateness, which conduces to the welfare of all beings, and which is free from all strife of disputation and contradiction". With this poem, I inaugurate the Golden *Jubilee National Symposium on Spices,* Medicinal and Aromatic Plants - Biodiversity, Conservation and Utilization.

Thank you.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 1- 15, 1999

Indian national plant genetic resources system (IN -PGRS)

P. L. GAUTAM & S. KOCHHAR

National Bureau of Plant Genetic Resources
Pusa Campus, New Delhi - 110 012.

Abstract

The paper describes the evolution of plant genetic resources (PGR) activity in the country, plant genetic resources in the Indian scenario, various dimensions of plant genetic resources activity in India, PGR policy area and role of National Bureau of Plant Genetic Resources in conserving India's plant diversity.

Evolution: The PGR discipline vis-a-vis the institutional mechanism

The field of plant genetic resources emerged, following the rediscovery of Mendel's laws and the theory of evolution in the beginning of twentieth century. Pioneer workers like Howard and Howard through their survey, collection and inventorization of agrobiodiversity, particularly of *desi* wheats in the north-western plain zone of India gave the required direction to the management of plant genetic resources (PGR) for present and future needs. The Indian (then Imperial) Council of Agricultural Research (ICAR) was established in 1929 and with its national efforts in the diverse agricultural fields/ disciplines, the Crop and Soils Wing of the Board of Agriculture and Animal Husbandry of the Imperial Govt. of India took particular interest in the development of germplasm exploration and exchange activities in the country, since 1935. The need for search for new genes was voiced in the forties by Dr. B. P. Pal and the subsequent era has witnessed tremendous development in the field of PGR. Table 1 presents the development in PGR and its various disciplines over different decades.

Table 1. Evolution of PGR activities vis-a-vis PGR discipline / areas of science.

Period	Activity
Pre- historic	Origin of agriculture
	Demonstration of plant species 10-1200 years ago
Historic	Creation and maintenance of variability
	Farmers' selection and their maintenance. Collection of variability and selection by breeders.
Indian PGR scenario 1940's	Pre-beginning. Search for new genes
1950's initiation of activities	Plant introduction
	Plant exploration and collection
	Plant quarantine and exchange services
1960's organizing	Mounting several expeditions within country/ region
	Evaluation for morphological variability
	Maintenance of variable collections
	Classification/grouping for use in breeding
	FAO's first technical conference on PGR-attracting global attention of scientific community towards plant genetic resources.
1970's further organising	Commissioning of NBPGR in the ICAR set-up-1976. Extensive exploration and collection activities enhanced introduction and exchange activity, planning/initiation of other components of genebank establishment of IBPGR (now IPGRI)-1974.
1980's strengthening	*Systematizing passport data for collections*
	Systematizing descriptors/descriptor based characterization and preliminary evaluation
	Further streaming PGR services : Introduction and exchange/post-entry quarantine/inland supply of germplasm
	Transforming from farm maintenance of germplasm to medium to long term ex-situ. Conservation initiation of *in vitro* conservation through plant tissue culture and molecular DNA characterization (Research scale)
	Biosystematic studies on some indigenous crops/relatives

Contd. . . .

	International awareness on PGR generated
	International undertaking on PGR signed (1983) and ratified by 135 countries.
	Recognizing Farmers' Rights
1990's culminating	Collaborative approaches in exploration and collection. Strengthening of exchange for introduction, modernizing post-entry quarantine facility strengthening germplasm conservation
	Ex situ/long term repository
	In situ/ citrus gene sanctuary
	In vitro/ NFPTCR
	Cryopreservation
	Field genebanks
	PGR system network/national active germplasm sites
	Sustainable conservation of agro-biodiversity. Molecular characterization and DNA fingerprinting
	Documentation and cataloguing
	Human resources development
	Several policy issues emerged
	Indigenous sovereign resources vis-a-vis traditional knowledge of native folks. *Sui generis* management and trade of plant species, varieties and associated microflora.
	Sustainable conservation of agro-biodiversity components.
	Compensation for "on-farm", conservation of traditional types
	Equitable sharing of benefits accrued
	Funding mechanism for PGR research and conservation *ex situ, in vitro,* and *in situ*/ onfarm.

The ICAR, way back in 1946, realizing the dire need for a systematic introduction of plant material, created a centralized Plant Introduction Scheme in the erstwhile Botany Division at Indian Agricultural Research Institute (IARI), New Delhi with Late Dr. Harbhajan Singh as the first Asst. Botanist in-charge of the scheme. Subsequently, it was elevated tot he Plant Introduction Division in 1969. Both Dr. B.P. Pal, the then Director of IARI, and Dr Harbhajan Singh, the first Head of the Division, played crucial roles in its creation and further strengthening of its various activities.

The National Bureau of Plant Genetic Resources (NBPGR) was established in August, 1976 as an independent organization under the ICAR; being the second among its Bureaus and the first one covering the genetic resources. Dr. M.S. Swaminathan, the then Director General of ICAR and Dr. A.B. Joshi, the then Director of IARI, played key role in this regard. The institution got good support from the Council with a keen interest of all its successive Director Generals. Its activities, mandate and infrastructure got phenomenal expansion, matching with the global developments in the field of PGR and the vision of the ICAR leaders. Several regional stations (11) were established in the diverse climatic zones of the country following the principles of phytogeographic distribution. (aero-ecological analogues).

Plant genetic resources - Indian scenario

A flash-back on the use of plant genetic resources (PGR) in Indian Agriculture shows that the production of different crops in past 30 years (1964-65 to 1994-95) has increased tremendously, helping in changed food scenario, from deficiency to self-sufficiency, including export surplus in some cases. PGR of Indian subcontinent have contributed greatly to the improvement, production and productivity of major crop plants, yielding substantial information on the use of these resources of genetic enhancement and improvement of productivity and production. Over two dozen crop plant species, besides some domesticated farm animals, particularly the buffalo, are known to have been domesticated by the natives in India. The country is bestowed with immensely rich landrace diversity in major agri-horticultural crops, due to the conscious and unconscious selections made and their seed/propagules inherited and perpetuated over generations by the indigenous farming communities. Enormous richness is also observed in wild crop plant relatives (326 species). With a bounty of nearly 18,000 species of higher plants occurring in16 major vegetation types out of the 49,000 plant species known to occur in the country, India occupies a unique position among the major gene rich countries of the world. About 33 per cent of these species are endemic.

Floristically very rich, India has got about 141 endemic genera belonging to over 47 families of higher plants. Of the 4,200 endemic species, the largest number (about 2532 species) is located in the Himalayas followed by the peninsular region (1,788 species) and Andaman and Nicobar islands (185 species). Besides, the native plant wealth includes over 8,900 species of ethno-botanical interest, mainly owing to the fact that the plants of medicinal and relio-ritual values were not formally domesticated but spotted from their respective habitats, gathered in limited quantities and allowed to dwell and evolve freely in nature. Much of the country's agrobiodiversity is in the custody of farming communities/tribals who followed age old farming systems, including shifting cultivation. However, it is being lost from the "natural" habitats due to the expansion of agricultural production to frontier areas. Hence, scientific management of these invaluable resources has assumed prime importance today.

India's richness in agro-biodiversity

Crops in which a rich diversity occurs in India include rice, wheat, barley, pigeonpea, chickpea, minor-millets, mungbean, uradbean, horsegram, mothbean, ricebean, clusterbean, sesame, forage grasses, okra, eggplant, cucumber, melons, citrus, banana and plantain, jackfruit, mango, tamarind, jamun, jute, cotton, ginger, turmeric, pepper, cinnamon and cardamom. Among tuberous crops, rich variability exists in sweet potato, taros and yams. Native resources are also available in *Coleus* species, sword bean, velvet bean and several plantation crops including arecanut and coconut. Diversity also occurs in several minor fruits, such as berries and nuts; and several species of *Rubus, Ribes, Juglans, Pyrus,* and *Prunus.* In medicinal plants, India's vast genetic resource base is well known in the world over. The usage of medicinal plant in India has an ancient history, dating back to the pre-vedic culture, at least 400 years B.C. It is estimated that at least 70 per cent of the country's population now rely on herbal medicines and over 7000 plants (out of 8900 species of ethnobotanical interest) are known to be used for medicinal purposes in the country.

The dimensions of PGR activities in India

Survey and collection : Survey and collection of germplasm in the country began at the onset of this century. Initial efforts were confined to need based, limited activity at the regional plant improvement centres or state agricultural colleges, till the late forties. The nucleus unit provided in 1946 at the Botany Division, Indian Agricultural Research Institute (IARI), New Delhi undertook specific activities on germplasm augmentation through exploration, collection and exchange. The period between 1946-1976, i.e., till the inception of the NBPGR, has witnessed several national and international collaborative explorations in the country, fetching a sizable collection of over 31,225 germplasm accessions of various agri-horticultural and other economic plant species. The pace of collection activity particularly increased with the inception of NBPGR, collecting, 1,41,578 samples from over 602 missions.

The number of species collected so far may not cover the entire available list of 168 cultivated plant species prevailing in the country and, accordingly, the relatively less common, underutilized and orphan species, horticultural and floricultural crop plants, medicinal & aromatic plants, aquatic plants, forage grasses and legumes, multipurpose/agroforestry tree species etc. need further attention of the collectors. At the same time, the still prevailing diversity of major crops in different remote and tribal pockets also needs to be revisited for collection, conservation and sustainable use to provide a continuous support to national food security programmes. Similarly, the collection and conservation of vegetatively propagated horticultural plant species and other non-orthodox seed species also requires appropriate attention.

Germplasm introduction and exchange and plant quarantine : Introduction of exotic crop species diversity is important for development of agriculture and improvement of varieties. The NBPGR provides a single window mechanism of germplasm exchange with other countries. It has contributed significantly to this area of PGR as a national service. Exchange of germplasm has been done with 82 countries and 8 international agricultural research centres. More than 12.00 lakh samples of improved varieties, parental lines etc. have been introduced and about 2.25 lakh sample of different crop species supplied. In order to check the introduction of disease, insect-pests and obnoxious weeds plants, quarantine checks are carried out for research materials as a national responsibility. Over 60,000 seed introduced every year are checked and issued phytosanitary certificates.

Germplasm characterization and evaluation: Systematic germplasm characterization and evaluation provides information about the identity/uniqueness of accessions and basic information to help promote its utilization in plant improvement programmes. The Bureau evaluates each year over 50,000 accessions of cereals, pseudocereals, legumes, oilseeds, millets, vegetables, fruits, fibre crops and wild relatives of crop plants at its headquarters and the regional stations. Over 1,24,000 germplasm accessions of various crops collected and augmented through introductions have been characterized, evaluated and maintained at different NBPGR centres.

In order to facilitate effective utilization of plant genetic resources it is important that these are evaluated for different morpho-agronomic attributes, resistance against biotic/abiotic stresses, chemical and biochemical traits and promising genetic stocks with potential genes or rare gene combinations are isolated/identified. At the same time, there is a strong need to validate the identity of accessions in case (s) of need. The NBPGR has, therefore, developed adequate research base for characterization of accessions at biochemical and molecular levels employing techniques like isozyme profiling, RFLP, AFLP and RAPD. Efforts are underway to develop and employ multilocus DNA probes for DNA fingerprinting of varieties and also single locus probes for screening available collections for detecting genotypes possessing desirable traits or co-adapted gene complexes.

Documentation for sustainable use

The evaluation and characterization information at the NBPGR has been documented and 71 crop catalogues brought out for use by the breeders, geneticists, biotechnologists and other interested users. It is obvious that the sustainable use of conserved genetic resources is effectively regulated with appropriate documentation and information management. Although the holdings of international/national gene banks have been often reported by the FAO, the International Plant Genetic Resources Institute (IPGR) and the System Wide Genetic Resources Programme of the Commonwealth Group Centres (SGRP) and it is evident that computerization of data has been done to a considerable extent, yet such information base (s) are by far inadequate. A lot more is required to be done in terms of planning and standardization of database globally, in particular for the National Gene Banks, rationalization of data, data input and dissemination for germplasm use.

PGR conservation

The conservation of PGR for their sustainable use and for posterity is obviously important. It involves both *in situ* as well as *ex situ* approaches. The in situ conservation (in natural habitats) protects continued evolutionary development under natural selection pressures and, thereby, promotes fitness of species. However, it does not provide safeguard in face of some unforeseen natural calamities. On the other hand *ex situ* conservation ensures safe conservation of existing genetic variability by maintaining/preserving it away from natural habitats in genebanks/field repositories. It ensures all weather availability of PGR for their sustainable use although it minimizes the further evolutionary processes. The most common *ex situ* conservation approach for orthodox seed samples comprises their long-term conservation in genebanks at -20°C. Other approaches, namely, cryopreservation (conserving the samples of seeds, including non-orthodox (recalcitrant) seeds, embroys, embryonic axes and pollen grains in liquid nitrogen at -196°C), *in vitro* conservation (by using tissue culture techniques for preservation of clonally propagated materials) and field repositories for tree/vegetatively propagated species are also adopted depending upon the characteristics/propagules of the species. Now, conservation as DNA Banks is also attracting attention.

Systematic long term conservation activities began at the NBPGR in the year 1983 with the commissioning of first built-in cold storage vault with the holding capacity of 30,000 accessions. Subsequently, four more modules were added to the genebank between the years 1986 to 1990, increasing the total holding capacity to 2,00,000 accessions and 13 new modules in 1996 that further increased the capacity to 10,00,000 accessions. In addition, a cryobank with holding capacity of a quarter million samples and an *in vitro* repository for tissue culture raised materials are available at the NBPGR.

The National Genebank compares very well with similar facilities developed by the most advanced nations in terms of both the technical standards as well as the size of germplasm holdings. The present holdings of 1,68,293 seed accessions in long-term conservation have been assembled over the years at an average rate of 1,000-1,500 accessions per year. In addition, cryo-preservation protocols have been standardized for different plant species and more than 1,400 accessions belonging to 50 species of 35 genera of small seeded plants have been conserved in the cryobank and nearly 880 accessions of 45 different species have been conserved using in vitro.

Plant conservation strategies

Medium term conservation facilities are important for maintaining active collections for sustainable use. Two modules have been kept exclusively to meet these needs at the NBPGR headquarters to manage active collections/material in transit for the long term conservation and 11 medium term conservation modules have also been provided to various National Active Germplasm Sites (NAGS) to help conserve their active collections effectively.

It is important to highlight that the pest free conservation of PGR is important to avoid perpetuation of the existing disease/pests, including their prevalent races, in the long term.

PGR policy areas

Another dimension that has been added through the recent global developments relates to the PGR policy areas. These include, I) PGR introduction and exchange, ii) Germplasm collecting and transfer, iii)

Promoting conservation and sustainable use of PGR, iv) Access to PGR on prior informed consent (PIC) and mutually agreed terms (MAT,v) Material Transfer and Material Acquisition Agreements (MTA/MAA), vi) Equitable sharing of benefits accrued from use of PGR , vii)Validation of accessions and evidence of properiety, viii) Bioprospecting, ix) Transgenics/Genetically Modified Organisms (GMOs) and Biosafety, and x) PGR literacy, mass awareness and agricultural human resource development (AHRD). Generating mass awareness along with collection of such valuable/rare resources should attract a high priority attention.

The global developments, viz., Convention on Biological Diversity (CBD), Global Plan of Action (GPA) and FAO Undertaking on PGR for Food and Agriculture have given impetus to fully understand the implications of agro-biodiversity - an essential component of our total biodiversity. These areas need to be systematically and scientifically attended to for their academic, socio-political and legal implications. In addition, the implications of the Trade Related Intellectual Property Rights (TRIPS) of the World Trade Organization (WTO) and the Plant Breeders Rights of the Union of Protection of New Plant Varieties (UPOV) have their distinct impact in the PGR area which should be well studied to find solutions. These areas have been covered through direct subject matter input or by organizing dialogues/workshops/training programmes/ meetings so as to formulate appropriate strategies and programmes. Subject matter input is highly required for the drafting of PVP & FR and national biodiversity legislations. A pro-active role includes sensitizing different stakeholders and the academic societies for recommending, planning and implementation of PGR policies. It envisages to respond to the natural calls and capitalize on its initiatives to strengthen the PGR area within the agricultural research of the nation.

About NBPGR

The need for a strong institutional mechanism to deal with PGR in India has been strongly felt in view of the foregoing discussions. Accordingly, the necessary mechanism has been provided in the country by the Department of Agricultural Research and Education (DARE) and the Indian Council of Agricultural Research (ICAR). Under the set up, the NBPGR is a national institution of the ICAR, dealing with collection, conservation, characterization and utilization of plant genetic resources. Located at New Delhi, the NBPGR has four PGR administrative Divisions-Germplasm Exploration and Collection, Germplasm Evaluation, Plant Quarantine and Germplasm Conservation. In addition, different PGR administrative units namely, Germplasm Exchange Unit, Cryopreservation and Tissue Culture Conservation Unit and Project Policy Planning and Bio-informatics Unit, National Herbarium of Cultivated Plants, Library, Experimental Farm, Specific Project based units (National Agricultural Technology Project - NATP), etc. are functioning at the NBPGR. One AICRP on Underutilized crops and a National Research Centre on DNA Fingerprinting are also located at the NBPGR. Besides, it has 11 Regional Stations to support its activities in different agro-climatic conditions.

The IN-PGS

NBPGR, the custodian of the country's agro-biodiversity, has grown considerably during the past two decades to meet the fast changing and expanding mandate responsibilities. Entrusted with the responsibility to plan, undertake and coordinate activities and services related to plant genetic resources (PGR), the NBPGR also functions as the nodal organization for exchange, collection, plant quarantine, conservation and utilization of (PGR) that maintains linkages with over 30 National Active Germplasm Sites (NAGS) constituting the Indian National Plant Genetic Resources System (IN-PGRS). As core of the IN-PGRS, it has acquired many-folds strength in various PGR related areas. The national system is estimated to maintain an active germplasm/working collections holding of over 2.00 lakh accessions of various agri-horticultural plant species in the National Active Germplasm Sites (NAGS) constituting the Indian National Plant Genetic Resources System (IN-PGRS). As core of the IN-PGRS, it has acquired many-folds strength in various PGR related areas. The national system is estimated to maintain an active germplasm/working collections holding of over 2.00 lakh accessions of various agri-horticultural plant species in the National Active Germplasm Sites (NAGs) and the NBPGR's network of regional stations maintains nearly 1.25 lakh accessions. The National Genebank is one of the excellent facility in Asia with *ex situ* storage capacity of one million seed samples and a holding of nearly 1,69,000 accessions up to June, 1998. Besides, the system provides a cryobank at NBPGR that maintains over 1400 accessions of orthodox and recalcitrant seed samples belonging to 75 genera and 90 species in addition to pollens and encapsulated shoot tips/meristems. The tissue culture bank holds more than 900 accessions of various horticultural, roots and rhizomatous, medicinal and aromatic plants, other commercial plants and wild species. Field repositories at the NBPGR network stations include tree plant species, spices and roots and rhizomatous plant species. NBPGR has provided required background input and assistance to the DARE and the Ministry of Environment and Forests for establishing the first citrus gene sanctuary in the country and is poised to develop some on farm conservation model on a limited/research scale.

The system is thus well organized to implement/effect germplasm conservation for sustainable use as per the requirements of the CBD. The NBPGR has an added strength by way of its capabilities for imparting training and human resource development besides a well organized mechanism of PGR services.

Some major issues which require further national level attention in the IN-PGR System are as follows:

i) Inventorization and proper documentation, patenting of indigenous knowledge, products, novelties in horticultural plants, processes and techniques. The cases of legal battle that arose in respect of neem and turmeric patents in the USA are now well known. In later case, the patent could be withdrawn only because the case was nicely presented by the Indian Government along with the documented records beginning right from ancient times.

ii) There is necessity to reorient our collection and exploration programmes to capture valuable traits or genes from hitherto unexplored and very remote areas. More emphasis should be given on underutilized and unexploited species as well as wild forms and relatives of crop plants.

iii) Conservation of germplasm in the National Genebank especially with reference to NAGs has been receiving the lowest priority in the country and this draws out attention for this otherwise highest priority action. Germplasm evaluation for specific attributes should be carried out before longterm conservation to make it more meaningful and useful. Serious thought must be given to conserve useful materials from country's biotechnology laboratories at the National Repository of the Bureau. Realizing the scope and significance of the traditional agro-ecosystems, there is need to evaluate, regenerate and conserve *ex situ* most of the agro-biodiverse resources in the country. The unmodified traditional agro-ecosystem provides better conditions for co-evolution of host and parasite and the general adaptability. *In situ* onfarm conservation of agro-biodiversity needs to be debated and discussed widely to evolve a national consensus on the issue.

iv) NBPGR has supplied the germplasm through exotic/inland exchange to the tune of 20 to30 thousands annually to various institutes, SAUs research centres, private research bodies or to individuals, but none in return, provided the feed back. The germplasm was hardly considered as a national wealth and as a result good material was not shared in majority cases; rather it was lost whenever the mentor of a programme left the particular institute/organization. The utility of germplasm accessions in different crops has not been established or documented at different research centres. At the same time, there should be readiness in sharing the good and useful germplasm among the concerned, keeping in mind the national interests.

v) Communication with partners, users and supporters of IN-PGRS must be improved to ensure quick response. There had been cases and also presently there can be cases where people have been bringing/taking the germplasm (clone or seed) from/to abroad, without going through established legal procedures leading to several unanticipated/phytosanitary problems. This may be partly due to ignorance and partly due to negligence of the system. Time is ripe now to think and come out with a National Policy on Exchange of genetic resources.

vi) National survey to spot out novelties in fruits, vegetables or other crops needs to be carried out and such materials must be registered. We must evaluate/screen and register the germplasm lines in different crops for their usefulness for various stresses, value addition and crop diversification. Evaluation of the unevaluated should be given high priority in future programmes. Public awareness about the genetic resources needs input from all the users and cooperators. Each partner must devote some time in creating public awareness for registration of valuable germplasm whether with an individual or community.

vii) The Human Resources Development, associated with the PGR system must receive priority to improve their working caliber.

viii) Pre-breeding and germplasm enhancement must be accorded the highest priority in order to facilitate breeding of improved varieties to usher a new era.

ix) Developing our National Data Base Management System should be a priority action.

National Linkages

The NBPGR collaborates with the Plant Protection Advisor, Government of India, under the powers delegated to the Director, NBPGR for quarantine of incoming and outgoing germplasm for research purpose. As mentioned earlier, the National Bureau of Plant Genetic Resource (NBPGR/ICAR) is a designated nodal national agency for exchange of plant material, this national responsibility/authority is delegated to the NBPGR as per Destructive Insects and Pests Act (DIP) Act, 1914 and Plants, Fruits and Seeds (Regulation of Import into India) (PFS) order, 1985, 1989 (Revised). The Director, NBPGR has been notified as the competent authority to regulate into India seeds/plants to be imported for research purposes, having jurisdiction for the entire country (vide Govt. of India Notification No. 8-4/87-PP.I dt. 27.3.90 under sub-clause (a) of clause (2) of the Plants, Fruits and Seeds Order, 1989.

The system of import of specific crop species germplasm is further regulated within the system wherein requests for particular crops are routed to Director, NBPGR through Directors of the respective ICAR crop based institutes.

Crop	Institute
Coconut seeds and plants (all *Cocos* species)	Director, Central Plantation Crops Research Institute, Kasaragod --671 124.
Coffee, plant, seeds (all species of *Coffea*)	Director, Central Coffee Research Institute, Chikmagalur (Karnataka)
Cotton seeds (only seeds can be imported) (all species of *Gossypium*)	Director, Central Institute of Cotton Research, Nagpur - 440 001.
Forest seeds (all species of *Pinus ulmus* and *Castanea*)	Director, Biological Research Institute, Forest Research Institute, New Forest Post, Dehradun or any organization under Central or respective State Government.
Potato	Director, Central Potato Research institute, Shimla - 171 001
Sugarcane (all species of *Saccharum*)	Director, Sugarcane Breeding Institute, Coimbatore - 641 007.
Tobacco (all species of *Nicotiana*)	Director, Central Tobacco Research Institute, Rajahmundry - 533 105.

Similarly, for importing transgenic material, the requests are routed to Director, NBPGR through Advisor, Department of Biotechnology (DBT), Ministry of Science and Technology, New Delhi. The said authority has been authorized to grant permission to import transgenic material for research use vide Govt. of India Notification No. GSR 1067 (E) dt. 5.12.89.

Further, the import seed/planting material is prohibited from the following countries indicated against each crop due to negative quarantine implications, under the PFS order, 1989. (Table. 2).

The NBPGR has active collaboration with Ministry of Environment & Forests. The first gene sanctuary on citrus genetic resources has been established in the Nkrek Biosphere reserve in Meghalaya. It has undertaken several projects/activities of mutual interest in common with the MoEF. The NBPGR has provided subject matter input at different stages of formulation of draft for the National Biological Diversity Legislation and has been designated in anticipation as a National Biodiversity Repository. In order to present the Indian case on agricultural biodiversity in the Conference of Parties (CoP) to the CBD, the NBPGR was represented in the country delegation in its fourth meeting held at Bratislava during May, 1998.

The NBPGR has developed close linkages with the Department of Biotechnology, which supported the National Plant Tissue Culture Repository to carry out work on *in vitro* conservation and cryopreservation of germplasm. Also, the two organizations are actively collaborating on the issue of regulation of exchange of transgenic/GMOs.

Germplasm Advisory Committees (GAC) focus on specialized crop (s) group of crops to advise the Bureau regarding the status of germplasm holdigns, collecting and evaluation needs, gaps and shortfalls in storage and management, as well as sustained utilization of the germplasm materials. The Committees also advise on the introduction of special germplasm required for crop breeding improvement from other countries and from the IACRs. The contribution of these committees is yet another milestone in NBPGR's efforts towards organizing a strong national PGR system linked effectively with crop and regional institutions and organizations.

The national coordination is accomplished through associations and linkages with 30 major crop - based ICAR institutes,

Table 2. List of countries where from specific crop species are prohibited to introduce.

Crop	Countries from where import is prohibited
Cacoa and all species of the family Bombaceae and Sterculiaceae	West Indies, Africa, Sri Lanka
Coffee beans	Sri Lanka, Africa, South America
Rubber (all species of *Hevea*)	America, West Indies
Sugarcane (all species of *Saccharum*)	Fiji, New Guinea, Australia, Philippines
Argentina, Peru	

agricultural universities, research foundations and non-governmental organizations (NGO's) and other stakeholders in the area of bio-diversity and plant genetic resources. It assists crop scientists in India and provides requisite support for achieving their crop improvement and production targets by providing them appropriate, useful and new germplasm resources.

International collaborations

CGIAR institutes: Besides operating network of active germplasm sites in the country, the Bureau also actively collaborates with international agricultural research centres (IARCs). The NBPGR collaborates efficiently and effectively with International Crops Research Institute for the Semi Arid Tropics (ICRISAT) for joint exploration and multi-location evaluation on chickpea, pigeonpea, groundnut, sorghum and pearlmillet - the five mandate crops of ICRISAT safety duplicates of Pigeonpea (ICRISAT) and lentil (ICARDA) are also maintained here. Considerable exchange of germplasm takes place between NBPGR and ICARDA, IRRI, CIMMYT, INIBAP and IJO (Bangladesh).

Bilateral programmes: ICAR (NBPGR) has memoranda of understanding/bilateral agreements with several nations. Collaboration in various plant genetic resources activities is carried out through involvement of NBPGR with over 82 countries, in the world. Prominent among these are USA, UK and other European countries, Mexico, Israel, Australia, Russia, New Zealand, Iran, Turkey and Zimbabwe.

IPGRI: The International Plant Genetic Resources Institute (IPGRI) has played significantly to the Bureau's efforts by offering expertise, training and funding for research. IPGRI office for South Asia is located in the NBPGR campus and there is an active collaboration between them based on biennial work plan. In addition to supporting joint exploration and collection programme in this region, the IPGRI helps in funding projects related to plant genetic resources. Under the MoU for scientific and technical cooperation between ICAR and IPGRI, the International Network for Improvement of Banana and Plantain (INIBAP), a programme of IPGRI, a work plan of cooperation has recently been agreed. INIBAP proposed to provide virus tested category of banana germplasm comprising popular varieties, hybrids, disease and pre-resistant cultivars for conservation and dissemination, paving way to INIBAP/ITC from directly serving the heavy demand from scientists and research institutions in India. Additionally, INIBAP will also help NBPGR with the virus indexing of its *in vitro* collection by providing assistance in obtaining appropriate antisera and protocols.

Indo-USAID PGR Project: The Indian National Plant Genetic Resources Programme has gained substantially from the system adopted by leading nations in this field. A Memorandum of Understanding was signed in 1988 between NBPGR and US Agency for International Development (USAID) to undertake nine years Indo-US PGR Project with a budget provision of US $ 27.95 million. USAID provided US $ 18.0 million while the Government of India had contributed the rest. The project was implemented to enhance NBPGR's infrastructural facilities and professional competence to enable it to play an enhanced role at the regional and international level. The project had helped in strengthening research linkages between NBPGR and US National Plant Genetic Resources system as well.

Indo-UK Project on PGR: ICAR/NBPGR also signed an MoU in 1989 with the British Council for funding by the U.K-Overseas Development Administration (ODA) to strengthen the network of regional stations with an allocation of 5 million US dollars. The project aims to provide medium term storage facilities, other essential equipments and training .

Outlook for the future

The NBPGR proposes to play a very dynamic role in the South and South-East Asian regions by promoting plant genetic resources activities covering collection, conservation, characterization and exchange under high plant quarantine standards and by sharing know-how in this area. Transfer of technologies in several other specialized areas of conservation of genetic resources through short term consultancies or by organizing training courses on a regular basis with funding support from FAO/IPGRI/GEF/ IDRC/USDA are proposed. It is also envisaged to contribute on policy matters concerning PGR through participation in negotiations aimed at harmonizing the text of International Understanding of PGRFA within provisions of the Convention on Biological Diversity.

Looking a decade beyond 2000 AD, the NBPGR will be a leading National PGR organization with comprehensive network system that will be comparable to the most advanced genetic resources programmes. Under NATP, the NBPGR proposes to undertake 600 explorations within 5 years time period with the help of 73 collaborators viz., ICAR institutes, State Agricultural Universities, Voluntary Organizations and non-governmental organizations (NGOs). This work is slated to be accomplished in mission mode manner. The landraces will be collected from different agro-eclogical zones, evaluated and conserved in the National Gene Bank for posterity. Public sector and non-government and private organizations may come together to establish a consortium to share genetic resources on committed contribution basis. *Ex situ* conservation, on-farm conservation of landrace diversity and *in situ* conservation will be judiciously integrated. *In vitro* and cryopreservation techniques will be refined and these will find increasing use in germplasm collections determined through critical of germplasm holdings is expected to progress rapidly on prioritized species and group of crops. Isozyme profiles and DNA Fingerprinting will be used for establishing unique identity of genotypes and this information along with video images of plant samples will be available in the computer database. Core subsets of primary germplasm collections having diverse genes for resistance/adoption/preferred specific traits will become available in priority selected crops. Quarantine services will be more efficient because of increasing use of ELISA and DNA probes for early detection of viruses and viroids in high risk seed material/plant propagules. A new activity during the coming decade is likely to be the rejuvenation and evaluation of seed samples kept under long-term storage. Thus plant genetic resources activities are going to enhance manifold. The access to PGR needs to be regulated keeping in view the Sovereign Rights of States and with the enforcement of new legislations relating to Plant Variety Protection (PVP) and TRIPS. Role has also to be played to regulate/oversee/monitor the influx of new patented material and extend help in resolving disputes.

Thus the component of Indian National Plant Genetic Resources System will go a long way in the conservation of immensely valuable genetic diversity required for sustained production & food security and thus alleviation of hunger and poverty.

Epilogue

The world's biological diversity is boundful and is full of valuable resources. The earth's biodiversity - its ecosystem, species and genes - are the product of over 3000 million years of evolution. Can we put a monetary value on this genetic pool?. One of the reasons why nothing/negligible has been done about gene loss is that national economic system and policies sometimes are not fully aware of the IN-PGRS probably ensures the conservation of biodiversity in the face of extensive destruction of plant rich habitats, species extinction and genetic erosion. There has been an international consensus on this point for more than 2 decades starting with United Nations Conference on Human Environment in 1972. The creation of IBPGR now IPGRI, the adoption of FAO Conference in 1983 of the International Undertaking on Plant Genetic Resources and establishment of Inter-governmental Commission on Plant Genetic Resources and documents like "Environmental Perspective to the year 2000 and Beyond", "the report of the World's Commission on Environment & Development", "Caring for the Earth : A strategy for sustainable living" and "Agenda 21 of the UN Conference on Environment & Development are the landmarks in importance of protecting biological diversity.

The important point is that, if conservation is to be given the priority it needs, all the institutions concerned must coordinate their efforts. Genetic resources underpin, and are threatened by virtually every area of human activity. Only the broadest possible cooperation by user agencies, NAGS and other institutions/agencies engaged and interested in PGR activities can help sustain/strengthen the system.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 16- 44, 1999

Genetic diversity of major spices and their conservation in India

P. N. RAVINDRAN

Indian Institute of Spices Research
Calicut – 673 012, Kerala.

Abstract

India is known as the Land of Spices. About 52 spices are grown in the country at present. Export of spices earned Rs.1352 crores worth of foreign exchange to the country during 1998-99. Among the major spices, black pepper and cardamom originated in India having their centre of diversity in Western Ghats. At present India is a major production centre of black pepper, cardamom, ginger, turmeric and various seed spices such as coriander, cumin, fennel, celery etc. India has remarkable diversity for many of these spices. This paper gives an overview of diversity of major spices, problems in their conservation and future needs.

Introduction

Webster's Dictionary defines spices as 'natural plant or vegetable products or mixtures thereof, in whole or ground form as are used for imparting flavour, aroma and piquancy to and for seasoning food'. The terms condiments and spices are used synonymously and the International Organization for Standardization (ISO) does not differentiate between them. In India, spices were used from ancient times and the literature of that time has many references on the use of saffron, turmeric and sesame. Spices were major articles of trade between India and the Middle East in the ancient and medieval times. They found their way to the Western Europe through Arab traders. The Western powers were vying one another to establish a trade route to the legendary Land of Spices - India. This finally led Vasco-da-Gama to land on the Malabar coast on May 20, 1498- an event that changed the very course of Indian history in the centuries followed. The Malabar coast of peninsular India was the nerve centre of spices trade, a tradition which the region retains even now.

Kerala region of the Malabar coast of India has the unique distinction of contributing both the 'King' and the 'Queen' of spices- back pepper and cardamom - to the world. Both have originated in the tropical evergreen forests of the Western Ghats, where wild pepper and cardamom are still common in many pockets. The depletion of forest area, the rampant destruction of the forest trees and undergrowth, the changes in the ecological conditions etc., led to sharp decline in the population of wild pepper and cardamom and their related taxa. In the case of ginger and turmeric, the South Asian region is believed to be the centre of origin, and they were under cultivation from ancient times, and India continues to be a major producer and exporter of these crops. In fact, 'Cochin ginger' and 'Alleppey turmeric' are synonymous with the highest quality produce in these spices. Apart from these major spices, there are other more recent introductions - but adapted to the Kerala conditions - such as nutmeg, clove and cinnamon. The spices grown in India are given in (Table 1). Spices are grown in all the states of India, some states grow many spices, others only a few. (Table 2). Spices cultivation play an important role in the economy of the country. The annual production of spices in the country is worth around Rs.7000 crores, and the annual export is around Rs.1300 crores (Table 3) (Rs.1352 crores in 1997-98). Spices rank fifth in the export earnings from agricultural products.

Black pepper *(Piper nigrum* L.)

Black pepper is the dried mature fruit of the perennial climber *Piper nigrum* L., a native of the humid tropical forests of the Western Ghats from where it has spread throughout the tropics. Black pepper belongs to the genus *Piper* and family Piperaceae. Over a thousand species are included in this genus, out of which about 110 are of Indian origin. In India, the north-eastern region and the south-western (Western Ghats) regions are recognised as two independent centres of distribution of *Piper*. The earliest record of description of *Piper* spp. of the Kerala region was by Van Rheede (1678) in his *Hortus Indious Malabaricus*, in which he described five types of wild peppers including black pepper and long pepper. The first major study on the Indian *Piper* was by Hooker (1886) in his Flora of British India. He divided the genus into six sections. Rama Rao (1914) in his Flowering Plants of Travancore listed 14 species of *Piper* from the Western Ghats. Fischer (1921) described six species from Anamalai Hills. The most authentic floristic study of south Indian *piper* was that of Gamble (1925) who in his Flora of Presidency of Madras,

Table 1. Spices grown in India

Botanical name	Part used	English common name	Family
Acorus calamus L.	Rhizome	Sweet-flag	Araceae
Allium cepa L.	Bulb	Onion	Alliaceae
Allium sativum L.	Bulb	Garlic	-do-
Alpinia galanga (L.) Wild	Rhizome	Greater galanga	Zingiberaceae
Amomum subulatum Roxb.	Fruit and seed	Greater Indian cardamom, Sikkim cardamom, Nepal cardamom	Zingiberaceae
Anethum graveolens L.	Fruit and leaf	Dill seed	Apiaceae
Apium graveolens L.	Fruit	Celery seed	Apiaceae
Armoracia rusticana Gaetn.	Root	Horse-radish	Apiaceae
Brassica juncea (L.) Czernajev & Cosson	Seed	Indian mustard	Brassicaceae
Brassica nigra (L.) Koch	Seed	Black mustard	Brassicaceae
Bunium persicum (Bioss.) *B. fedtsch*			
Capparis spinosa L.	Unopened flower, bud	Caper	Capparidaceae
Capsicum frutescens L.	Fruit	Bird eye chillies or Capsicum	Solanaceae
Capsicum annuum L.	Fruit	Chillies, Paprika, etc.	"

Carum bulbocastanum L.	Fruit	Black caraway	Apiaceae
Carum carvi L.	Fruit	Caraway seed	Apiaceae
Cinnamomum cassia B. & Presl.	Bark, leaf	Cassia, China or Cassia	Lauraceae
Cinnamomum tamala (Buch. Ham) Nees & Ebermaier	Bark and leaf	Cassia, Indian	Lauraceae
Cinnamomum verum B. & Presl.	Bark	Cinnamon	Lauraceae
Coriandrum sativum L.	Leaf and seed	Coriander	Apiaceae
Crocus sativus L.	Stigma	Saffron	Iridaceae
Cuminum cyminum L.	Fruit	Cumin seed	Apiaceae
Curcuma longa L.	Rhizome	Turmeric	Zingiberaceae
Elettaria cardamomum (L.) Maton	Fruit and seed	Cardamom	Zingiberaceae
Foeniculum vulgare P.Miller	Fruit	Fennel	Apiaceae
Garcinia gummi-gutta (L.) N.Robson.	Pericarp-lobes	Camboge	Clusiaceae
Garcinia indica (Thouars) Choisy	Peel of fruit (cured)	Kokum	Clusiaceae
Hyssopus officinalis L.	Leaf	Hyssop	Lamiaceae
Juniperus communis L.	Berry	Juniper berry	Cuppressaceae
Mentha arvensis L.	Leaf	Japanese mint	Lamiaceae
Mentha spicata (L.)	Leaf	Spear mint, Garden mint	Lamiaceae
Mentha piperita L.	Leaf	Peppermint	Lamiaceae
Murraya koenigii (L.) C. Sprengel	Leaf	Curry leaves	Rutaceae
Myristica fragrans Houttuyn	Aril	Mace	Myristicaceae
	Kernel	Nutmeg	"
Nigella sativa L.	Fruit	Black cumin	Ranunculaceae
Ocimum basilicum L.	Leaf	Sweet basil	Lamiaceae
Origanum vulgare L.	Leaf and flowering top	Marjoram	Lamiaceae

Origanum majorana L. (*Majorana hortensis* Moench)	Leaf and Flowering top	Sweet marjoram	Lamiaceae
Papaver somniferum L.	Seed	Poppy seed	Papaveraceae
Petroselinum crispum (Miller) Nyman ex A.W.Hill	Seed	Parsley	Apiaceae
Pimenta dioica (L.) Merill	Fruit and leaf	Pimento or allspice	Myrtaceae
Pimpinella anisum L.	Fruit	Aniseed	Apiaceae
Piper nigrum L.	Fruit	Black pepper, white pepper	Piperaceae
Punica granatum L.	Seed (dried with flesh)	Pomegranate	Punicaceae
Rosmarinus officinalis L.	Leaf	Rosemary	Lamiaceae
Salvia officinalis L.	Leaf	Sage	Lamiaceae
Saturega hortensis L.	Stem, leaf and flowering top	Savory	Lamiaceae
Sinapis alba L. Boissier	Seed	White mustard, yellow mustard	Brassicaceae
Tamarindus indica L.	Fruit	Tamarind	Cesalpiniaceae
Thymus vulgaris L.	Leaf and flowering top	Thyme	Lamiaceae
Trachyspermum ammi (L.) Sprague ex Turrill	Fruit	Bishops weed or Ajowan	Apiaceae
Trigonella foenum-graecum L.	Seed	Fenugreek	Fabaceae
Vanilla fragrans (Salisburry) Ames [Syn *Vanilla planifolia* Adrews]	Pod	Vanilla	Orchidaceae
Zingiber officinale Roscoe	Rhizome	Dried ginger	Zingiberaceae

Table 2. Major spices growing states in India and their share in spices production (share in percentage)

State	Black Pepper	Large cardamom	Carda mom	Ginger	Turmeric	Coria-nder	Cumin	Fennel	Fennu-greek
Andhra Pradesh	--	--	--	3	39	10	--	--	--
Karnataka	1.5	--	24	4	11	4	--	--	--
Kerala	97	--	67	23	2.5	--	--	--	--
Gujarat	--	--	--	1	--	--	63	90	--
Himachal Pradesh	—	—	—	2	—	—	—	—	—
Meghalaya	--	--	--	20	--		--	--	--
Mizoram	--	--	--	4	--	--	--	--	--
Maharastra	--	--	--	1	5	--	--	--	--
Madhya Pradesh	--	--	--	2	--	18	--	--	--
Orissa	--	--	--	9	8	5	--	--	--
Rajasthan	--	--	--	--	--	50	37	10	99
Sikkim	--	83	--	6	--	--	--	--	--
TamilNadu	1.5	--	9	--	11	10	--	--	--
Uttar Pradesh	--	--	--	1	--	1.5	--	--	1
West Bengal	--	9	--	9	4	--	--	--	--
Assam	--	--	--	--	6		--	--	--
Bihar	--	--	--	1	2.0	--	--	--	--
Tripura	--	--	--	--	1.0	--	--	--	--
Arunachal Pradesh		--	--	9	--	--	--	--	--

Source: Area and production of spices in India and the world - 1997 by Spices Board, Ministry of Commerce: Govt. of India

Table 3. Export of spices from India [Qty in MT: Value in Rs. Lakhs]

Commodity	1994-95		1995-96		1996-97	
	Quantity	Value	Quantity	Value	Quantity	Value
Black pepper	37264	23664.19	26346	19647.09	47770	41652.25
Cardamom (S)	257	762.61	500	1239.55	240	921.30
Cardamom (L)	1293	812.74	1784	1234.95	1450	1047.40
Chillies	20096	5711.63	56073	19414.78	51900	20964.25
Ginger	12022	1673.03	18191	3828.73	28350	5723.70
Turmeric	28286	4517.96	27376	4607.07	21600	5470.95
Coriander	10702	1793.84	11308	2200.36	12700	3080.55
Cumin	5618	2449.65	3895	1733.85	4500	2508.45
Celery	2601	777.28	2678	624.67	3400	702.10
Fennel	2029	581.56	2602	755.59	3000	1369.80
Fenugreek	7956	1224.97	15135	1874.07	8100	1074.30
Other seeds	2338	486.86	2309	502.18	2500	604.50
Garlic	633	122.87	3776	490.03	3780	628.00
Other spices	16523	2954.61	23136	3980.42	20920	4373.00
Curry powder	4135	1443.27	4131	1698.25	4250	1823.15
Mint oil	1583	4356.78	1242	4058.05	2120	10490.00
Spice oleoresins & other oils	1672	8676.68	1715	10699.45	2020	15566.70
Grand total	**155008**	**62010.53**	**202197**	**78589.09**	**219400**	**118000.40**

described 14 species of *Piper* with keys. The other floristic enumerations are those of Saldanha and Nicholson (1978), Rao and Razi (1981) and Ravindran(1990). New taxa were reported by Ravindran *et al.* (1990) and Nirmal Babu *et al.* (1993a). The species diversity of *Piper* in South India is given in Table 4. The species of *Piper* are one of the most affected by deforestation. Many of the taxa are now confined only to a few locations and may soon be extinct, if not collected and conserved. *P. barberi, P. hapnium, P. silentvalleyensis, P. wightii* and *P. schmidtii* are extremely rare and are confined only to a few restricted niches.

Table 4. Species diversity of *Piper* in Western Ghats, the centre of diversity for black pepper.

Species	Chromosome No.	Remarks
P. argyrophyllum	2n: 52	A species occurring at medium elevations at the peripheral areas of evergreen forests, becoming rare now.
P. attenuatum	2n: 52, 104	A common wild *Piper* sp. occurs in low and medium elevations.
P. barberi	2n: 52	Endangered species – once included in the Red Data Book. First reported in 1912. First collection of female plant by IISR, Calicut from Tinnaveli forests. Species was re-described.
P. betle	2n: 32, 64,195 etc.	A collection was made from the forests, though this species believed to be not occurring under wild conditions.
P. galeatum	2n: 52	Occurs at low to medium elevations, bold fruits.
P. hapnium	2n: 52	Very rare, endangered species occurring at low elevations.
P. longum	2n: 26 to 96	Distributed all over India at low elevations, creeping habit.

P. mullesua	2n: 132	A small scandent climber occurring only at higher elevations. The only species having globoid spike.
P. hymenophyllum	2n: 104	Occur at medium to high elevations, the only pubescent species.
P. hookeri	2n: 104	A variant of *P. hymenophyllum*
P. nigrum	2n: 52	Occurs at low to high elevations the most versatile species cultivated, bisexual, monoecious. Dioecious under natural wild conditions.
P. silentvalleyensis		Extremely rare and new species. Only species having bisexual flowers, erect, thin, elongated spikes, minute fruit.
P. schmidtii	2n: 96	High elevation species, occurs at above 1500m
P. sugandhi	2n: 52	New species reported by IISR, Calicut, closely related to *P. nigrum*.
P. sugandhi var. *brevipilis*	2n: 52	A new variety reported by IISR, Calicut.
P. trychostachyon	2n: 52	A medium elevation species resembling *P. galeatum*.
P. wightii	2n: 52	Occurs only at high elevation around 2000m, the pepper of hill tops, Ooty and Kodaikanal.

The chromosome numbers of *Piper*, ranging from 2n=26 to 2n=132, indicate clearly the existence of a polyploid series. All the species studied from South India and Sri Lanka could be traced to a common basic number of x=13 (Jose and Sharma 1985). Kerala accounts for nearly 70% of black pepper cultivation in India followed by Karnataka (22%). Over a hundred cultivars are known to exist, but most of them have gone out of cultivation with the spread of the improved varieties. If not collected and conserved, these land races may be lost for ever. Collection, conservation, cataloguing and evaluation of genetic resources of black pepper is given high priority at Indian Institute of Spices Research (IISR). Systematic surveys of pepper growing areas and the forests of Western Ghats were conducted to collect the existing variability of cultivated and wild *P. nigrum.* At present, the germplasm holding of black pepper at IISR is the largest in the world, consisting of 2969 accessions, comprised of cultivars, wild relatives and genotypes having special characteristics (Table 5). In addition to the germplasm collections maintained at IISR, small collections are also being conserved at the All India Co-ordinated Research Project on spices (Table 6).

Table 5. Status of black pepper germplasm maintained at IISR, Calicut

Species	No. of holdings
Piper nigrum	
a) Cultivated types	
1. Indigenous	650
2. Exotic	3
3. Karimunda selection	213
4. Kottanadan selection	75
5. Intercultivar hybrids	1016
6. OP progenies/cytotypes	120
7. Natural triploid	1
8. Induced tetraploid	1
Total	2079
b) Related taxa :	
P. arboreum	1
P. longum	18
P. betle	12
P. chaba	1
P. attenuatum	44
P. argyrophyllum	34
P. hymenophyllum	19
P. mullesua	6
P. barberi	2
P. wightii	6
P. trichostachyon	12
P. galeatum	15

Contd..

P. sugandhi	2
P. sungandhi var.*brevipilis*	2
P. colubrinum	2
P. magnificum	1
P. schmidtii	2
Undetermined and doubtful taxa	46
c) Wild accessions	665
Total accessions	2969

Table 6. Black pepper germplasm conserved at the All India Co-ordinated Project Centres.

Centre	Cultivars (including exotic)	Wild and related taxa	Total
Pepper Research Station, Panniyur, Kerala	75	120	195
Pepper Research Station, Sirsi, Karnataka	50	15	65
Regional Agricultural Research Station, Chintapalli, Andhra Pradesh	27	19	46
Horticultural Research Station, Yercaud, Tamil Nadu	99	3	102

Intracultivar or intervarietal variability has also been reported in the case of certain cultivars grown extensively. Ratnambal *et al.* (1985) in a study reported much intravarietal variability in morphological and quality characters in case of the cv. Karimunda. Ravindran and Nirmal Babu (1994) have reported variability for morphological and chemical characters in black pepper cultivars. Variability in quality characters among cultivars is also reported by Raju *et al.* 1983. The major quality parametres are the content of essential oil, oleoresin and piperine (Table 7). Gopalam and Ravindran (1986) have categorized the common pepper cultivars into high, medium and low quality classes based on the percentage contents of essential oil, oleoresin and piperine. In spite of such variability for important agronomic characters, resistance to the dreaded *Phytophthora capsici*, (foot rot disease) or to the burrowing nematode or to the virus which causes the little leaf (or mottle disease) is lacking.

Table 7. Variability in chemical quality in pepper. (values on dry weight basis)

Cultivar	Volatile oil % (v/w)	Oleoresin % (w/w)	Piperine % (w/w)	Starch % (w/w)
Arikottanadan	4.7	12.9	4.5	24.6
Arakkulam munda	4.7	9.8	4.4	36.1
Balankotta	5.1	9.3	4.2	25.2
Ceylon	3.7	13.5	7.6	15.6
Cheriyakaniakkadan	3.7	9.0	3.9	24.8
Chumala	2.2	5.4	3.3	46.6
Doddigya	2.5	7.1	2.8	36.0
Kalluvally	3.2	8.8	4.2	31.5
Kalluvally (PTB)	0.4	10.9	4.6	29.0
Kalluvally Type 1	3.0	8.4	5.4	20.7
Kaniakkdan	4.7	11.6	6.0	12.4
Kottanadan	2.5	17.8	6.6	23.4
Karimunda	4.0	11.0	4.4	39.6
Karuvilanchy	3.5	9.7	4.3	27.0
Kumbhakodi	4.5	14.9	7.6	18.2
Kuthiravally	4.5	14.9	5.9	14.0
Munda	4.7	7.0	5.6	22.7
Mundi	3.5	7.5	3.6	23.4
Narayakodi	4.0	10.8	5.4	24.5
Nilgiris	5.5	15.5	6.0	23.6
Palulauta	3.0	7.6	3.6	19.2
Panniyr-1	3.5	9.5	3.6	35.1
Perumkodi	3.0	8.6	4.0	28.8
Perumunda	4.0	8.0	7.4	26.6
Shimoga	2.5	7.2	4.5	17.6
Sullia	4.0	6.8	3.6	20.7
Tmb II	2.5	10.8	5.8	32.6
Uthirankotta	4.7	8.5	3.9	28.8
Vally	2.5	6.5	4.9	16.0

Cardamom (*Elettaria cardamomum* (L.) Maton) and Large Cardamom (*Amomum subulatum* Roxb.)

Cardamom of commerce is the dried fruit of the rhizomatous, herbaceous perennial, *Elettaria cardamomum* (L.) Maton belonging to Zingiberaceae. Willis (1984) included seven species in this genus that is distributed in the Indo-Malayan-Indonesian regions. Mabberly (1987) lists six species. Only one species occurs in India- *Elettaria cardamomum,* and this is the only economically important species. Two botanical varieties were recognized by earlier workers, namely *var.major* and *var. minor* (or var. *cardamomum*). But now var. *major* is treated as a separate species, *E. ensal (Abheyv.)* (=*E. major* Thw.). This is the native cardamom of Sri Lanka. *E. longituba* (Ridl.) Holtt. and *E.aquatilis* are the other species endemic to Malaysia and Indonesia respectively.

Origin of cardamom is not clearly known. Holttum (1950) felt that *E. cardamomum* and the Malaysian *Elettaria* represent parallel development from different points of origin in the *Alpinia* stock. Cardamom has a somatic chromosome number of 2n=48 (Sato 1960, Ramachandran 1969).

Cardamom consists of three morphologically distinct varieties that are distinguishable on the basis of plant type. They are:

i) Malabar : Panicles prostrate, plants of medium size, capsules roundish to oblong

ii) Mysore : Panicles erect, plants robust, capsules greenish and elongated

iii) Vazhukka : Panicles semi-erect (flexuous), plants robust, characters intermediary to those of 'Mysore' and 'Malabar', and is believed to be their natural hybrid.

Cardamom occurs in its native state only in the tropical evergreen forests of the Western Ghats, common in the Silent Valley forests. The domestication of cardamom is a relatively recent event, started only in the 19th century, when the European settlers began large scale clearing of the forests for establishment of plantations of tea, coffee and also cardamom. The wild populations of cardamom gradually declined as a result of the large scale destruction of forest habitats. Conservation of cardamom genetic resources was initiated in the 1960s and now they are being conserved at the Indian Cardamom Research Institute at Myladumpara, Idukki (Kerala) and at the IISR Research Centre at Appangala in Coorg district (Karnataka). Small collections also exist at the Cardamom Research Station at Mudigere (University of Agriculture Sciences, Bangalore), and at the Cardamom station at Pampadumpara under the Kerala Agricultural University. The present germplam holding in India is given in Table 8.

Table 8. Germplasm holdings of cardamom in India.

Centre	Cultivated germplasm	Wild and related taxa	Total
IISR Regional station, Appangala, Coorg, Karnataka	314	13	327
I CRI, Myladumpara, Idukki, Kerala	600	12	612
Cardamom Research Station, Pampadumpara, Idukki, Kerala	72	15	87
Regional Research Station, Mudigere, Chikmagalur, Karnataka	236	7	243

Much variability exists in cardamom with regard to quality characters such as essential oil content, percent of 1,8- cineole and alpha-terperyl acetate in essential oil. Zachariah and Lukose (1992) found that cardamom accessions vary in quality composition as given below (Table 9).

Table 9. Variation in quality composition among cardamom accessions.

Constituent	Range
Essential oil	5.5 - 9.0%
Alpha – terpinyl acetate	34.0 – 52.5%
Linalyl acetate	0.7 - 6.3%
1,8 – cineole	23.0 – 51.0%
Linalool	1.4 - 4.5%
Alpha – terpenol	1.4 - 4.5%
Nerolidol	0.3 – 1.6%

Zachariah *et al.* (1998) also reported variability for quality traits in Wynad selections of cardamom. Variations have also been reported in fruit (capsule) size, shape, leaf and plant pubesence etc. (Madhusoodanan *et al.* 1994).

Large cardamom, is also known as Nepal cardamom, is the dried fruits of *Amomum subulatum*, indigenous to the moist deciduous and evergreen forests of the lower eastern Himalayas. Its centre of origin and diversity is believed to be Sikkim. Large cardamom is the most important cash crop of Sikkim, from where the cultivation has spread out to Nepal, northern hill of West Bengal and Bhutan. India is the largest producer, the major area being in Sikkim. It is grown at altitudes ranging from 900-2000m above msl, at a temperature ranging from 10-30^{0} C, and rainfall of 2000-3000mm.

Genus *Amomum* is represented by large number of species, occurring in India, Malaysia, Indonesia and in many other pacific ocean islands. In India there are two independent centres of distribution for the genus - the north eastern India and the Western Ghats. Eighteen species have been reported from the North East region. Gamble (1926) has described few Species from the Western Ghats, Sabu (1991) has also described some species from the

Kerala region of Western Ghats. Of the various species only large cardamom and *A. aromaticum* (Bengal cardamom) are of economic importance, the later is used by local people for flavoring dishes.

Natural variability is not abundant in large cardamom unlike in other spices. There are three popular varieties (or cultivar) grown in Sikkim. They are *Ramsey, Golsey* and *Sawney*. Ramsey is the most popular, occupying over 60% of the total area, and is more adaptable to higher elevations. In addition other cultivars recognised by local growers are *Ramla, Chivey Ramsey, Garday Seto Ramsey, Ramnag, Madhusay, Seto Golsey, Red Sawney, Green Sawney* etc. *Amomum* has 2n=48 as its chromosome number, though variation has been occasionally reported.

Large cardamom contains about 2% essential oil. The major components of the essential oil are 1, 8 - cineole (65%), terpinine, sabinine, terpenyl acetate, terpineol etc.

The Sikkim Himalayas is facing severe ecological crisis and it is essential to collect and conserve the diversity present in large cardamom in the area. The present germplasm collections are conserved at the Regional Station of ICRI Gangtok, Sikkim. Germplasm collection is also being maintained at the ICAR Research Complex Station at Gangtok.

Ginger *(Zingiber officinale* Rosc.)

Ginger is known to exist only under cultivation and nothing is known about its origin. It was under cultivation in India from time immemorial. Variability for cultivated ginger exists mainly in the north-eastern region of India and Kerala. *Zingiber* is included in the tribe Hedychieae along with other genera such as *Curcuma, Hedychium* and *Kaempferia* (Holttum 1950), and in the series Zingiberae which contains only the genus *Zingiber*. The genus name is derived from the Tamil word *'Ingiver'*, meaning ginger rhizome. The genus is divided into four sections by Baker (1886) and ginger is included in section Lampuzium along with *Z. intermedium* Baker, *Z. griffithi* Baker, *Z. gracile* Jack., *Z. zerumbet* Smith, *Z. cylindricum* Moon, *Z. macrostachyum* Dalz., *Z. spectable* Griff., *Z. casumunnar Thw* and *Z. parishii* Hook.

Baker (1886) described 24 species from the Indo-Malayan region. Fischer (1928) reported seven species from south India including Z. *officinale*. Recently Sabu (1991) described the following species from Western Ghats and adjacent areas.

Zingiber roseum Rosc.

Z. *nimmonii* Dalz.

Z. *wightianum* Thew.

Z. *zerumbet* (L.) Smith

Z. *neesanum* (Graham) Ramamoorthy

(Syn. Z. *macrostachyum* Dlz.)

Z. *cernum* Dalz.

Z. *purpureum* Roscoe

(Syn. Z.*cassumunar* Thw.)

Z. *officinale* Rosc.

The chromosome number of the Genus is 2n=22and all the species so far studied from India have this number. Sato (1960) proposed that the protocaryotype of *Zingiber* is a species with four chromosomes and the present basic number is derived from such species. Ginger is probably a sterile hybrid between two distant species, but survived because of the successful vegetative mode of propagation.

The National Conservatory for Ginger germplasm at IISR, Calicut has 530 accessions, all being maintained in cement tubs for protecting them from diseases. The other centres of ginger conservation are High Altitude Research Station, Pottangi, (Orissa) where 147 accessions are maintained, and the Department of Vegetable Crops of Dr Y.S. Parmar University of Horticulture and Forestry, Solan, (Himachal Pradesh) with 132 accessions. Though variability for yield attributes and quality parameters are reported in ginger (Ravindran *et al.* 1994, Sasikumar *et al.* 1992), none of the cultivars possess resistance to the serious diseases such as *Pythium* rot and bacterial wilt.

Turmeric (*Curcuma longa* (L.) Koening)

Turmeric is believed to have originated in the Indo-Malayan region, and was one of the most ancient spices used by people of India. The history of turmeric is entwined with the history of the Indian culture and also with the religious practices of most tribal people of the country. The processed and dried rhizomes of *C. longa* constitute the spice of commerce. India is the largest producer and exporter of turmeric. The most striking feature of turmeric is the bright yellow colour of the rhizome. Probably this character attracted man, who selected this plant as a source of colour and food. Domestication of turmeric could have occurred in India. Holltum (1950) reported that at least two other species- *C. colorata* Val. and *C. xanthorhiza* Roxb, have equally deep yellow rhizome colour but they never gained any prominence either as spice or as a source of colour.

The genus *Curcuma* is mainly distributed in the Indo-Malayan region and about a hundred species are known. Baker (1886) described 27 species in the Flora of British India. He subdivided the genus into three sections - Exantha, Mesantha, and Hitcheniopsis. The section Exantha consists of 14 species including turmeric and other economically important species such as *C. anguistifolia* Roxb. (Indian arrow root), *C. aromatica* Salisb. and *C. zedoaria* Rosc. From South India, 17 species of *Curcuma* were reported in a recent study (Sabu, 1991) out of which nine are endemic to India (Table 10).

Among the related species, *C. aromatica* is important in medicine and in preparation of toiletry articles. The pale yellow rhizome of *C.aromatica* has a comphor-like odour. *C. amada* (mango ginger) is used as a vegetable. *C. zedoaria.* is a source of starch for tribals in many parts of India.

Collection and conservation of genetic resources of turmeric are pursued actively by IISR, Calicut and NBPGR Regional Station at Trichur. The National Conservatory for Turmeric Germplasm at IISR has currently 730 accessions of turmeric, all maintained in large cement tubs to main-

Table 10. *Curcuma* species from South India

Curcuma longa L.	*C. montana* Roxb.
C. aromatica Salis.	*C. nilgherrensis* Wight
C. amada Roxb.	*C. oligantha* Trimen (*C.oligantha* var.*oligantha; C.oligantha* var.*lutea*)
C. aeruginosa Roxb.	*C. pseudomontana* Graham
C. coriaceae Mnaglay & Saboo	*C. raktakanta* Manglay & Sabu
C. ecalcarata Sivarajan & Indu.	*C. vamana* Sabu & Mangaly
C. haritha Sabu	*C. zedoaria* (Christamann) Roscoe (Syn. *C. zerumbet* Roxb.)
C. inodora Blatter	
C. kudagensis Velayudhan *et al.*	

* Endemic

tain purity. Turmeric germplasm collections are also being maintained at the following centres:

NBPGR Regional Station, Trichur, Kerala - 769

High Altitude Research Station, Pottangi, Orissa - 157

Regional Agricultural Research Station, Jagtial,Andhra Pradesh - 188

Dr. Y.S. Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh - 164

Velayudhan *et al.* (1991) reported 21 different morphotypes and six taxonomic groups is *Curcuma*. Nirmal Babu *et al.* (1993b) also reported variability for yield and yield attributes in turmeric.

Chillies *(Capsicum* Spp.)

It is one of the most widely used spices in the world. In India, this is a household article of daily use. The two species cultivated are *Capsicum annuum* and *C. frutescens*. Chillies are grown all over India. The area covered is approximately 9,56,000 ha and the average annual production is around 9,45,000 tons (during 1996-97). India ranks first in both area and production.

Research on chillies is being carried out by the Indian Institute for Horticultural Research, Bangalore and by most of the State Agricultural Universities. Considerable movement of germplasm has taken place in this crop during the last two centuries. A lot of varietal collections do exist in various agencies, both private and public. Though it is a spice, under the set up of the Indian Council of Agricultural Research, chillies is included under vegetables. Hence this crop is not dealt here in detail.

Tree spices

There are many tree spices occurring in India, some native, others introduced (Table 11), a few of them are cultivated commercially. Of these, nutmeg, clove and cinnamon are widely grown in the states of Kerala, Karnataka and Tamil Nadu. All the three are recent introductions. Allspice is also a recent introduction, but is less popular. Tamarind and curry leaf are grown widely while *Garcinia* occurs widely and also grown mainly in South Western region of India.

Table 11. Tree spices occurring in India

Botanical Name	Common name	Family	Useful part
Averrhoa carambola L.	Carambola.	Averrhoaceae	Fruit
A. bilimbi L.	Bilimbi, cucumber tree	"	"
Cinnamomum cassia Bercht & Presl	Cassia	Lauraceae	Leaf, bark
C. tamala Nees	Indian Cassia	"	Leaf,bark
C. verum Brecht & Presl.	Cinnamon	"	"
Garcinia gummi-gutta (L.)N. Robson	Gamboge	Clusiaceae	Fruit rind
G. indica Choisy	Gamboge	"	Fruit rind
Illicium verum Hook.	Star anise	Illiceaceae	Fruit
Juniperus communis L.	Common Juniper berry	Cupressaceae	Fruit
Murraya koenigii (L.) Sprengal	Curry leaf	Rutaceae	Leaf
Myristica fragrans Houtt.	Nutmeg, mace	Myristicaceae	Seed and aril
Pimenta dioica (L.) Merr.	Allspice	Myrtaceae	Fruit
Syzygium aromaticum (L.) Merr. Perry	Cloves	Myrtaceae	Unopened flower bud
Tamarindus india L.	Tamarind	Caesalpiniaceae	Fruit pulp
Zanthoxylum acanthopodium DC	Chinese pepper	Rutaceae	Fruit
Z. limonella (Dennst.) Alston	Indian pepper tree	"	Fruit

Nutmeg (*Myristica fragrans* Houtt.)

Nutmeg tree is the only plant that produces two separate spices - nutmeg and mace. The former is the kernel of the seed and the latter, the aril covering seed. Nutmeg belongs to Myristicaceae, one of the primitive families of dicots. Indonesia, New Guinea and Grenada are the major producers. The species is believed to have originated in the Moluccas Islands of Indonesia. Nutmeg was introduced to the Kerala coast of India by Portuguese from Indonesia (earlier the Dutch East Indies) possibly during the 16th century.

The following species occur in India: *Myristica amygdalina* Wall., *M. andamanica* Hook., *M. attenuata* Wall., *M. dactyloides* Gaertn. (=*M. laurifolia* Hook. f., *M. beddomeii* King.), *M. gibbosa* Hook., *M. glabra* Blume, *M. glaucescens* Hooker., *M. irya* Gaertn; *M. kingii* Hook., *M. longifolia* Wall., and *M. magnifica* Bedd. Most of these are endemic to the Indo-Malayan region and the Western Ghat forests. Though they are not very much used for commercial purposes, earlier the mace was used as substitute for true mace from *M. fragrans*. The mace and seeds of *M. dactyloides* are used in tribal and indigenous medicine.

The Nutmeg Germplasm Conservatory at IISR, Calicut consists of 471 accessions of *M. fragrans* and some of the related species. The genetic base of nutmeg is rather limited in the country, as the presentday population have started from a few introductions to India by the Western colonisers. But being a dioecious and seed propagated plant, some variability exists in the present day nutmeg population, especially for characters such as fruit size, fruit shape, mace and seed weight (Krishnamoorthy *et al.* 1996). The chemical composition also shows quantitative variations for major quality components. The oleoresin content varies from 2-14%. The main components in the volatile oil present in the oleoresin are pinene, alpha pinene, beta pinene, sabinene, alpha phellandrene, myristicin, elemicin, 1,8-cineole etc. (Gopalakrishnan, 1992). Alpha pinene, beta pinene and sabinene together constituted 77.4% of nutmeg oil and 60.8% of mace oil. The concentration of hallucinogenic principles (myristicin, elemicin, myristic acid) are reported to be high in Indian nutmeg (Gopalakrishnan, 1992).

Cinnamon

The true cinnamon comes from *Cinnamomum verum* Bercht & Presl, belonging to Lauraceae; indigenous to Sri Lanka and southern Western Ghats of South India. The cassia cinnamon is obtained form various sources, the most important being *C. cassia* Bercht & Presl. (Chinese cassia). The other cassia cinnamons are : Indonesian (Javan) cassia (*C. burmanii* C.G & Th. Nees), Saigon (Vietnam) cassia (*C. loureirii* Nees.) and Indian cassia (*C. tamala* Nees). The earliest description of cinnamon was in van Rheede's *Hortus Malabaricus*, in which two species were described under the local name '*Karuva*' and '*Kattukaruva*' which are *C. verum* and *C. malabathrum* Bercht & Presl. respectively. Gamble (1925) described, with diagnostic keys, eleven species of *Cinnamomum* mainly from the Western Ghats. Kostermans

(1983) described 13 species from South India, most of them from the Western Ghats. The species occurring in south India are:

C. filipedicellatum Kosterm., *C. goaense* Kosterm, **C. macrocarpum* Hook., **C. malabathrum* (Burmaf.) Bl, **C. nicolsonianum* Manilal and Shylaja, *C. perottetti* Meisson, **C. riparium* Gamble, **C. keralense* Kosterm, **C. travancoricum* Gamble, **C. verum* Brecht & Presl, **C. wightii* Meisson, **C. sulphuratum* Nees, **C. heynianum* Nees, **C. gracile* Hook f, **C. chemungianum* Mohan and Henry, *C. walaiwarense* Kosterm. (*species endemic to India)

Hooker (1886) in his flora reported 26 species from Indian subcontinent and adjoining areas. He subdivided the genus into two sections, *Malabathrum* and *Camphora*, based mainly on the character of buds; naked in the former and enclosed in scale leaves in the latter. The former consists of 22 species and the latter four species. Rich variability exists both in Western Ghat forests and the North Eastern regions of India. Out of the many species only a few are being exploited commercially. Apart from cinnamon and cassia, *C. tamala* (Indian cassia) leaves are extentensively used in northern and north eastern India for flavouring various dishes. The wild population of cinnamon are in real peril because of the indiscriminate bark extraction from them. Species like *C. malabathrum*, *C. macrocarpum*, *C. riparium* and *C. nicolsonianum* are especially vulnarable, all of them (except the first one) are endangered. In addition to the above species two of the species occurring in northeast, namely *C. impressinervium* and *C. pauciflorum* are highly aromatic and are being used like *C. tamala* leaves.

Much variations have been reported for morphological, chemical as well as bark characters among species (Shylaja 1984; Shylaja and Manilal 1992; Ravindran *et al.* 1991; 1993a,b; 1996). The quality of cinnamon depends on the essential oil content and composition and leaf and bark oil. The leaf oil contains eugenol as the chief component, while the bark oil has cinnamaldehyde as the chief constituent. In the case *C. cassia*, both leaf and bark oils contain cinnamaldehyde. Evaluation and selection has led to the selection of a few high quality lines such as Nithyashree and Navashree (Krishnamoorthy *et al.* 1996). Krishnamoorthy *et al.* (1988), and Krishnamoorthy and Rema (1994) have also studied the genetic variability existing in the cultivated *C. verum*

Clove (*Syzygium aromaticum* (L.) Merrill & Perry)

Clove tree, belonging to the family Myrtaceae, is a native of Moluccas Islands (Indonesia) from where it has spread to many tropical countries. Under natural condition in Moluccas both clove producing (aromatic) and non-clove producing (non-aromatic) trees co-exist. It was the selective multiplication and culture of the aromatic clove producing trees, that led to the clove plantation in all producing countries. Clove was brought to India by the British planters who introduced the first trees to Courtallam and Nilgiri areas of Tamilnadu. The spice is the dried, mature, unopened flower buds. The clove buds contain around 15-17% volatile oil, the main component of which is eugenol (about 70-90%). Clove is grown as inter crop in many households in Kerala and Karnataka and some pure plantations exist in Kanyakumari district in Tamil Nadu and Trivandrum district in Kerala. Clove trees have become a valuable inter crop in many tea plantations. There are many species of *Syzygium* occurring in India, especially in the Western Ghats forests, none of them is closely related to clove. Because of the limited introductions that have taken place and due to the naturally self pollinating nature of the species, variability is very limited and the genetic base available in India is very narrow for use in any meaningful crop improvement work. The germplasm conservatory at IISR presently consists of 215 accessions, the notable variant are a dwarf clove accession and a king clove.

Other tree species

Garcinia (*G. indica* Choisy and *G. gummi-gutta* (L.) N. Robson - Clusiaceae)

These are evergreen trees, their fruit rind is a common spice in Kerala, Karnataka and Maharashtra areas, also used as a substitute for Tamarind. They are also used for manufacture of syrups and squashes and in pharmaceutical field as a source for hydroxycitric acid, an antiobesity compound. Many species of *Garcinia*, especially *G. morella*, are also the source for gamboge, a vegetable dye, used in earlier times for dying clothes and for various other purposes including in the preparation of water colours and as a vegetable dye for hand painting clothes, potteries etc. This was the dye used by Buddhist Priests to dye their clothes. The gamboge is used in many indigenous medicines as well. In India, *Garcinia* is distributed in Western Ghats and adjoining areas; in Assam; and certain areas in West Bengal. They also occur in Indonesia, Polynesia and South Africa.

Wight (1864) described 18 species of *Garcinia* from the Indo-Malayan region. Hooker (1886) divided the genus *Garcinia* into subgenus *Garcinia* and *Xanthochymus*. The subgenus *Garcinia* proper is further divided into two series - one having stigma divided into rays or deeply four lobed, and the other with entire stigma. The former consists of 17 species, including *G. mangostana*, *G. indica* and G. *gummi-gutta*. The later series consist of ten species. The subgenus *Xanthochymus* consists of three species. There are two major centres of diversity in the Indian sub continent - the North Eastern Region from Assam extending upto to Burma. and the Western Ghats. Gamble (1925) reported 12 species from the Western Ghats: (*G. mangostona* L. *G. echinocarpa* Thw; *G. morella* Desr; *G. indica* Choisy; *G. cambogia* Desr. (=*G. gummi-gutta* (L.) Robson), *G. cowa* Roxb; *G. imberti* Bourd; *G. wightii* T. Anders; *G. travancorica* Bedd., *G. tinctoria* Bedd., *G. malabarica* Talbot and *G. spicata* Hook f.). Of these *G. mangostana* is famous for its delicious fruit, often qualified as the queen of tropical fruits. Only three species are used as spices. They are *G. gummi-gutta*, *G. indica* and *G. cowa*. Most popularly the dried rind is used as a substitute for tamarind, especially in fish preparations, for which it gives a special flavour and taste. Small germplasm collections exist at IISR, Calicut, NBPGR Regional station Trichur and at Kerala Agricultural University, Vellanikkara, Kerala, Regional Agricultural Research Station, Kumarakam, Kottayam, Kerala.

Tamarind (*Tamarindus indica* L.)

Tamarind (Caesalpiniaceae) is one of the commonest spices used in South Indian kitchens. The fruit pulp, the useful part, is a rich source of tartaric and ascorbic acids. Tamarind has originated in tropical Asia, but also occurs in Central Africa. Little work has been carried out on germplasm collection and evaluation, though two elite selections are available -*Periakulam*-1 (PKM-1) developed at the Horticultural college, Periakulam, Tamilnadu and *Prathisthan* developed by the Rajasthan Agricultural University. Two other elite genotypes are *Urukumpuli* and *Kumbum* Tamarind both are very popular among growers. Tamarind is a monotypic genus, also known as Indian date.

Curry Leaf (*Murraya koenigii* (L.) Sprengal)

Curry leaf (Rutaceae) is an essential leafy spice in South Indian food preparation. It is known to have originated in India and cultivated extensively as a backyard plant in most house holds. It is grown as a commercial crop in Tamil Nadu, Karnataka and Andhra Pradesh. The genus *Murraya* is represented by only three species in the Indian environment, of which *M. exotica* is a garden shrub distributed all over India while *M. elongata* Alp. DC is found only in northeastern parts. *M. koenigii* is distributed from the hills of Himalayas to Kerala in south, except in the arid regions. Very little conservation and improvement work is available in this crop. One type with pink midrib is usually preferred over the green ones and the broad leaved ones over narrow leaves. The former has better aroma. Small germplasm collections are being maintained at the University of Agricultural Sciences, Dharwad (Karnataka) and Andhra Pradesh Agricultural University. A selection – *Suvasini* – has been released from Dharwad.

Vanilla (*V.planifolia* Andr. syn. *V.fragrans* (Salis.) Ames)

Vanilla plant is a climbing orchid and is a native of tropical America. This plant is the source for natural vanillin, which is extracted from mature, processed fruits (called pods or beans). The agro-climatic conditions of Kerala and parts of Karnataka and Tamil Nadu are suitable for growing vanilla. The only constraint being the absence of the pollinating insect -*Melapona* sp., so that artificial pollination is required for fruit setting.

Five species of vanilla are reported from India (Kumar and Manilal 1993), out of which *V. pilifera* Hot. is endemic to Assam., *V. andamanica* Rolf is endemic to Andamans, *V. vatsalae, V. walkeriae* and *V. wightiana* are endemic to Western Ghats. Of these, *V. pilifera* and *V. andamanica* are leafy species while the others are leafless (having only scale leaves).

V. planifolia, the only commercially important species, is of Mexican origin, now grown in many pacific ocean islands, Indonesia and in many African countries. It was introduced into India probably by the beginning of the present century, though the interest in the cultivation is only recent. IISR, Calicut has taken up the programme on vanilla recently and presently maintains a germplasm collection of 45 accessions, in addition to a population of over 1000 somaclones and plants developed from ovule culture. This population shows many morphological variations and will be useful in crop improvement work (Divakaran *et al.* 1997). A germplasm collection is being maintained at the Indian Cardamom Research Institute (Myladumpara) also.

Seed spices (Grain spices)

Seed spices constitute a major group grown and used extensively in India. The important seed spices are coriander, cumin, fennel and fenugreek. They originally came from the central Asian and Mediterranean region. The first introduction probably might have taken place along with the movement of army during the invasion of Alexander the Great. These spices are under cultivation for a very long time in the whole of North India. Now India is a major producer and consumer of seed spices. The productivity of these spices remained more or less static and efforts are in full swing to evolve better yielding and disease and pest resistant lines.

The genetic resources of seed spices are mostly introduced from Central Asian and Mediterranean regions, perhaps a long time ago. The current germplasm holdings are all under the State Agricultural Universities (Table 12).

Table 12. Grain spices – germplasm holdings in India

Spices	Centre	Number of accessions
Coriander	(*Coriandrum sativum* L. Apiaceae)	
	Rajasthan Agricultural Unversity. (Jobner)	683
	Gujarat Agricultural Unversity (Jagudan)	143
	Tamil Nadu Agricultural University (Coimbatore)	372
	Andhra Pradesh Agricultural University (Guntur)	230
	Haryana Agricultural University (Hissar)	30
Cumin	(*Cuminum cyminum* L. Apiaceae)	
	Jobner	224
	Jagudan	566
Fennel	(*Foeniculum vulgare* Mill. Apiaceae)	
	Jobner	139
	Jagudan	98
Fenugreek	(*Trigonella foenum - graecum* L. Fabaceae)	
	Jobner	270
	Jagudan	40
	Coimbatore	179
	Guntur	70
	Hissar	80

Apart from the above four major seed spices, there are many which are less common and cultivated on a smaller scale - such as celery (*Apium graveolens* L. Apiaceae), dill (*Anethum graveolens* L. and *A. sowa* Roxb. Ex. Flem. Apiaceae), ajowan (*Trachyspermum ammi* (L.) Sprague - Apiaceae), black caraway (*Carum bulbocastanum* L.- Apiaceae), caraway (*Carum carvi* L. Apiaceae), black cumin (*Nigella sativa* L.Ranunculaceae). (black fennel-*Bunium perssicum* (Bsiss) B. Fedtsch; Apiaceae) etc.

Genetic resources programmes in seed spices were initiated only in1975 when the All India coordinated spices improvement project has established four centres for seed spices research, one each at Jobner (Rajasthan), Jagudan (Gujarat), Coimbatore (Tamil Nadu) and Lam (Guntur, Andhra Pradesh), and the present germplasm collections are located in these centres. Two weaknesses have been pointed out regarding the present germplasm: (i) most germplasm expeditions have been made at random and unsystematically, also the collections have been made by breeders whose prime objective was to develop improved varieties. A biasness for superior types might have occurred in such collections. (ii) All seed spices, except fenugreek, are cross pollinated. The traditional varieties therefore exist in the form of complex gene mixtures (Sevda, 1980, Kathiria, 1980). Proper sampling as well as regeneration is essential to recover and to maintain the full range of genetic variabilities of these crops (Sharma, 1994).

The germplasm evaluation and their utilization in crop improvement work has led to the development of many new varieties in coriander, cumin, fennel and fenugreek.

Conservation of spices germplasm

In situ conservation

The ideal form of conservation is *in situ* conservation, in which plants are conserved in their natural habitat. But this form of conservation is difficult, requires large areas, and their establishment and management is not easy. Biosphere reserves and national parks are such *in situ* conservatories where the natural resources are conserved. The IISR, Calicut has plans to establish such an *in situ* conservatory for black pepper and cardamom and their related taxa - in collaboration with the Forest Department.

Ex situ conservation

Currently all genetic resources of spices are being conserved by the *ex situ* conservation method. The IISR has established National Conservatories of major spices at its research farm at Peruvannamuzhi. IISR is having the world's largest collection in black pepper, ginger turmeric and tree spices. Table 13 depicts the status of the genetic resources being maintained in the National Conservatory of IISR. The IISR has drawn up an ambitious programme of completing the survey and collection of spices genetic resources of our country within a period of next five years. All the genetic resources will be documented and conserved at IISR not only for today and tomorrow but also for generations to come.

In vitro conservation

An *in vitro* genebank has been estab-

Table 13. Genetic resources of spices conserved at the National Spices Conservatory at IISR, Calicut

Crop	No. of Acc.	Important species maintained
Black pepper	2969	*Piper nigrum, P. colubrinum, P. barberi, P.sugandhi, P. silentvalleyensis, P. chaba, P. longum, P.arboreum, P. magnificum, P. crocatum, P. bababudani, P. argyrophyllum, P. mullesua, P. hapnium, P. trichostachyon, P. betle, P. galeatum* etc.
Cardamom	286	*Elettaria cardamomum*
Ginger	570	*Zingiber officinale, Z. roseum, Z. macrostachyum, Z. zerumbet, Z. casumunnar* etc.
Turmeric	715	*Curcuma longa, C. aromatica, C. amada, C. zedoaria, C. angustifolia, C. cassia, C. peethapushpa, C. brog, C. sylvatica, C. aeruginosa, C. latifolia, C. comosa, C. montana* etc.
Nutmeg	471	*Myristica fragrans, M. fatua* var.*magnifica, M. malabarica, M. beddomeii, M. andamanica, Knema andamanica* etc.
Clove	215	*Syzygium aromaticum, S. jambolana* etc.
Cinnamon	274	*Cinnamomum verum, C. aromaticum, C. camphora, C. malabathrum, C. riparium* etc.
Allspice	1	*Pimenta dioica,*
Vanilla	4	*Vanilla vatsalae, Vanilla andamanica, Vanilla planifolia, V. pilifera*
Capsium (Paprika)	236	*Capsicum annum, C. frutescens*
Garcinia	16	*G. indica, G. gummi-gutta, Garcinia* sp.
Tamarind	2	*Tamarindus indicus*
Herbal spices	15	*Mentha* Spp., *Origanum* sp., *Ocimum* Spp., *Marjorana* sp., *Apium* sp., *Thymus* sp., *Salvia* sp., *Lavendula* sp., *Anethum* sp., *Foeniculum* sp., *Pimpinella* sp. etc.

lished at IISR. Here, pepper, cardamom, ginger, turmeric and their allied taxa are being conserved under *in vitro.* This is a medium term conservation strategy, and is a way to conserve the germplasm safely in case of major spices, because of the serious threats from soil-borne and virus diseases. At IISR, we have so far conserved over 550 accessions of pepper and cardamom and their related taxa. It is our aim to conserve all the present germplasm of pepper, ginger and cardamom in this way by 2005 AD. We have also initiated studies on the long term storage through cryoconservation.

Future perspective

It is the aim of IISR to establish the global spices genebank so that the genetic diversity available in the major spices will be conserved there for the benefit of posterity. Top priority in being given for characterization and cataloguing of the germplasm. Characterization based on molecular markers is also being initiated. This is an extremely important area, and will be useful in developing a collection from the existing vast assemblage of germplasm. Cryopreservation protocols have to be evolved for long term conservation.

References

Baker, J. G. 1880 - 1892. Scitamineae, In: Flora of British India (J. D. Hooker, ed.) Vol. 6. London. pp. 198–264.

Divakaran, M., Sajina, A., Nirmal Babu, K and Ravindran, P. N. 1997. Ovule culture of vanilla and its potential in crop improvement. In: Edison, S., Ramana, K.V., Sasikumar, B., Nirmal Babu, K. and Santhosh J. Eapen (eds.) Biotechnology of Spices, Medicinal & Aromatic Plants, Indian Society for Spices, Calicut, pp. 112-118.

Fischer, C. E. C. 1921. A survey of the flora of Annamalai Hills in Coimbatore Dist., Madras Presidency. Rec. Bot. Surv. Ind., 9 (1): 151.Fischer, C. E. C. 1928. Zingiberaceae. In: *Flora of the Presidency Madras*. J. S. Gamble, (ed.) London Publisher, pp.1478-1493.

Gamble, J. S. Flora of the Presidency of Madras (Reprint, Botanical Survey of India, Calcutta). pp. 1916-1935.

Gopalakrishnan, M. 1992. Chemical composition of nutmeg and mace. J. Spices & Aromatic Crops, 1: 49-54.

Gopalam, A. and Ravindran, P. N. 1986. Indexing quality parameters in black pepper cultivars. Indian Spices, 22 – 23 : 8-11

Hooker, J. D. (ed.) 1872-1897. The Flora of British India, L. Reave and Co., London (Reprint).

Holttum, R. E. 1950. Zingiberaceae of the Malay Peninsula. Gar. Bullentin, Singapore, 13:1-249

Jose, J. and Sharma A. K. 1985. Structure and behaviour of chromosomes in *Piper* and *Peperomia* (family Piperaceae). Cytologia, 50 : 301-310.

Kathiria, K. B. 1980. Cited from Sharma, 1994.

Kostermans, A. J. G. H. 1983. and Kattivia 1980. The South Indian species of

Cinnamomum Schaeffer (Lauraceae). Bull. Bot. Survey Ind. 25 (1-4) : 90-133.

Krishnamoorthy, B., Gopalam, A and Jose Abraham. 1988. Quality parameters of Cinnamon (*Cinnamomum verum*) in relation to flush colour. Ind. Cocoa, Arecanut and Spices, J., 12 : 38.

Krishnamoorthy, B and Rema, J. 1994. Genetic resources of tree spices. In: Chadha, K.L. and Rethinam, P. (eds.) Advances in Horticulture, Vol.9 (1) Plantation and Spice Crops,. Malhotra Publishing House, New Delhi. pp. 169-192.

Krishnamoorthy, B., Sasikumar, B. and Rema, J. 1996. Genetic variability and segregation of sen in nutmeg. J. Plant. Crops (Suppl.) 24: 468-472.

Krishnamoorthy, B., Rema, J., John Zachariah, T., Jose Abraham and Gopalam, A. 1996. Navashree and Nithyashree two new high yielding and high quality cinnamon (*Cinnamomum verum* Bercht. & Presl.) selections. J. Spices & Aromatic Crops 5 (1) : 28-33.

Mabberly, D. J. 1987. *The Plant Book.* Cambridge University Press, Cambridge.

Madhusoodanan, K. J., Kuruvilla, K. M. and Priyadarshan, P. M. 1994. Genetic resources of cardamom. In: Chadha, K.L. and Rethinam, P. (eds.) Advances in Horticulture, Vol. 9 (1), Plantation Crops and Spices, Malhotra Publishing House, New Delhi. pp.121-130.

Nirmal Babu, K., Naik, V. G. and Ravindran, P. N. 1993a. Two new taxa of *Piper* (Piperaceae) with a note on their origin and interrelationship. J. Spices & Aromatic Crops, 2: 26-33.

Nirmal Babu, K., Sasikumar, B., Ratnambal, J., Johnson George, K. and Ravindran, P. N. 1993b. Genetic variability in turmeric (*Curcuma longa* L.). Indian J. Genet., 53: 91-93.

Raju, K., Ravindran, P. N. and Nair, M. K. 1983 Quality evaluation of black pepper cultivars. Indian spices, 20 : 3-5

Rama Rao, R. S. M. 1914. Flowering Plants of Travancore, Govt. Press, Trivandrum, pp. 336-368.

Ramachandran, K. 1969. Chromosome numbers in Zingiberaceae., Cytologia, 34: 213-221

Rao, R. R. and Razi, B. A. 1981. A Synoptic Flora of Mysore District. New Delhi.

Ratnambal, M. J., Ravindran, P. N. and Nair, M. K. 1985. Variability in the black pepper cultivar Karimunda. J. Plant. Crops, 13 :154-157.

Ravindran P.N., Nair R.A., Nirmal Babu.K., Chandran, K and Nair, MK. 1990. Morphological and taxonomical notes on the *Piper* Spp. from Silent valley forests, Kerala. J. Bombay Nat. Hist. Society, 87:421-26.

Ravindran, P. N. 1990. Studies on Black Pepper (*Piper nigrum* L.) and some of its wild relatives. Ph. D thesis, Univ. Calicut, Kerala.

Ravindran, P. N., Sasikumar, B. Ratnambal, M. J., Nirmal Babu, K., Zachariah, T. J, and Nair, R. R. 1994. Genetic resources of ginger (*Zingiber officinale* Rosc.) and its conservation in India. Plant Genet. Res. News l. 98 : 1 - 4.

Ravindran, P. N. and Nirmal Babu K. 1994. Genetic resources of black pepper. In: Chadha, K. L. and Rethinam, P. (eds.) Advances in Horticulture, Vol. 9 (1) Plantation Crops and Spices, pp. 99 - 120.

Ravindran, S., Manilal, K. S and Ravindran, P. N. 1993a. Epidermal morphology of *Cinnamomum* and its bearing on the taxonomy of the genus J. Plant Anatomy and Morph., 6 : 42-50.

Ravindran, S., Krishnaswamy, N. R., Manilal, K. S. and Ravindran, P .N. 1993b. Chemotaxonomy of *Cinnamomum* Scheef. occurring in Western Ghats. J. Ind. Bot. Soc., 71: 37-41.

Ravindran, S., Krishnaswamy, N. R., Manilal, K. S. and Ravindran, P. N. 1991. A cluster analysis study of *Cinnamomum* from Kerala, India. Feddes Report., 102: 13-21.

Ravindran, S., Manilal, K. S and Ravidran, P. N. 1996. Numerical taxanomy of *Cinnamomum* II. Principal component analysis of major species occurring in Kerala. In: Manilal K and A.K. Pnadey (ed.) Taxonomy and Plant Conservation Oxford and IBH Pub. Co., New Delhi, pp. 321-332.

Sabu. M. 1991. A taxonomic and phylogenetic study of south Indian Zingiberaceae. Ph. D Thesis, University, Calicut, Kerala.

Saldanha, C. J. and Nicholson, D. H. 1978. Flora of Hassan District, Karnataka, India . Amerind Pub. Co. New Delhi.

Sarma, R. K. 1994. Genetic Resources of Seed Spices. In: Chadha, K.L. and Rethinam, P. (eds.) Advances in Horticulture Vol. 9 (1) Plantation and Spices Crops. Malhothra Pub. Co., New Delhi, pp. 193-207

Sasikumar, B., Nirmal Babu, K., Jose Abraham and Ravindran, P. N. 1992. Variability, correlation and path analysis in ginger germplasm. Ind. J. Genet. 52 : 428-31.

Sato, D. 1960. Karyotype analysis in Zingiberales with special reference to the protokaryotype and stable karyotype. Sci. Paper Coll. Genet. Education, Univ. Tokyo. Biol., 10: 225-243.

Sevda. 1980. Cited from Sharma 1994.

Shylaja, M. 1984 Studies on Indian *Cinnamomum*. Ph. D Thesis, University of Calicut, Calicut, Kerala.

Shylaja, M and Manilal, K. S. 1992 Bark anatomy of four species of *Cinnamomum* (Lauraceae) from Kerala. J. Spices & Aromatic Crops, 1: 84-87.

Van Rheede, H. 1678 Hortus Indicus Malabaricus, Publishers. Vol.74, pp. 23-31.

Velayudhan, K. C., Amalraj, V. A. and Muralidharan, V. K. 1991. The genus *Curcuma* in India: A morphotaxonomic assessment. In: Manilal, K. S. and Pandey, A. K. (eds.) Taxonomy and Plant Conservation, CBS Pub., New Delhi. pp. 281-296.

Wight. 1864. A Dictionary of the Economic Products of India (Reprint), Peridiual Experts, New Delhi.

Willis, J. C. 1984. Dictionary of Flowering Plants and Ferns. Cambridge Uni. Press. (Revised ed.).

Zachariah, T. J. and Lukose, R. 1992. Aroma profiles of selected germplasm accessions in cardamom (*Elettaria cardamomum* Maton). J. Plant. Crops (Suppl.) 20 pp. 310-312.

Zachariah, T. J., Mulge, R., and Venugopal. M. N. 1998. Quality of cardamom from different accessions. Developments in plantation crops research, Mathew, N. .M. and Jacob, C. K. (eds.), Allied pub; New Delhi, pp. 337-340

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants pp. 45- 53, 1999

In vitro approaches for conservation and exchange of spices germplasm

K. NIRMAL BABU, S. P. GEETHA, D. MINOO, K. RAJALAKSHMI,
P. GIRIJA, P. N. RAVINDRAN & K. V. PETER.

Indian Institute of Spices Research,
Calicut - 673 012.

Abstract

In vitro technology is developed for medium term conservation of black pepper, cardamom, ginger, turmeric, vanilla, capsicum and many herbal spices by maintaining the shoot tip cultures under minimal growth conditions. Cryopreservation technology is available for seed conservation in black pepper, cardamom, capsicum and mint. Technologies are available in black pepper, cardamom, ginger and vanilla for meristem culture and disease elimination. *In vitro* plantlets, synthetic seeds and micro-rhizomes can be used for movement of disease free planting material, thus minimizing the disease spread. Thus *in vitro* storage becomes an important component in the overall strategy of conserving genepool in spice crops.

Introduction

In many crop species conventional seed storage can satisfy most of the conservation requirements. But in crops with recalcitrant seeds and those which are normally propagated vegetatively in which the conservation needs cannot be satisfied by seed storage, have to be stored *in vitro*. Most field genebanks are prone to high labour cost, vulnerability to hazards like natural disasters, pests and pathogens attack (especially viruses and systemic pathogens), to which they are continuously exposed and require large areas of space (Chandel and Pandey, 1991). This supports *in vitro* conservation. In addition, other resources like continuous supply of standard stock cultures for experiments to examine physiological and biochemical processes, cell and callus lines developed for *in vitro* synthesis of valuable secondary products (flavours and other important compounds etc.) will benefit strongly from *in vitro* cultures.

Most of the spice crops are either vegetatively propagated or have recalcitrant seeds. This presents problems to the conservationist and plant breeder.

Thus *in vitro* storage system becomes an important component in the overall strategy of conserving genepool. Each technology should be chosen on the basis of utility, security and complementarity to the other components of strategy. A balance need to be struck between seed, field genebank, *in vitro* pollen, cell lines and DNA storage for overall objective of conserving gene pool (Withers, 1991).

Conservation of spices genetic resources

Indian Institute of Spices Research (IISR) Calicut maintains a very large collection of spices germplasm. The germplasm is at present conserved in field genebanks. Most of the spices are plagued by destructive diseases such as foot rot of black pepper caused by *Phytophthora capsici*, 'Katte' and 'Azhukal' disease of cardamom caused by virus and *Phytophthora* species, respectively, rhizome rot of turmeric caused by *Pythium graminicolum* etc. which makes germplasm conservation in field genebanks risky. In such cases, *in vitro* conservation will support the field genebanks. The available information on conservation of spices germplasm is given in Table 1.

Micropropagation

Plant regeneration and successful cloning of genetically stable plantlets in tissue cultures is an important pre-requisite in any *in vitro* conservation effort. Micropropagation protocols for stable cloning of elite genotypes of spice crops viz., black pepper and its related species, cardamom, ginger, turmeric and related genera, large cardamom, vanilla, cinnamon, camphor, cassia, seed and herbal spices like lavender, celery, thyme, mint, anise, savory, spearmint, origano etc. were standardized at IISR, Calicut (Nirmal Babu *et. al.,* 1997). The other reports on micropropagation of important spices crops are by Hosoki and Sagawa 1977; Broome and Zimmerman, 1978; Nadgauda *et. al.,*1978, 1983; Philip and Nainar, 1986; Balachandran *et. al.,* 1990; Dekkers *et. al.,* 1991; Philip *et. al.,* 1992 etc. These techniques formed the base for establishing tissue cultures of various spice crops and conserving them in the laboratory. The basal medium used are MS (Murashige and Skoog, 1962) for crops like cardamom, ginger, turmeric, kasturi turmeric, mango ginger, large cardamom, Kaempferias, vanilla Spp and herbal spices, and WPM-woody plant medium (McCown and Amos, 1979) for black pepper and its related species, cinnamon, camphor and cassia. Simultaneously these tissue cultured plants are being evaluated for their morphological and genetic characterization to estimate their genetic stability in culture (Luckose *et. al.*, 1993). Though micropropagation protocols were standardized using growth regulators, all the in vitro storage experiments were carried out using growth regulators free media to reduce the rate of multiplication which in turn will reduce the extent of variation.

Short and medium term conservation by slow growth

Various factors like temperature, culture medium, use of osmoticum, physiological state of the ex-plant, culture vessel, minimization of evaporation loss, encapsulation, desiccation etc. are shown to influence slow growth. Growth reduction can generally be achieved by lowering the culture temperature, but the scope for temperature reduction depends upon the species to be conserved. Tissue cultures of cardamom could not be stored under low temperatures (Nirmal Babu *et. al.*, 1994). Normal culture room temperatures of 22 - 20°C is suitable for the storage of spices germplasm. Though cotton plugs, used to cover the mouth of culture vessel, allowed comparatively better gaseous exchange, there is a faster rate of loss of moisture depletion of culture media and drying up of cultures between 120 and 180 days depending upon the species. However, use of screw caps, polypropylene caps or aluminium foil as vessel closures minimized the moisture loss, helped in retention of the medium and thereby resulted in increased longevity of cultures and the subculture period could be prolonged upto 30 days (Nirmal Babu *et. al.*, 1994, Geetha *et. al.*, 1995). Sealing the culture tube with parafilm helped in reducing the chance of contamination and moisture loss. The use of polypropylene caps as vessel closures to minimize evaporation and to enhance the longevity of culture was reported earlier in ginger and turmeric (Balachandran *et. al.*, 1990).

Black pepper and related species

Black pepper (*Piper nigrum* L.) shoot tip cultures could be stored up to 360 days without subculture in half strength WPM with 15 gl^{-1} each of sucrose and mannitol in screw capped culture tubes with 85% survival. Half strength of the basal medium supplemented with mannitol was insufficient for the survival of the related species like *P. barberi, P. colubrinum and P. longum. P. barberi* cultures could be stored up to 360 days in full strength WPM in 25 gl^{-1} sucrose and 5gl-1 mannitol with 80% survival. The survival rate after 360 days found reduced to 70% when half strength of the basal medium with 30 gl^{-1} was used. In higher concentration of mannitol, the growth rate was highly reduced with poor rooting and the cultures showed yellowing, shoot tip necrosis, decaying etc. and the cultures could not be maintained more than 180 days. Shoot tip cultures of *P. colubrinum* and *P. longum* could be stored up to 360 days in full strength WPM with 20 gl^{-1} sucrose and 10 gl^{-1} mannitol with 70% and 75% survival respectively. The technique standardized is presently used to conserve other *Piper* species also (Table 2).

Cardamom

Tissue cultures of cardamom could be stored up to 360 days with 85% survival and up to maximum period of 420 days with 70% survival in half strength MS medium with 10gl^{-1} each of sucrose and mannitol in screw capped culture tubes. Under these conditions the cultures attained miniature but healthy appearance (Nirmal Babu *et. al.*, 1994; Geetha *et. al.*, 1995). Similar growth patterns were noticed during second and third years of storage.

Ginger

Slow growth methods for short term conservation of ginger, turmeric, kasthuri turmeric, mango ginger, *Kaempferia* Spp.

(*K. galanga* and *K. rotunda*) are also standardized. All these taxa could be stored up to 1 year without subculture in half strength MS medium $10gl^{-1}$ each of sucrose and mannitol in sealed culture tubes (Geetha *et. al.,* 1995). *Alpinia purpurata* and *Amomum subulatum* cultures could be stored up 8 and 6 months respectively in the same medium. Refining the technique is in progress to increase the subculture interval for over 360 days.

Vanilla

Shoot tip cultures of *V. planifolia* and *V. vatsalae* could be stored in full strength MS medium with $10gl^{-1}$ each of sucrose and mannitol, without subculture easily upto 1 1/2 years. In *V. vatsalae* growth is much more reduced as it is slow in growth under normal conditions also (Nirmal Babu et. al., 1996). *In vitro* storage of another species of *Vanilla* (*V. walkeriae*) was reported by Agarwal *et. al.* (1992).

Seed and berbal spices

Cultures of seed and herbal spices like anise, oregano, lavender, mint, spearmint, thyme, savory, chives, ocimum etc could be established in minimal media (i.e. half strength MS medium with 20 gl^{-1} sucrose and full strength MS medium with 15 gl^{-1} each of sucrose and mannitol. (Nirmal Babu et. al., 1996). Based on the preliminary observations these cultures can be maintained only for around 90 days after which transfer to fresh medium is required. Slow growth storage using shoots (Hussey, 1978), and microbulbs (Keller 1995) was reported. Capsicum shoot tip cultures could be maintained under minimal growth conditions by yearly subculture (unpublished). Studies on increasing the subculture interval by further alterations in culture conditions are in progress.

Enacapsulation of somatic embryos for shot tip.

Encapsulation is a technique used in the production of 'synthetic seeds' by coating somatic embryos/shoot tips in alginate beads. Synthetic seeds can be an ideal source for conservation and distribution of germplasm. Encapsulation of somatic embryos/shoot tips were successfully achieved at IISR, in ginger, cardamom, vanilla, camphor and cinnamon (Sajina *et. al.*, 1997).

Long term storage by cryopreservation

Successful cryopreservation of seeds, meristems, somatic or zygotic embryos were reported in *Allium* Spp. (Niwata, 1995), black pepper (Chaudhury and Chandel, 1994) and cardamom (Chaudhury and Chandel, 1995). Preliminary success are reported in cryo preservation of mint (Chaudhury, personal communication) and capsicum. Most of the reports are confined to a few genotypes and hence the techniques standardized needs to be extended to more genotypes before adopting them for routine conservation.

Germplasm exchange

Germplasm exchange using *in vitro* cultures is to a certain extent practiced in potato, other tuber crops, orchids, anthuriums etc. In view of the necessity of reducing the possibility of introduction of new pathogens and pests along new plant introductions it is imperative that we use in vitro technology for plant introduction wherever possible, especially in spices. Utilization of microtubers in tuber crops and in vitro rhizomes in ginger and turmeric is a positive development in this regard.

Table 1. Present state of information on in vitro conservation of spices

Application	Technique	Reference
Black pepper and related species	Meristem culture	Philip *et. al.* 1992
Disease eradication propagation	Shoot culture Leaf/root	Broome and Zimmerman, 1978
Slow growth storage	*In vitro* plantlets at 22ºC	Nirmal Babu *et. al.*, 1993
Cryopreservation	Seeds	Chaudhury and Chandel 1994
Allium Spp		
Disease eradication	Meristem culture and thermotherapy	Conci and Nome 1991
Propagation	Shoot culture from bulb from inflorescence	Husseyn 1978
	Microbulbets	Novak and Havel 1981
	Shoot culture, microbullbets	Keller 1991
Slow growth storage	Apical meristem	El-Gizawy and Ford-Lioyd 1987
Cryopreservation		Keller 1991, Niwata 1995
Cardamom		Authors (unpublished)
Disease eradication	Meristem culture	Nadagauda *et. al.* 1983
Propagation	Shoot buds, callus regeneration	Sreenivasa Rao *et. al* 1982
Slow growth storage	*In vitro* plantlets at 22ºC	Geetha *et al.* 1995.
Cryopreservation	Seeds	Chaudhury and Chandel 1995
Zingiber Spp.		
Disease eradication	Shoot cultures, shoot buds	Balachandran *et al.* 1990
Propagation	Inflorescence, callus regeneration	Hosoki and Sagawa 1977
Slow growth storage	Somatic embryogenesis	Nirmal Babu *et. al.* 1992b
Distribution	Shoot cultures at 22ºC	Nirmal Babu *et. al.* 1992a
	Shoot cultures in parafin oil	Kacker *et. al.* 1993
	Microrhizomes	
		Bhat *et. al* 1995
Curcuma Spp		
Propagation	Shoot buds	Cervera and Madrigal 1981

	Callus cultures	Shetty *et. al.*, 1982
Slow growth storage	*In vitro* plantlets at 22°C	Geetha *et. al.*, 1995
Distribution	Microrhizomes	Reghurajan et. al., 1997
Vanilla Spp.		
Disease eradication	Apical meristem	Cerevera and Madrigal 1981
Propagation	Root	Philip and Nainar 1986
Slow growth storage	*In vitro* plantlets	Nirmal Babu *et. al.*, 1996
Distribution	Synthetic seeds	Sajina *et. al.*, 1997
Herbal spices		
Slow growth storage	*In vitro* plantlets	Nirmal Babu *et. al.*, 1996
Capsicum		
Slow growth storage	*In vitro* plantlets	Authors (unpublished)
Cryopreservation	Seeds	Authors (unpublished)

References

Agarwal, D. C., Morewal, G. C. and Mascarenhas, A. F. 1992. *In vitro* propagation and slow growth storage of shoot cultures of *Vanilla walkariae* Wight - an endangered orchid. Lindleyana, 7 : 95 - 99.

Balachandran, S. M., Bhat, S. R. and Chandel, K. P. S. 1990. In vitro clonal multiplication of turmeric (*Curcuma* Spp.) and ginger (*Zingiber officinale* Rosc). Plant Cell Rep. 8 : 521 - 524.

Bhat, S.R., Chandel, K.P.S. and Kacker, A. 1995. *In vitro* introduction of rhizome in ginger Zingiber officinale Rosc. Ind. J. Expt. Biol. 32 : 340 - 344.

Broome, O. C. and Zimmerman, R. N. 1978. In vitro propagation of black pepper. Hort. Sci., 43 : 151 - 153.

Cerevera, E and Madrigal, R. 1981. In vitro propagation of black pepper. Hort. Sci. 43 : 151 - 153.

Chandel, K. P. S. and Pandey, R. 1991. Plant Genetic Resources Conservation: Recent Approaches. In. R. S. Paroda and R. K. Arora (eds.) Plant Genetic Resources Conservation and Management - Concepts and Approaches. IBPGR, New Delhi p. 247 - 272.

Chaudhury, R. and Chandel, K. P. S. 1994. Germination studies and cryopreservation of seeds of black pepper (*Piper nigrum* L.) - a recalcitrant species. Cryo Letters, 15 : 145 - 150.

Chaudhury, R and Chandel, K. P. S. 1995. Studies on germination and cryopreservation of cardamom (*Elettaria cardamomum* Maton.) seeds. Seed Sci. & Technol. 23 : 235 - 240.

Conci, V. C. and Nome, S. F.1991. Virus free garlic (*Allium sativum* L.) plants obtained by thermotherapy and meristem tip culture. J. Phytopathol. 132 : 186 - 192.

Dekkers, A.J., Rao, A. N. and Goh, C. J. 1991. In vitro storage of multiple shoot cultures of gingers at ambient temperatures of 24-200C. Sci. Hort. 47 : 157 - 167.

El-Gizawy, A. M. and Ford-Lloyd, B. V. 1987. An *in vitro* method for the conservation and storage of garlic (Allium sativum) germplasm. Plant Cell Tiss. Org. Cult. 9 : 147 - 150.

Geetha, S. P., Manjula, C and Sajina, A. 1995. *In vitro* conservation of genetic resources of spices. In : Proc. Seventh Kerala Science Congress, State Committee on Science, Technology and Environment, Kerala, pp 12-16.

Hosoki, T. and Sagawa, Y. 1977. Clonal propagation of ginger (Zingiber officinale Rosc.) through tissue culture. Hort. Sci. 12 : 451-452.

Hussey, G. 1978. *In vitro* propagation of the onion *Allium cepa* by axillary and adventitious shoot proliferation. Sci. Hortic. 9 : 227-236.

Kacker, A., Bhat, S. R., Chandel, K. P. S. and Malik, S. K. 1993. Plant regeneration via somatic embryogenesis in ginger. Plant Cell Tiss. Org. Cult. 25 : 153-159.

Keller, J. 1991. In vitro conservation of haploid and diploid germplasm in *Allium cepa* L. Acta Hort. 289 : 231-232.

Luckose, R., Saji, K. V., Venugopal, M. N. and Korikanthimath, V.S. 1993. Comparative field performance of micropropagated plants of cardamom (*Elettaria cardamomum*). Ind. J. Agric. Sci. 63 : 417-418.

Mc Cown, H. P. and Amos, R. 1979. Initial trials of commercial micropropagation with birch. In : Proc. Int. Plant. Pro. Soc. 29 : 387-393.

Murashige, T and Skoog, F. 1962. A revised medium for rapid growth and bioassays with tobacco tissue cultures. Physiol Plant. 15 : 473-497.

Nadgauda, R. S., Mascarenhas, A. F., Hendre, R. R. and Jagannathan, V. 1978. Rapid clonal multiplication of turmeric, Curcuma longa L. Plantlets by tissue culture. Ind. J. Exp. Biol. 16 : 120-122.

Nadgauda, R. S, Mascarenhas, A. F. and Madhosoodanan, K. J. 1983. Clonal multiplication of cardamom (*Elettaria cardamomum* Maton.) by tissue culture. J. Plant. Crops, 11 : 60-64.

Nirmal Babu. K., Geetha, S. P., Manjula, C., Ravindran, P. N. and Peter, K. V. 1994. Medium term conservation of cardamom germplasm - an *in vitro* approach. II Asia Pacific Conf. Agri. Biotech, Madras, Abst. p. 15.

Nirmal Babu, K., Ravindran, P. N. and Peter, K. V. 1997. Protocols for Micropropagation of Spices and Aromatic Crops. Indian Institute of Spices Research, Calicut, India. 35p.

Nirmal Babu, K., Samsudeen, K and Ratnambal, M. J. 1992a. In vitro plant regeneration from leaf derived callus in ginger, *Zingiber officinale* Rosc. Plant cell Tiss. Org. Cult. 29 : 71-74.

Nirmal Babu, K., Samsudeen, K and Ravindran, P. N. 1992b. Direct regeneration of plantlets from immature inflorescences of ginger (*Zingiber officinale* Rosc.) by tissue culture. J. Spices and Aromatic Crops 1 : 43-48.

Nirmal Babu, K., Rema, J., Ravindran, P. N. and Peter, K. V. 1993. Micropropagation of black pepper and related species - its potential in crop improvement. In. Golden Jubilee Symposium on Horticultural Research - Changing scenario, Horticulture Society of India. Abst. p. 250.

Nirmal Babu, K., Geetha, S. P., Manjula, C., Sajina, A., Minoo, D., Samsudeen, K., Ravindran, P. N. and Peter K. V. 1996. Biotechnolgoy - its role in conservation of genetic resources of spices. In. M R Das and M Sathish (eds.) Biotechnology for Development, State Committee on Science, Technology and Environment, Kerala pp : 198-212.

Niwata, E. 1995. Cryopreservation of apical meristems of garlic (*Allium sativum* L.) and high subsequent plant regeneration. Cryo-Letters 16 : 102-107.

Novak, F. J. and Havel, L. 1981. Shoot production from in vitro cultured flower heads of *Allium porrum* L. Biol. Plant. 23 : 266 - 269.

Philip, V. J. and Nainar, S. A. Z. 1986. Clonal propagation of *Vanilla planifolia* (Salisb.) Ames. using tissue culture. J. Plant Physiol. 122 : 211 - 215.

Philip, V. J., Joseph, D., Triggs, G. S. and Dickinson, N. M. 1992. Micropropagation of black pepper (*Piper nigrum* L.) through shoot tip cultures. Plant Cell Rep. 12 : 41 - 44.

Raghurajan, V. 1997. Micropropagation of turmeric (Curcuma longa L.) by in vitro microrhizomes. In: S. Edison, K.V. Ramana, B. Sasikumar, K. Nirmal Babu and Santhosh J. Eapen (eds.). Biotechnolgoy of Spices, Medicinal and Aromatic Plants. pp. 25 - 28. Indian Society for Spices, India.

Sajina, A., Minoo, D., Geetha, S. P., Samsudeen, K., Rema, J., Nirmal Babu, K. and Ravindran, P. N. 1997. Production of synthetic seeds in few spice crops. In: S. Edison, K.V. Ramana, B. Sasikumar, K.Nirmal Babu and Santho J.Eapen (eds.). Biotechnology of spices, Medicinal and Aromatic Plants. Pp. 65 - 69. Indian Society for Spices, India.

Scowcroft, W. R. 1984. Genetic variability in tissue culture: impact on germplasm conservation and utilization, Technical Report, IBPGR, Rome.

Shetty, M. S. K., Hariharan, P. and Iyer, R. D 1982. Tissue culture studies in turmeric. In Proceedings of National Seminar on Ginger and Turmeric, Calicut (Nair, M.K, Premkumar, T., Ravindran P.N. and Sarma, Y.R. **(Eds.) pp. 39-41. CPCRI, Kasaragod.**

Sreenivasa Rao, N. K., Narayanaswamy, S., Chacko, E. K. and Doraiswamy, R. 1982. Regeneration of plantlets from callus of Elettaria cardamomum Maton. Proc. India. Aca Sci. (Plant Sci.) 91 : 37 - 41.

Withers, L. A 1991. Biotechnology and plant genetic resources conservation. In R.S. Paroda and R. K. Arora (Eds.). Plant Genetic Resources Conservation and Management - Concepts and Approaches. IBPGR, New Delhi p 273-297.

Withers, L. A and Williams, J. T. 1986. In vitro conservation; International Board of Plant Genetic Resources - **Research Highlights 1984-85.** IBPGR, Rome, 21p.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 54- 61, 1999

Genetic resources and conservation of black pepper

K. V. SAJI, JOHNSON K. GEORGE, B. SASIKUMAR, NIRMAL BABU, P. N. RAVINDRAN

Indian Institute of Spices Research
Calicut 673 012, Kerala

Abstract

Black pepper is the most important and most widely used spice. The black pepper of commerce is the dried mature fruit of the perennial climber *Piper nigrum* L. *Piper* is a large genus comprising more than a thousand species having maximum diversity in the Central and North America. *Piper nigrum* L. the cultivated black pepper, has originated in the humid tropical evergreen forests of Western Ghats. Besides *P. nigrum* all species closely related to black pepper also occur in the region.

The cultivated black pepper has evolved from the wild *P. nigrum*, over years of domestication and selection by man. More than a hundred black pepper cultivars are known, but many of them have disappeared during the past two decades due to various reasons.

In order to collect and conserve the genetic resources, the ICAR has established the National Conservatory of Black pepper at IISR, Calicut. The conservation strategy includes resource mapping for *in situ* conservation, field genebank and *in vitro* genebank in a complementary approach. Apart from this, smaller germplasm collections also exist in the co-ordinating centres of All India Coordinated Research Project on Spices. These genetic resources are being characterised and evaluated in a phased manner for yield, tolerance to biotic and abiotic stress factors and quality.

Introduction

Piper nigrum belongs to the family *Piperaceae*. Genus *piper* is distributed mainly in Central and South America in the new world and India, Malaysia, Indonesia and Sri Lanka in the old world. In India, the north east and the south west regions are recognised as two independent centres of distribution of the genus *Piper*. The earliest description of pepper was by Van Rheede (1678) in his *Hortus Indicus Malabaricus*, where he has described five types of wild pepper including black pepper and long pepper. The first major study on *Piper* spp. from Indian subcontinent was by Hooker (1886) in his Flora of British India where in he described few species under six sections. Rao (1914) listed 14 species of *Piper* from Western Ghats in his "Flowering Plants of Travancore". However, the most authentic study of *Piper* spp. was conducted by Gamble (1925) in his Flora of Presidency of Madras. Gamble listed 14 species with taxonomic keys.

Ravindran (1991) classified the South Indian *Piper* genus under two major sections *viz*., 'Pippali' and 'Maricha'. The major diagnostic character between them is the orientation of spikes; erect in 'Pippali' and pendent in 'Maricha'.

Four new taxa were reported by Ravindran *et al*. (1987) Velayudhan *et al*. (1992) and Nirmal Babu *et al* (1993).

Diversity in black pepper

The major centre of diversity of the genus *Piper* is central and northern South America where 60% of the species are concentrated. In India, north eastern region and south western regions are recognized as two independent centres of distribution of the genus *Piper*. Among the wild species which occur in India seventeen are reported from Western Ghats. (Table 1).

Table 1. *Piper* species reported from south India (Western Ghats)

Species
P. argyrophyllum Miq.
P. attenuatum Buch-ham
**P. barberi* Gamble
P. betle L.
**P. galeatum* (Miq) CDC
* *P. hymenophyllum* Miq.
**P. hapnium* Ham
**P. hookeri* Miq.
P. longum L.
P. mullesua Ham.
**P. nigrum* L.
**P. pseudonigrum* Velayudhan
**P. schimidtii* Hook. f.
**P. silentvalleyensis* Ravindran and Asokan
**P. sugandhi* Ravindran, Babu and Naik
P. trichostachyon CDC
**P. wightii* Miq.

*represent endemic species

Cultivar diversity is one of the principal components of diversity in black pepper. Over 100 cultivars are known. These cultivars differ in morphological characters like leaf size, shape, spike length, fruit shape, fruit size and also in biochemical characters. Most of the black pepper varieties are named in vernacular indicating a specific feature of the vine such as colour or appearance of the vine, leaf shape, spike features or the place from where the vine originated initially or by suffixing "kodi" after the name of a place or person. The cultivar diversity is given in Table 2.

Table 2. Cultivar diversity of (more important cultivars)

Cultivar/variety	Remarks
Aimpiryan	High yielder, performance excellent in higher elevations, good in quality.
Arakkulammunda	Moderate and regular bearer, medium in quality.
Balankotta	Cultivar with large droop leaves, moderate and irregular bearing medium in quality.
Bilimallegesara	Moderate yielder, grown in Karnataka State.
Chengannurkodi	Moderate yielder from South Kerala, medium in quality.
Cheppakulamundi	Moderate yielder from central Kerala, medium in quality
Cheriyakaniakadan	Popular in north Kerala, moderate and early bearing variety.
Jeerakamundi	Cultivar with small leaves and short spikes, alternate bear.
Kalluvally	A promising north Kerala cultivar, good yielder, medium in quality, high dry recovery, drought tolerant.
Karimunda	Most popular cultivar suitable for most of the black pepper growing areas, high yielder medium in quality.
Kottan	A cultivar found in north Kerala, moderate in yield medium in quality
Kottanadan	A high yielding cultivar from south Kerala, medium in quality, drought tolerant type.
Kutching	A high yielding Malaysian cultivar with medium quality.
Kurimalai	A cultivar from Karnataka, moderate yielder medium in quality
Kuthiravally	A cultivar with long spikes, high yield and good quality.
Kuttianikodi	A moderate yielder from central Kerala with relatively long spikes and good spiking intensity
Malamundi	A moderate yielder, medium in quality.

Malligesara	A common cultivar from Karnataka, relatively good in yield.
Manjamundi	A moderate yielder from north Kerala, medium in quality.
Narayakodi	Popular in south Kerala, moderate yielder medium in quality.
Neelamundi	A good yielder from central Kerala, medium in quality, tolerant to *Phytophthora* infection.
Nedumchola	A cultivar with small leaves and short spikes, moderate yielder.
Neyyattinkaramundi	A cultivar from central Kerala, medium in quality and yield.
*Panchami	An improved cultivar developed as a selection from Aimpiryan, high yielder.
*Panniyur –1	The first improved hybrid in black pepper. High yielding, popular throughout the pepper growing tracts, medium quality, bold berries.
*Panniyur –2	An improved cultivar, selection from open pollinated progenies of Balankotta high yielder, good in quality.
*Panniyur – 3	An improved hybrid with long spikes, high yield, medium quality.
*Panniyur –4	An improved cultivar developed as a selection from 'Kuthiravally'. Late maturing type, high yield medium quality.
*Panniyur –5	An open pollinated progeny selection from 'Perumkodi'. A good yielder, medium quality.
Perambramunda	A cultivar from north Kerala, moderate yielder, medium quality.
Perumkodi	A cultivar from central Kerala, moderate in yield and quality.
Poonjaranmunda	A cultivar originally from central Kerala, sporadically found in gardens of north Kerala. Moderately good in yield and quality.
*Pournami	An improved cultivar tolerant to root knot nematode. Good yielder, high quality.
*Sreekara	An improved selection from Karimunda high yielding type, medium quality.

*Subhakara	An improved cultivar selected from Karimunda high yielding type, medium quality.
Thommankodi	A cultivar from central Kerala, moderately good in yield and quality.
Thulamundi	A central Kerala cultivar, medium in yield and quality.
Uddagara	A popular cultivar of Karnataka, good in yield, medium in quality.
Vadakkan	A triploid cultivar from north Kerala, medium in quality and yield, relatively large berries.
Valiyakaniyakadan	A cultivar with larger leaves, medium in yield and quality.
Vattamundi	A moderate yielder from central Kerala.
Vellanamban	Relatively moderate yielder, medium in quality, characterised by the white colour of the young shoot tip.

* Improved variety

Collection and conservation strategies

Collection, conservation, cataloguing and evaluation of genetic resources of black pepper high priority area of work at the Indian Institute of Spices Research, Calicut. Systematic surveys of all pepper growing areas - the Western Ghats forests and part of the north east region of India where conducted to collect the existing variability of black pepper and *Piper* species. These accessions have been assembled at the National Repository of Black pepper Germplasm at IISR, Calicut. The collected accessions are conserved in the nursery, field genebanks and in *in vitro* genebank. Conservation of germplasm is done is four stages.

1. In nurseries where each accession is trailed in bamboo splits in serial orders and are under continous multiplication and maintenance.
2. In clonal repository where ten rooted cuttings of each accession are maintained.
3. In field genebank where the accessions are planted for evaluation
4. In *in vitro* genebank.

The multi conservation strategy is adopted because of the threat of disease epidemics. National Repository of Black pepper Germplasm at IISR is in the unique position of having the largest germplasm collection of black pepper in the world. The present status of the germplasm in the conservatory is 2969. Details of the accessions available in the conservatory are given in Table 3.

Table 3. Black pepper germplasm at IISR, Calicut

Species	No. of holdings
Piper nigrum	
a) Cultivated types	
1. Indigenous	650
2. Exotic	3
3. Karimunda selection	213
4. Kottanadan selection	75
5. Intercultivar hybrids	1016
6. OP progenies/cytotypes	120
7. Natural triploid	1
8. Induced tetraploid	1
Sub total	2079
b) Related taxa :	
P. arboreum	1
P. attenuatum	44
P. argyrophyllum	34
P. barberi	2
P. betle	12
P. colubrinum	2
P. chaba	1
P. crocatum	
P. galeatum	15
P. longum	18
P. hymenophyllum	19
P. magnificum	1
P. mullesua	6
P. sugandhi	2
P. sungandhi var. *brevipilis*	2
P. schmidtii	2
P. trichostachyon	12
P. wightii	6
Undetermined and doubtful taxa	46
c) Wild accessions	665
Total accessions	2969

Apart from this, small collections of black pepper germplasm are being maintained under the All India Coordinated Research Project on Spices located at different parts of the country. Details of germplasm holding of these centre are given in Table 4.

Table 4. Black pepper germplasm under the All India CoordinatedResearch Project on Spices

Centre	Cultivated (including exotic)	Wild and related species	Total
Pepper Research Station, Panniyur (Kerala)	75	120	195
Pepper Research Station, Sirsi (Karnataka)	50	15	65
Regional Agricultural Research Station, Chintapally (A.P)	27	19	46
Horticultural Research Station, Yercaud (Tamilnadu)	99	3	102

Discussion

The tropical evergreen forests of Western Ghats is as the centre of origin of black pepper. The bisexual types of cultivated forms, were probably originated from the wild ones as a result of continuous selection and vegetative propagation. A study of the species occurring in Western Ghats indicated that *P. nigrum* might have originated through hybridization between species with or without polyploidization of the hybrid. Ravindran (1991) suggested that three species namely *P. wightii*, *P. galeatum* and *P. trichostahyon* are the most probable putative parents of *P. nigrum*.

The most compelling evidence for this suggestion is the nature of the bracts. In *P. galeatum* the bracts are connate, fleshy and shoe shaped, in *P. wightii* the bracts are fully adnate to the rachis and the shape is more or less oblong. In *P. nigrum* bracts form a shallow cup like structure, this character being typically intermediate between the first two cases.

Recently the authors have surveyed the Anamudi forests, Munnar and found intermediate types types occuring in the forests. One of them, a bisexual type having more resemblance to *P. galeatum*. while another resembled more to *P. nigrum*. Probably these are missing links between the unisexual wild type.

Most of the wild species related to *Piper nigrum* are endemic to Western Ghats and their existence in this area is threatened due to one or other reasons. Wild species like *P. schmidtii*, *P. wightii* and *P. silentvalleyensis* occur only in certain restricted niches around 1500-2000 meter above sea level. The major menace faced by these species is human encroachment for the establishment of eucalyptus and tea plantations. It is necessary to have an *in situ Piper* gene sanctuary in Western

Ghats for conserving this valuable species and we feel that the time is already late for the establishment of such a gene sanctuary.

References

Gamble, J. S. 1925. Flora of the Presidency of Madras, Vol. II Botanical Survey of India, Calcutta.

Hooker, J. D. 1886. The flora of British India. Today & Tomorrow's printers & Publishers, New Delhi.

Nirmal Babu, K., Naik V. G. and Ravindran P. N. 1993. Two new taxa of *Piper (Piperaceae)* from Kerala, with a note on their origin and inter relationships. J. Spices & Aromatic Crops, 2 : 26-23.

Rao, M.. 1914. Flowering Plants of Travancore. Govt. Press, Trivandrum pp.336-338 (Reprint).

Ravindran P. N., Nair. M. K. and Asokan Nair, R 1987. New Taxa of *Piper (Piperaceae)* from silent valley forest. Kerala. J. Econ. Tax. Bot. 10 : 167-169.

Ravindran P. N. 1991. Studies on black pepper and some of its wild relatives. Ph. D thesis, Univ. Calicut, Kerala.

Rheede, H. van. 1678. *Hortus Indicus Malabaricus.* Vol-7 Ametelodam, PP 23-31.

Velayudhan. K. C. and Amal Raj V. A. 1992. *Piper pseudonigrum* - a new species from Western Ghats J. Eco. Tax. Bot. 16 : 247-250.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 62- 67, 1999

Genetic variability and adaptation to moisture stress in black pepper germplasm accessions

K. S. KRISHNAMURTHY, S. J. ANKEGOWDA* & K. V. SAJI

Indian Institute of Spices Research
Calicut 673 012, Kerala

Abstract

One hundred black pepper accessions were studied for various physiological characters like relative water content, membrane leakage, stomatal resistance and transpiration rate. Though all the accessions exhibited similar values (lesser range) for these parameters under control (well watered) conditions, the values differed significantly (wider range) under moisture stress. The relevance of these parameters under moisture stress and the possibility of utilizing these parameters for screening black pepper germplasm accessions for moisture stress is discussed.

Introduction

Crop responses to water deficit are mediated by processes of response to water deficit and associated strains at various levels of plant organization. Drought has been a major challenge to crop physiologists and plant breeders in many crops despite several decades of research. Drought seldom occurs in isolation. It often interacts with other abiotic (mostly high temperature) and with biotic stresses. This makes breeding for drought resistance more complex (Ceccarelli and Grando, 1996). Here lies the importance of screening germplasm as the germplasm may have variants which can adapt to extreme environments and yield better than the rest. Utility of certain physiological parameters such as stomatal resistance, transpiration rate and leaf water potential (Vasantha *et al.*, 1990) have

* Cardamom Research Centre, Appangala, Madikeri, Karnataka

been implicated in literature for germplasm screening. It is in this context that a preliminary study was conducted with the objective to screen black pepper germplasm accessions for their adaptation to moisture stress based on above mentioned physiological parameters. The experiment was conducted at the Indian Institute of Spices Research, Calicut. One hundred black pepper germplasm accessions were used in the study. Cuttings of the selected accessions were raised in polybags containing 3:1:1 forest soil : sand : FYM. The cuttings were maintained in polybags till sufficient growth was attained. Stress was imposed when plants developed 10-15 leaves. The experiment was conducted under shade. Observations on stomatal resistance, transpiration rate, relative water content and cell membrane leakage were recorded one day prior to stress induction, four and eight days after stress induction. Stomatal resistance and transpiration rate were measured using steady state porometer (LI 1600).

Relative water content was calculated using the formula, RWC (%) = fw-dw/tw-dw X 100 where, RWC = Relative water content, tw = turgid weight of leaf discs after immersing leaf discs in double distilled water for 4h, fw=fresh weight of the leaf discs and dw = dry weight of the leaf discs. To calculate membrane leakage percentage, leaf discs were incubated in double distilled water in test tubes for 3h and at the end of 3h, optical density of the diffusate was read at 273nm. This was treated as initial reading. Then the contents of the tube were boiled at 100^{0}C for 10 minutes on a hot water bath to release all solutes, then cooled, filtered and optical density of the filtrate read at 273 nm. This was treated as final reading. Membrane leakage was calculated using the formula. Percent membrane leakage = initial OD/final OD x 100. The data were subjected to statistical analysis using MStat C package. Also mean, range and class interval (CI) under each range and frequency (F) of accessions under each CI were worked out.

Variability for drought resistance parameters

Stomatal resistance varied significantly among accessions both under control and stress conditions (Table 1). Stomatal resistance ranged between 0.75 to 3.0 sec cm^{-1} with an average of 1.9 under control and that under eight days after stress ranged from 13 to 23 with a mean of 18.2 sec cm^{-1}. About sixty five per cent of accessions showed <2 sec cm^{-1} under control while it was only ten per cent after 4 days of stress. About eighty per cent of accessions recorded values between 16 and 21 after eight days of stress. The results clearly demonstrate the change in stomatal resistance with stress intensity and also varied stomatal response among accessions to moisture stress.

Table 1. Mean stomatal resistance (sec cm^{-1}), range, class interval (CI) and frequency (F) of accessions under each class interval under control and stress conditions

		Stomatal resistance (sec cm^{-1})			
		Control	Stress (4d)	Stress (8d)	
Range		0.75 -3.0	1.0 - 5.0	13 - 23	
Average		1.9	3.4	18.2	
CD (p= .05)		0.38	0.46	2.15	
CI	F	CI	F	CI	F
0.75 - 1.25	25	1.00 - 2.0	10	13-15	12
1.26 - 2.00	40	2.01 - 3.0	50	16 -18	46
2.01 - 3.00	35	3.01 - 4.0	32	19 - 21	34
		4.01 -5.0	08	22 - 24	08

Table 2 shows significant variations in transpiration rate among black pepper accessions as affected by moisture stress. Transpiration rate decreased drastically under moisture stress and after eight days of stress, transpiration rate was reduced to 1.7 (0.75 to 3.5 range) from an average of 11.2 (range of 6.5 to 15) cm S^{-1} under control condition. Sixty eight per cent genotypes showed values between 1.3 to 2 cm S^{-1} under eight days of stress while 14% showed lower transpiration values which may be a useful trait under long duration stress which is mostly experienced by black pepper during summer.

Table 2. Mean transpiration rate (cm S^{-1}), range, class interval (Cl) and frequency S^{-1} (F) of accessions under each class interval under the control and stress conditions.

		Transpiration			
		Control	Stress (4d)	Stress (8d)	
Range		6.5 - 15.0	3.5 - 12.0	0.7 - 3.5	
Average		11.2	7.4	1.7	
CD (p=.05)		0.94	1.05	0.31	
CI	F	CI	F	CI	F
6.5 - 9.0	42	3.5 - 6.0	44	0.7 - 1.2	14
10.0 - 12.0	30	7.0 - 9.0	40	1.3 - 2.0	68
13.0 - 15.0	28	10.0 - 12.0	16	2.1 - 3.5	18

Relative water content decreased in all accessions with stress intensity (average of 93.4 under control to 62.7 per cent under eight day after stress) and the extent of decrease varied among accessions (Table 3). Eighty six per cent of accessions showed values above 90 per cent under control while only 16 per cent of accessions showed values above 80 per cent after eight days of stress. Fifteen per cent of accessions showed very low values (32-47%). The data indicates the amount of variability among accessions for their adaptation to moisture stress with respect to relative water content.

Table 3. Mean relative water content (%), range, class interval (CI) and frequency (F) of accessions under each class interval under control and stress conditions.

	Relative water content (%)				
	Control	Stress (4d)	Stress (8d)		
Range	78 - 100	60 - 98	37 - 95		
Average	93.4	87.2	62.7		
CD (p=.05)	1.17	3.83	5.28		
CI	F	CI	F	CI	F
79 - 84	02	60 - 69	03	32 - 47	15
85 - 90	11	70 - 79	14	48 - 63	42
91 - 96	78	80 - 89	28	64 - 79	27
97 - 100	08	90 - 99	52	80 - 95	16

Black pepper accessions showed differential membrane leakage values in response to moisture stress (Table 4). Though the response varied even under control condition, the range was small (3.96 to 6.96 per cent) when compared to the response eight days after stress (6.1 to 34.2 per cent). Ninety one per cent of accessions showed values between 3.96 and 6.21 under control while only 12 per cent of accessions recorded values ranging from 8 to 13. This again highlights the extent of genetic variability among germplasm accessions which may be helpful for further crop improvement.

Discussion

Most of the physiological processes of the plant are altered when plants are subjected to abiotic stresses. Role of physiological parameters such as stomatal resistance, transpiration rate and leaf water potential under water stress condition is well documented in literature (Jones *et. al.,* 1985; Rajagopal *et al.,* 1988). Reduction in stomatal conductance, photosynthetic rate, leaf water potential and transpiration rate under field condition as crop water stress index increased was noticed by Neilson and Anderson, 1989. Drought stress is known to reduce leaf carbon exchange rates due

Table 4. Mean membrane leakage (%), range, class interval (CI) and frequency (F) of accessions under each class interval under control and stress conditions

	Membrane leakage (%)				
	Control		Stress (4d)		Stress (8d)
Range	3.96 - 6.96		4.75 - 21.75		6.10 - 34.20
Average	5.2		9.4		14.2
CD (p=.05)	0.42		1.04		2.3
CI	F	CI	F	CI	F
3.96 - 4.70	22	5.0 - 10.0	74	6.0 - 7.0	12
4.71 - 5.45	47	11.0 - 16.0	20	8.0 - 13.0	53
5.46 - 6.21	22	17.0 - 22.0	06	14.0 - 19.0	20
6.22 - 6.96	09			20.0 - 25.0	03
				26.0 - 34.0	12

to both stomatal and non-stomatal mechanisms (Cortes and Sinclair, 1987; Nicolodi *et al.*, 1988). In the present study also black pepper exhibited similar response. Moreover, significant genotypic variations were recorded for transpiration rate and stomatal resistance. These parameters may be used to screen black pepper germplasm for drought tolerance (Vasantha *et al*, 1990) during initial stages of stress. Under severe stress conditions, these parameters may not be useful as all geneotypes show similar values. Under severe stress, water loss was minimized by a steep decrease in transpiration rate while under mild stress leaf water potential is maintained by a slow decline in transpiration rate.

Significant variations also existed for relative water content and membrane leakage percentages among black pepper accessions. Relative water content is related to the water potential of the same tissue though the relationship is dependent on species and stages of growth (Roberts and Knoerr, 1977). Leaf water potential is dependent on transpiration rate (Schulze and Hall, 1982). The leaf water retention capacity as one of the essential character of drought tolerant genotypes of wheat and oats was reported by Ritchie *et. al.*, 1990. Similarly, ion leakage was relatively less in drought tolerant wheat and sunflower cultivars (Deshmukh *et al.*, 1985). Similar observation was made in black pepper also in the present study. In essence, large amount of genetic variation exists for drought response and this variation may be amplified by molecular means or by hybridizing with their wild relatives (Richards, 1996) to develop stress tolerant lines.

Acknowledgement

The authors thank the Director, Indian Institute of Spices Research, Calicut for providing facilities to carry out the work.

References

Ceccarelli, S and Grando, S. 1996. Drought as a challenge for the plant breeder. Plant Growth Regulation, 20 : 149-155.

Clarke, J. M. and Mc Caig, T. N. 1982. Evaluation of technologies for screening drought resistance in wheat. Crop Sci., 22 : 503-506.

Cortes, P. M. and Sinclair, T. R. 1986. Gas exchange of field grown soybean under drought. Agron. J. 78 : 454-458.

Deshmukh, P. S., Hill, R. D., Shukla, D. S. and Wasnik, K. G. 1985. Influence of high temperature stress on ion leakage and nitrate reductase activity in crop plants. Proc. National Seminar on Plant Physiology, Imphal, Manipur, Dec 15-17, pp. 1-6.

Jones, G. H., Lakso, A. N. and Syvertsen, J. P. 1985. Physiological control of temperate and subtropical fruit trees. Hort. Rev. 7 : 301-344.

Neilson, D. C. and Anderson, R. L. 1989. Infared thermometry to measure single leaf temperature for quantification of water stress in sunflower. Agron. J. 81 : 840-842.

Nicolodi, C., Massacci, A and Di Marco, G. 1988. Water stress effect on net photosynthesis in field grown alfalfa. Crop Sci, 28 : 944-948.

Rajagopal, V., Kasturibai, K. V., Voleti, S. R. and Shivashankar, S. 1988. Water stress in coconut palms. Intern. Congress Plant Physiol. p. 135.

Richards, R. A. 1996. Defining selection criteria to improve yield under drought. Plant Growth Regulation, 20 : 105-111.

Ritchie, S. W., Nguyen, H. T. and Holiday, A. S. 1990. Leaf water content and gas exchange parameters of two wheat genotypes differing in drought resistance. Crop Sci. 30 : 105-111.

Roberts, G. W. and Knoerr, K. R. 1977. Components of water potential estimated from xylem pressure in five tree species. Oecologia, 28 : 191-202.

Schulze, E. D. and Hall, A. E. 1982. Stomatal responses, water loss and CO2 assimilation rates of plants in contrasting environments. In : Physiological : Plant ecology II. Water relations and carbon assimilation (ed.) O.L. Lange et. al., Encyclopedia of Plant Physiology. Vol. 12B. Springer Verlag, Berlin, pp. 181-230.

Vasantha, S., Varghese Thomas, T., Ramadasan, A. and John Zachariah, T. 1990. Drought tolerance in black pepper (*Piper nigrum L.*) cultivars. An evaluation of physiological parameters. Ind. J. Plant Physiol. 33 : 363-366.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 68- 72, 1999

Genetic resources and diversity of cardamom

K. J. MADHUSOODANAN, V. V. RADHAKRISHNAN & K. M. KURUVILLA

Indian Cardamom Research Institute
Myladumpara - 685 553
Idukki, Kerala.

Abstract

Cardamom (*Elettaria cardamomum* Maton) is native to the Western Ghats of India. Considerable variability is collected in the country for this cross pollinated but clonally propagated crop. The paper describes the history of cardamom research, genetic resources, and new varieties/hybrids available.

Introduction

Small cardamom (*Elettaria cardamomum* Maton), is indigenous to India and its natural habitat is the evergreen rainforests of Western Ghats of South India. The crop is an inseparable component of the forest ecosystem and it is cultivated under the shade of tree canopy. India ranks first in the cardamom map of the world covering an area of 72,444 ha, out of which 40,867 ha are in Kerala, 25,686 ha in Karnataka and 5,891 ha in Tamil Nadu (Radhakrishnan *et al.*, 1998). From north to south, it is an elongated tract extending over 1200 km, from Sirsi of Karnataka. From east to west, it is a narrow belt of land distributed over the Western Ghats at elevations ranging from 600 to 1500 M above MSL.

History of research and germplasm collection

Cardamom being a cross-pollinated crop, a lot of phenotypic variants exist in nature. Inspite of its prominence in world trade from time immemorial, cardamom received research attention for genetic upgradation only in the second half of this century (Madhusoodanan and Radhakrishnan, 1996). Six research organisations viz., Indian Cardamom Research Institute (Spices Board); Indian Institute of Spices Research (ICAR); Regional Research Station, Mudigere (UAS, Banglore); Cardamom Research Station, Pampadumpara (KAU); Horticultural Research Station, Yercaud (TNAU) and UPASI, Vandiperiyar, are at present engaged in research on improvement of cardamom. Regular surveys for germplasm collection are being undertaken by these institutes for gathering the available natural variants in cardamom and exploit the desirable genes through various crop improvement techniques. Collections are being made based on some passport characters and cataloging done based on the descriptor prepared by Dandin *et al.* (1981) in the earlier days. During 1994, a descriptor for cardamom was brought out by the International Plant Genetic Resources Institute, Rome, Italy.

Varieties

E. cardamomum exhibits an array of variation and naming of types after the place of cultivation has led to confusion regarding identity of varieties. Based on the size of fruits, two types namely *E. cardamomum* var. major Thw. and *E. cardamomum* var. minor Walt. are recognised. This classification is not widely accepted due to lack of distinct demarkation on the size and shape of fruits. Considering the nature of panicles, three cultivars of cardamom such as 'Malabar', 'Vazhukka' and 'Mysore' are recognised. Cultivar 'Malabar' is characterised by prostrate panicle while cv. 'Mysore', erect panicle – 'Vazhukka', a natural hybrid between these two has semi erect panicle.

Conservation

Extensive surveys for germplasm in cardamom have resulted in the collection of a large number of indigenous samples in different centres. These valuable resources are being conserved *ex situ* in the field genebanks in respective institutions (Table 1).

Table 1. *Germplasm accessions available in* different organisations

Organisation	Accession
Indian Cardamom Research Institute	660
Indian Institute of Spices Research	288
Regional Research Station, Mudigere	245
Cardamom Research Station, Pampadumpara	77
Horticultural Research Station, Yercaud	35
UPASI, Vandiperiyar	45

Source, ACIRP on Spices, Annual Report - 1996-97

Characterisation and documentation

Efforts to characterise germplasm resources in cardamom are going on at various centres. The accessions available at Regional Research Station, Mudigere have been characterised based on the criteria such as pubescence on foliage, height and colour of psuedostem, panicle type and size and shape of capsules. This has resulted in the identification of 26 distinct types (Krishnamurthy *et al.*, 1989). Sudharshan *et al.* (1988) categorised 276 accessions based on the morphological traits and recognised 29 types of cardamom. These types of characterisations are however too preliminary and vague. Considering the importance of characterisation, documentation based on the descriptor for cardamom published by IPGRI is in progress. Some of the exceptional variants in cardamom have panicles of various types, terminal panicle, branched raceme, female sterility and cleistogamy (Madhusoodanan *et al.* , 1994).

Utilisation

The genetic resources available with different centres are not fully exploited in the breeding programmes. Crop improvement techniques such as selection and hybridisation employed by the centres have resulted in the development of a few elite clones adapted to different agroclimatic conditions. Presently Mudigere-1, CCS-1, PV-1, some of the selections from ICRI (ICRI-1, 2, 3 and 4) and 'Njallani Green Gold' are the high yielding varieties being popularised among the planters for large scale cultivation (Table 2). Selected clones were utilised for hybridisation and a few F_1 hybrids were also evolved (Table 3). Intergeneric hybridisation has been carried out between *E. cardamomum* (female parent) and *Amomum subulatum, Alpinia neutans, Hedychium flavescence and H. Coronarium* (male parents) by Parameshwar (1997). Out of all the combinations, cross with *Alpinia neutans* is the only one reported to have produced a few seeds. Hybridisation of cardamom with *Aframomum* sp. and *Alpinia galanga* gave no seed set due to incompatibility barriers (Madhusoodanan *et al.*, 1988).

Table 2. Released and pre released clones in cardamom

Selection	Cultivar	Source
*ICRI-1	'Malabar'	Indian Cardamom Research Institute
*ICRI-2	'Mysore'	Indian Cardamom Research Institute
*ICRI-3	'Malabar'	Indian Cardamom Research Institute
**ICRI-4	'Mysore'	Indian Cardamom Research Institute
**MCC-12	'Malabar'	Indian Cardamom Research Institute
**MCC-21	'Vazhukka'	Indian Cardamom Research Institute
**MCC-40	'Malabar'	Indian Cardamom Research Institute
**MCC-85	'Mysore'	Indian Cardamom Research Institute
*CCS-1	'Malabar'	Indian Institute of Spices Research
* RR-1	'Malabar'	Indian Institute of Spices Research
*Mudigere-1	'Malabar'	Regional Research Station, Mudigere
*PV-1	'Malabar'	Cardamom Research Station, Pampadumpara.

* Released **Pre-release

Table 3. Cardamom - F_1 hybrids evolved at ICRI, Myladumpara

Hybrid	Projected yield (kg/ha)
MCC-16 x MCC-40	610
MCC-61 x MCC-40	675
MCC-21 x MCC-16	650
MCC-21 x MCC-40	870
MCC-16 x MCC-61	800

Biotechnological approaches

A few of the prospective biotechnological areas relevant to cardamom are *in vitro* propagation, production of androgenic plants for raising homozygous lines, somatic hybridization through protoplast fusion, and *in vitro* germplasm conservation.

In vitro protocol for cardamom has been developed and refined at various laboratories in the country and it is being employed for the commercial production of planting material. Somatic embryogensis is one of the alternative methods adopted for ensuring the genetic uniformity of tissue culture plantlets. *In vitro* conservation protocol was standardised for medium term conservation of cardamom (Nirmal Babu *et al.*, 1996).

Acknowledgements

The authors wish to express their deep sense of gratitude to Dr. S. N. Potty, Director, ICRI, Myladumpara for facilities and encouragement. Thanks are also due to Smt. Sreelatha Haridas and Shri K. Vijayakumar for secretarial assistance.

References

Krishnamurthy, K., Khan, M. M., Avadhani, K. K., Venkatesh, J., Siddaramaiah, A. L., Chakravarthy, A. K. and Gurumurthy, B. R. 1989. Three decades of cardamom research at Regional Research Station, Mudigere, UAS, Banglore, p. 97.

Madhusoodanan, K. J., Sudharshan, M. R. and Kuruvilla, K. M. 1988. Improved crop variety for higher yield and better capsule quality in cardamom. Spice India.1 :10-13.

Madhusoodanan, K. J., Kuruvilla, K. M., and Priyadarshan, P. M. 1994. In: Advances in Horticulture. Vol. 9 (1) Plantation and Spice crops. (eds). K. L Chadha and P. Rethinam). Malhothra Publishing House, New Delhi. pp. 121-129.

Madhusoodanan, K. J. and Radhakrishnan, V. V. 1996. Cardamom breeding in Kerala. In: Proceedings of the Seminar on Crop Breeding in Kerala. Department of Botany, University of Kerala. pp. 73-81.

Nirmal Babu, K., Geetha, S. P., Manjula, C., Sajina, A., Minoo, D., Samsudeen, K., Ravindran, P. N. and Peter, K. V. 1996. Biotechnology - its role in conservation of genetic resources in spices. In: Biotechnology for development. The State Committee on Science, Technology and Environment, Kerala. pp. 175-197.

Parameshwar, N. S. 1997. Intergeneric hybridisation between cardamom and related genera. Curr. Res. 6 : 10.

Radhakrishnan, V. V., Madhusoodanan, K. J. and Kuruvilla, K. M. 1998. Tree flora of cardamom tract. Journal of Environmental Resources (in press).

Sudharshan, M, R., Kuruvilla, K. M. and Madhusoodanan, K. J. 1988. A key to the identification of types in cardamom. J. Plant. Crops. 18 : 52-55.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 73- 78, 1999

Biodiversity and conservation of cardamom (*Elettaria cardamomum* Maton)

K. PADMINI, M. N. VENUGOPAL & V. S. KORIKANTHIMATH

Indian Institute of Spices Research
Cardamom Research Centre
Appangala, Madikeri - 571 201, Karnataka.

Abstract

Small cardamom (*Elettaria cardamomum* Maton) contributes a major share in earning India's foreign exchange. *Elettaria* is a monotypic genus of the family Zingiberaceae cultivated in the evergreen forests of Western Ghats in South India. Small cardamom being a cross-pollinated crop exhibits a wide range of variability for many characters of scientific and commercial interest. Genetic variants exist for precocity, panicle emergence, length, position and branching of panicles, number of panicles per tiller, size and shape of leaf length and size of tiller, number of capsules per raceme, size, shape and colour of matured capsules, essential oil content and resistance to disease which could be used in further crop improvement programmes. However, the bottlenecks in conservation of cardamom genetic resources are i) purity of accessions in *ex-situ* conservatory and genebanks in field. ii) under utilization of related genera such as *Alpinia* and *Amomum* to transfer resistance against viral diseases and iii) deforestation and disturbance to natural habitats of cardamom. Rapidly dwindling area under cardamom and convertion of cardamom area for other remunerative crops like pepper and coffee etc are also posing serious threat to genetic resources of cultivated types. Detailed study of genetic, cytological and biochemical aspects of variation and evaluation for identifying types with high essential oil content, endurance against drought and pests and resistance against diseases needs to be taken up.

Introduction

Small cardamom (*Elettaria cardamomum* Maton) is an important spice crop with good export potential. India has a rich wealth of genetic resource of cardamom as the crop originated in the tropical forests of Western Ghats. Cardamom being a cross-pollinated crop, a lot of diversity exists in the population which can be exploited both for commercial and scientific interest. The current situation experiences a fall in cardamom cultivation even in the traditional cardamom growing regions due to prevailing low prices and many complex problems. The rapid shift from cardamom to other remunerative crops is gaining impetus in most of the conventional cardamom growing zones due to economic reasons. The deforestation and conversion of cardamom areas is posing a serious threat to the genetic resources. The genetic resources of cardamom have been well documented by Mayne (1951), Abraham and Tulasidas (1958), Madhusoodanan *et. al.*, (1994), Sudarshan *et. al.*, (1989) and Sudharshan *et. al.* (1991). This paper attempts to analyze the existing variability among cardamom genotypes for use in breeding programmes and practical problems and thrust areas in conservation.

The study was conducted at Indian Institute of Spices Research, Cardamom Research Centre, Appangala, Madikeri, Kodagu district, Karnataka which is located in heavy rainfall regions (2500-3500 mm per annum) at an elevation of 1000m above MSL. The experimental material involved 210 accessions spaced 2mx2m between the rows and plants. The accessions represented collections and distinct morphotypes, from cardamom growing tracts suchas Wayanad, Anamalais, Manjoli Hills, Nelliampathy, Lower Pulneys, Meghamalai and Cardamom hills. Crop was raised as per the standard practice in vogue. Observations were recorded on plant height, total number of tillers, bearing tillers, pseudostem diameter, number of leaves/plant, leaf length, leaf breadth, number of panicles/plant, length of the panicle, number of nodes/panicle, internode length, capsule length and capsule breadth as recommended in IPGRI descriptor 1994. The data were statistically analyzed for range, mean and co-efficient of variation between and within 'Malabar', 'Mysore' and 'Vazhukka' types (Panse and Sukhatme, 1957).

Variability

A wide range of variation was observed between and within cultivars of small cardamom for economically important characters and the results are presented in Tables 1, 2 and 3.

Variability among types of small cardamom

In general, the 'Vazhukka' and 'Mysore' types were robust, compared to 'Malabar' types. The total number of tillers and bearing tillers per plant and pseudostem diameter, number of leaves was also higher in 'Vazhukka' and 'Mysore' types than 'Malabar' types. The mean number of panicles/plant was highest in 'Malabar' (42.65) followed by 'Mysore' (40.18) and 'Vazhukka' (37.25). The mean internode length was shortest (3.05 cm) in 'Malabar' types compared to other types. This is a desirable feature as plants with shorter internodes on panicles would lead to compact bearing nature of capsules. The characters like number of panicles per plant, number of nodes/panicle, internode length and capsule length, exhibited high co-efficient of variation.

Variability in 'Malabar' types

The co-efficient of variation (CV%) was the highest for number of panicles/plant (78.76) followed by capsule breadth (69.77) and bearing tillers/plant (56.30). Number of panicles/plant was highest in the Acc. 75 of 139.33. Capsule breadth was maximum in the Acc. 40 (3.20). Acc. 58 recorded the highest number of bearing tillers per plant of 27. Moderate variability existed for yield contributing characters such as panicle length, number of nodes/panicle, internode length, capsule length, number of leaves per plant and total tillers/plant. Internodal length was minimum (2.17 cm) in Acc. 8 resulting in compact bearing nature of capsules. Leaf length and leaf breadth exhibited low variability but leaf breadth varied from 3 cm in Acc. No. 124 to 11.33 in Acc. 58.

Table 1. Variability in small cardamom cv Malabar

Characters	Mean	Range	CV (%)
Plant height (cm)	1.67	0.58 - 2.19	20.96
Total tillers/plant	28.92	0.66 - 61.33	39.49
Breeding tillers/plant	8.65	0.00 - 27.00	56.30
Pseudostem diam (cm)	1.08	0.32 - 1.99	23.15
No. of leaves/plant	20 8.93	10.00 - 411.80	43.64
Leaf length (cm)	46.96	19.00 - 64.00	15.74
Leaf breadth (cm)	7.64	3.00 - 11.33	17.80
No. of panicles/plant	42.65	0.00 - 139.33	78.76
Panicle length (cm)	35.18	0.00 - 80.83	43.69
No. of nodes/panicle	16.71	0.00 - 29.00	36.39
Internode length (cm)	3.05	0.00 - 5.13	32.79
Capsule length (cm)	0.69	0.00 - 1.50	42.03
Capsule breadth (cm)	0.43	0.00 - 3.20	69.77

Variability in 'Mysore' types

A high variability was exhibited for number of panicles/plant (74.81%) and internode length (69.31%). Maximum number of panicles/plant of 135.60 was recorded in Acc. 98. Internodal length ranged from 1.30 cm to 4.63 cm, the least being recorded in Acc. 109. Moderate variability existed for the character number of bearing tillers/plant, capsule breadth, capsule length, total tillers/plant and number of leaves/plant. Least CV of 14.87 per cent was recorded for leaf length.

Table 2. Variability in small cardamom cv Mysore

Characters	Mean	Range	CV (%)
Plant height (cm)	1.72	0.91 - 2.28	18.60
Total tillers/plant	31.78	13.66 - 67.90	30.28
Breeding tillers/plant	9.58	5.15 - 11.00	36.01
Pseudostem diam (cm)	1.26	0.83 - 1.81	19.84
No. of leaves/plant	250.08	45.80 - 421.70	32.83
Leaf length (cm)	49.16	35.00 - 61.00	14.87
Leaf breadth (cm)	8.44	5.15 - 11.00	17.06
No. of panicles/plant	40.18	1.00 - 135.60	74.81
Panicle length (cm)	41.73	21.30 - 74.80	28.80
No. of nodes/panicle	20.18	7.33 - 30.67	25.07
Internode length (cm)	3.78	1.30 - 4.63	69.31
Capsule length (cm)	0.83	0.30 - 1.43	36.14
Capsule breadth (cm)	0.47	0.20 - 1.05	40.43

Variability in 'Vazhukka' types

Highest co-efficient of variation (CV) was recorded for number of panicles/plant (74.50%) followed by number of bearing tillers/plant (62.32%). Number of panicles/ plant ranged from 2 to 138.7. Acc. 138 recording the maximum panicle numbers. Number of tillers ranged from 1.33 to 33. Moderate to low variability existed for capsule length, number of leaves/plant, panicle length, number of nodes/panicle, capsule length and breadth. The characters leaf length exhibited the lowest variability with a co-efficient of variation of 9.28 per cent.

Conservation of cardamom genetic resources

Since cardamom exhibits diversity for economically important traits, the genetic resources need to be conserved otherwise, it would be lost for ever. Some of the methods of conservation of cardamom are as follows.

1) *In situ* conservation : In this method, accessions are maintained in field conditions itself as clonal repository or field or genebanks.

2) *Ex situ* conservation: Conservation in this method is of three types.

i) Short term storage by inducing slow growth in micro-propagated plants.

ii)Long term storage by means of cryopreservation using liquid Nitrogen at 196°C

iii) Field genebanks.

Under *in situ* conservation or conservation in field genebanks, there are many chances of exposure of the genetic resources to recurring biotic and abiotic stresses particularly, drought, treefall, viral diseases, root grubs, hairy caterpillars and rhizome rot. Establishment of in vitro genebanks will serve as a safe alternative in protecting the precious genetic resources. The purity of the genetic material conserved, conservation and safe exchange of disease free germplasm also pose problems in conservation of cardamom genetic resources.

Exploitation of exotic biodiversity

Though cardamom is a native of India, it is grown in countries such as Guatemala, Ceylon, Papua New Guinea and Malaysia and no information is available regarding utilization of those germplasm resources. Systematic expeditions are organized in the places where cardamom and allied members are found in wild state within the country. Similar expeditions and collections through National Bureau of Plant Genetic Resources (NBPGR), New Delhi are to be organized to exploit the diversity in exotic cardamom resources.

Utilization of related genera

The related genera *Hedychium* and *Alpinia* belonging to the same family Zingiberaceae possess resistance to disease and these have not been well utilized in crop improvement programmes of cardamom. Emphasis should be given on these areas for transfer of resistance to disease in cultivated cardamom.

Genetic, cytological and biochemical studies

Indepth studies need to be taken up on genetic, cytological and bio-chemical aspects of cardamom. The variation existing in cardamom needs to be studied on the basis of chromosomal number and biochemical markers.

Table 3. Variability in small cardamom cv Vazhukka

Characters	Mean	Range			CV (%)
Plant height (cm)	1.81	1.38	-	2.20	13.25
Total tillers/plant	31.65	16.33	-	42.33	23.19
Breeding tillers/plant	9.90	1.33	-	33.00	62.32
Pseudostem diam (cm)	1.30	1.05	-	1.56	12.31
No. of leaves/plant	246.49	115.00	-	409.00	28.46
Leaf length (cm)	49.26	42.00	-	57.67	9.28
Leaf breadth (cm)	8.06	6.33	-	11.33	14.76
No. of panicles/plant	37.25	2.00	-	138.70	74.50
Panicle length (cm)	44.71	28.63	-	76.70	25.27
No. of nodes/panicle	20.74	11.50	-	27.33	24.30
Internode length (cm)	3.46	1.90	-	4.67	18.21
Capsule length (cm)	0.86	0.46	-	1.37	30.23
Capsule breadth (cm)	0.47	0.30	-	0.73	23.40

Cataloguing and evaluation

Effective cataloguing and evaluation of cardamom germplasm for high yield, essential oil content, drought tolerance and resistance to pests and diseases needs immediate attention.

Documentation

Documentation of the data on genetic resources and utilizing the variability in future crop improvement programmes is a must to increase the production potential of cardamom.

References

Abraham, P. and Tulasidas, G. 1958. South Indian Cardamoms and their agricultural value. ICAR Bulletin, 79 : 1-27.

IPGRI, 1994. Descriptors for cardamom (*Elettaria cardamomum* Maton). International Plant Genetic Resources Institute, Rome, pp. 27-41.

Madhusoodanan, K. J., Kuruvilla, K. M. and Priyadarshan. P. M. 1994. Genetic resources of cardamom. In: Advances in Horticulture, Vol. 9(1). Plantation and Spice Crops. (eds.) K.L. Chadha and P. Rethinam, Malhotra Publishing House, New Delhi, pp. 121-130.

Mayne, W. W. 1951. Report on cardamom cultivation in South India. ICAR Bulletin, 50 : p. 62.

Panse, V. G. and Sukhatme, P. V. 1957. Statistical methods for agricultural workers. ICAR, New Delhi, p. 36.

Sudharshan, M. R., Madhusoodanan, K. J and Jagadeesan, P. J. 1989. Evaluation of germplasm in cardamom. J. Plant. Crops, 16 (Supplement) : 331-334.

Sudharshan, M. R., Kuruvilla, K. M. and Madhusoodanan, K. J. 1991. A key to the identification of types in cardamom J. Plant. Crops, 18 (Supplement) : 52-55.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 79- 81, 1999

Biodiversity of chillies in India and its utilisation

S. J. PATIL, R.C. JAGADEESHA & S. SIRASAT

University of Agricultural Sciences
Dharwad – 580 005, Karnataka.

Abstract

Capsicum or Chilli is a native of the new world tropics and subtropics. The genus *Capsicum* belongs to the family Solanaceae. Five major cultivated species are known viz., *Capsicum annuum, C. chinense, C. frutesense, C. pendulum* and *C. pubesense. C. annuum* is divided into five major groups. Crossability between species, diversity and breeding of 'Byadagi' chilli are mentioned.

Introduction

Chilli is used as spice, condiment, culinary supplement, medicine, vegetable and ornamental plant. Globally, chillies are grown over 1.816 m ha producing about 10.598 m tonnes of fresh and dry fruits. India ranks first in the world with an area of 8,10,400 ha (46%) of world area. But production (7,47,00 tonnes) and productivity (923 kg/ha) are considerably low in India. Five states *viz.*, Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and Orissa contribute over 85% of chilli production, 95% of which is consumed within the country.

Origin and botanical classification

Capsicum or chilli is a native of the new world tropics and subtropics. The word *Capsicum* is possibly derived from the Greek word "Kapso" meaning "to bite" with reference to pungency. Dried *Capsicum* pods were recovered from 2000 year old burials in Peru. Capsicum was unknown to the old world till 16th century. Columbus on his way back home introduced *Capsicum* to Spain in 1493. Portuguese introduced *Capsicum* to India by 16th century *via* Brazil. The major countries growing *Capsicum* are India, Nigeria, Mexico, China, Indonesia and Korean Republic.

The genus *Capsicum* belongs to family Solanaceae. It comprises of 20-30 species of the New World tropics and sub tropics. Five major species are-

1. *Capsicum annuum, C. frutescense, C. chinense, C. pendulum, and C. pubesense*

These five major cultivated species are derived from different ancestral stocks found in 3 distinct centres of origin *viz.*, *Capsicum annuum* : Mexico (Primary Centre) Guatimala (Secondary Centre); *Capsicum chinense* : Amazonia; *C. frutescense* : Amazonia; *C. pendulum* : Peru, Bolivia; *C. pubescense* : Peru, Bolivia.

C. annuum is classified into 5 major groups

Ceraliforme: Cherry pepper – Fruit erect globose, up to 2-5 cm across, yellow or purplish green, very pungent.

Conoides: Cone pepper – Fruit usually erect, conical or oblong, cylindrical up to 5 cm long.

Fasciculatum: Cluster pepper : Fruit erect, clustered, very slender, up to 7.5 cm long, red, very pungent.

Grossum: Bell pepper – Plant tall, stout, fruit long, thick fleshed, inflected with depression at base, broadly oblong bell, yellow or red when matures, non pungent, mild in flavour, used as vegetable.

Longum : *Capsicum* pepper – long pepper, red pepper, fruit drooping, elongate, up to 20 cms, tapering to apex. Often 5 cm across at base, very pungent, source of chilli powder.

Species crossability

C. annuum	-	*C. chinense*
C. frutescense	-	*C. chinense*
C. frutescense	-	*C. pendulum*
C. annuum	-	*C. frutescense*
C. annuum	-	*C. pendulum*
C. chinense	-	*C. pendulum*
C. pubescense	-	*C. chinense*

C. annuum and *C. frutescense* will cross reciprocally with *C. chinense* producing partially fertile hybrids. *C. frutescense* is cross compatible with *C. pendulum*. Fertile seeds are not obtained with *C. pubescense*. Sterility of interspecific hybrids are seen at embryonic and zyogotic level. The cause of sterility is attributed to cryptic structural hybridity.

Breeding of Byadagi 'Chilli'

A project was undertaken with the financial assistance of Spices Board with the main objective of reviving the original 'Byadagi' cultivar with its quality characters. A total of 815 collections were made by visiting the commercial fields of farmers. Individual plants were selected and 4-5 first formed fruits were collected, as individual plant progenies. All such progenies were systematically numbered and listed based on a systematic classification done by keen observation of fruit features, shape, length, thickness, wrinkles and colour. Broadly 2 commercially popular groups *viz.*, 'kaddi' and 'dabbi', were made Within each group since lot of variation was noticed, three subgroups, K_1, K_2, K_3 within 'kaddi' and D_1, D_2, D_3 within 'dabbi' were made. The collections were grown during kharif 1992, progenies harvested, dried and stored for atleast one month. Based on the selections made both in field and after storage 150 progenies were selected. Similar process was carried out in kharif 1993 ending with 90 selected progenies (15 progenies from each subgroup); these 90 progenies were evaluated at 2 locations in replicated trials, at Dharwad and Hanumanmatti locations during kharif 1994. There was considerable variability in respect of most of the characters studied. Plant aspect, fruit wrinkles, fruit colour, were scored on a rating scale. The capsaicin content was analyzed. Fifteen genotypes in each category of kaddi and dabbi were selected. These selected progenies were bulked and grown in isolation during kharif 1995 to get the purified bulk with desirable qualities. The seed of these bulks was distributed to farmers for seed production by Spice Board and seeds were procured during 1996 for further distribution.

Genetic resources and problems

Chilli is subjected to very high degree of loss of natural variability. So priority should be for preservation of genetic resources. Major difficulty arises due to taxonomic complexity. There is still confusion over scientific name. A dozen wild species are there in addition to closely related species. Their importance as a source of useful genes has to be identified. The useful genes may be utilized in breeding programme. Hence collection and preservation of genetic resources of wild species is important.

Major problem is identification of genotypes, since a particular genotype is known by different names in different places. Another problem is great variability within accession which is often comparable to that existing between different accessions.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 82- 84, 1999

Genetic diversity in chilli (*Capsicum annuum* L.) germplasm

S. SIRASAT, S. J. PATIL & R. C. JAGADEESHA

University of Agricultural Sciences
Dharwad 580 005, Karnataka..

Abstract

High diversity was observed in 75 accessions of chilli. Seventy five accessions were grouped into 28 cluster based on D^2 values. Two clusters accommodated 25 accessions.

Introduction

Chilli (*Capsicum annuum*) is one of the major spice crops of India. It is consumed mainly in the form of green chilies, dry chilies and powder. The demand for chilli is highly consumer and area specific. So to meet these demands there is a need for studying diversity in the chilli germplasm. An experiment was undertaken at the University of Agricultural Sciences, Dharwad to study the diversity in chilli germplasm.

The study was conducted on 75 genotypes comprising of 72 germplasm lines obtained from NBPGR and three local checks *viz.*, 'Byadagi', Jwala and G-3. The experiment was laid out in a randomized block design with three replications. The crop was grown as per the recommended package of practices for the area. The observations were recorded for eighteen different characters.

The genetic diversity between genotypes was assessed by using Mahalanobis's (1936) generalized D^2 values obtained as per Tocher's method as described by Rao (1952). The inter cluster and intra cluster distances were computed by the formula given by Singh and Chaudhary (1977).

Biodiversity

The magnitude of all D^2 values ranged from 11.38 between genotypes W - 07 and A - 07 to 4220.00 between genotypes A - 03 and W - 03. The D^2 values give clear idea about diverse nature of the population and thus enables to discriminate between different cultivars. Based on the D^2 values the genotypes were clustered into 28 clusteres. The cluster II was largest with 13 genotypes followed by cluster I (12 genotypes), cluster VI and XIII. It was observed that the three checks were grouped into three different clusteres (Table 1). 'Byadgi' was more diverse than other two checks.

The cluster VII and cluster XII were nearest to each other with an inter cluster distance of 72.59, where as clusters XX and XXVI were most diverse as distance between them was 3993.81. Cluster XXVI comprised of genotype A - 03 was most diverse as eighteen out of twenty eight clusters showed maximum inter cluster distance from it, thus indicating its highly diverse nature.

Intra cluster distance was observed only in ten clusters as remaining clusters had only one constituent genotypes (Table 2). The intra cluster distance also showed wide variation and ranged from 43.11 in cluster IX and 119.51 in cluster XIII. thus revealing high diverse nature of genotypes in different clusters.

Clusters I and II accounted for 25 genotypes out of 75 genotypes under study. The inter cluster distance between these two clusters was moderate, indicating moderate diversity between the clusters. However, intra cluster distance in both clusters was less varying suggesting that in both cluster the constituent genotypes are not much diverse. Similar observations were reported (Khadi 1983, Varalaxmi and Haribabu 1991).

Table 1. Composition of clusters based on D^2 statistic

Cluster	Genotype
I	W-07, A-07, A-06, B-01, A-15, V-07, A-08, W-02, C,01, A-11, V-01, E-01.
II	S-01, S-03, A-17, K-03, W-11, W-10, S-05, A-10, A-16, A-20, B-08, V-05, W-08
III	N-04, V-10, V-09, N-05, V-03, V-04
IV	W-03
V	N-08, N-09, A-02
VI	K-02, K-03, S-04, A-10, A-09, A-05, A-12
VII	S-07, B-01, M-02
VIII	E-02
IX	N-02, N-07
X	A-13, N-05
XI	A-04
XII	W-06
XIII	W-01, W-05, I-01, B-02, A-18, K-01, W-09
XIV	N-03
XV	V-06
XVI	B-03
XVII	S-06, Jawla

Contd....

XVIII	W-04
XIX	A-19
XX	A-01
XXI	S-02
XXII	M-01
XXIII	E-03
XXIV	N-01
XXV	G-3
XXVI	A-03
XXVII	Byadgi
XXVIII	V-02

Table 2. Intracluster distance in different clusters

Clusters	No. of genotypes	Intracluster distance
XII	7	119.51
VI	7	96.05
XVII	2	84.79
II	13	78.18
I	12	76.16
VII	3	68.65
III	6	65.21
V	3	58.52
X	2	44.14
IX	2	43.11

References

Khadi, B. M. 1983. Genetic studies on ascorbic acid content, fruit yield, yield components and accumulation of some mineral elements in chilli (*Capsicum annum* L.) Ph. D Thesis. University of Agricultural Sciences, Bangalore.

Mahalanobis, P. C. 1936. On the generalized distance in statistics. Proc. Nat. Acad. Sci. India. 2 : 49-55.

Rao, C. R., 1952. Advanced Statistical Methods in Biometrical Research, John Wiley and Sons, New York, pp. 357-369.

Singh, R. K. and Choudhari, B. D. 1977. Biometrical methods in quantitative genetic analysis. Kalyani Publishers, New Delhi.

Varalaxmi, B and Hari Babu, K. 1991. Genetic divergence, heritability and genetic advance in chilli (*Capsicum annuum* L.) Ind. J. Genet. 51 : 174-178.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 85- 87, 1999

Variation in 'Byadagi' chilli (*Capsicum annuum* L.)

R. C. JAGADEESHA, S. T. PRABHU & P. K. BASAVARAJA

Chilli Research Centre
Agricultural Research Station
Hanumanamatti – 581 135, Karnataka.

Abstract

Chilli is one of the major spices and cash crops of India. 'Byadagi' chilli types extensively grown in North Karnataka are known locally as *Byadagi kaddi, Byadagi Dabbi, Dyavanu Kundagol* and *Masur*. *Byadgi* chilli are highly wrinkled, dark red coloured, have low pungency and are susceptible to leaf curl. Collections were made from sixteen taluks of Dharwad and Haveri Districts, out of which 103 collections were evaluated at Chilli Research Centre, Hanumanamatti, during 1997, to assess the variability for ten characters. Dry pod yield, number of pods per plant and number of branches/plant showed high phenotypic (PCV) and genotypic (GCV) variability. The GCV and PCV were moderate to low for plant height, pericarp weight and seed weight per fruit.

Introduction

Chilli is an important spice crop and cash crop of India. Local land races of *Byadagi* chillies are grown extensively in Northern Karnataka. *Byadagi* chilli types are having dark red colour, wrinkles and low pungency. There is lot of variation among the local cultivars. This paper intends to assess the genetic diversity, coefficient of variability, heritability and genetic advance in a set of 103 local *Byadagi* collections.

Five hundred fifteen collections made from sixteen taluks of Dharwad district were planted during 1996. Out of which selected 103 collections were evaluated to assess the variability for ten characters in a randomised block design with two replications during kharif 1997 at Chilli Research Centre, Agriculture Research Station, Hanumanamatti. Each replication consisted of two rows of ten plants per treatment. Five randomly tagged plants were used for recording observations plant height (cm), number of branches per plant, number of pods per plant, pod length (cm), pod width (mm), pericarp weight, seed weight, length to width ratio, pod weight and dry pod yield were recorded.

Variability

Wide range of variation was observed for all the characters except for pericarp weight and seed weight. The maximum range of variation was observed for number of pods per plant (Table 1).

Phenotype coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were high for number of pods per plant, number of branches per plant, dry pod yield, pod weight. Whereas, for **plant height**, pericarp weight and seed weight per pod the PCV and GCV estimates were only moderate. Moderate to low differences between GCV and PCV were observed for pod length and pod width indicating lesser sensitivity to environment. So selection can be practiced to improve the characters effectively. Other characters showed higher differences indicating sensitive to environment effects (Table 1).

Table 1. Genetic parameters for yield and yield attributes in *Byadagi* chilli

Character	Range	Mean	PCV (%)	GCV (%)	Heritability %	GA	GA% mean
Plan height (cm)	39.0 - 66.4	46.52	14.29	13.60	84.26	8.32	16.38
No. of branches per plant	4.2 - 14.0	7.32	16.24	5.24	89.10	6.35	8.27
No. of pods per plant	12.2 - 73.0	39.32	19.02	18.06	78.20	30.62	38.97
Pod length (cm)	7.62 - 15.1	10.32	12.19	10.08	86.02	3.26	19.87
Pod width (mm)	6.7 - 19.3	9.63	14.26	12.89	89.32	0.74	18.57
Pericarp weight (g)	0.28 - 0.73	0.48	18.74	11.80	51.28	0.03	16.28
Seed weight (g)	0.19 - 0.73	0.56	19.21	12.10	48.26	0.15	17.86
Length to width ratio	5.42 -14.49	9.35	18.26	13.20	72.90	1.31	53.06
Pod weight (g)	0.53 - 1.50	0.82	23.88	18.45	48.40	0.40	28.28
Dry pod yield (kg/ha)	165 - 970	396.00	35.86	16.220	49.26	37.40	39.86

High heritability estimates, coupled with low advance were recorded for number of branches per plant, plant height, pod length, pod width, length to width ratio. Heritability values were medium to low for pod weight, pod yield and genetic advance was moderate indicating the role of non additive gene action. High heritability coupled with high genetic advance were observed for number of pods per plant and number of branches per plant, indicating the involvement of additive gene action and scope for selection. Similar observation are reported in chillies. (Bhagyalaxmi *et. al.*, 1990; Nandeesh Hiremath, 1997; Gomathinayaga and David, 1993; Varalaxmi and Haribabu, 1991).

References

Bhagyalaxmi, C., Ravi Shankar, B., Subramanya and V. G. Babu. 1990. Study on heritability, genetic advance, character association in chilli. South. Ind. Hort. 38 : 15-17.

Nandeesh V. Hiremath. 1997. Genetics of fruit yield components and reaction to major biotic stresses in chilli (*Capsicum annuum* L.) Ph.. D. Thesis, Univ. Agri. Sci., Dharwad.

Gomathinayaga S. P. and David, P. M. 1993. Studies on variability in chilli. Madras Agric. J. 80 : 585-587.

Varalaxmi, B. and Haribabu, K. H. 1991. Genetic divergence in chilli *(Capsicum annuum* L.) Ind. J. Genet. 51 : 174-178.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants pp. 88- 90, 1999

Variability in paprika (*Capsicum annuum* L.) germplasm

A. ANU, K. NIRMAL BABU, P.A. MATHEW & K.V. PETER

Indian Institute of Spices Research
Calicut - 673 012, Kerala.

Abstract

Twenty nine selected paprika lines were evaluated for morphological, yield and quality characters. PBC 385, PBC 066 and Kt-pl-19 were found to be promising with high colour and moderate yield.

Introduction

The term 'paprika' is used for sweet (low pungency) red capsicum powder, which is rich in Vitamin C. It is mainly used for adding colour and flavour to food products. The outer fleshy pericarp contains the major portion of the colouring matter *viz.*, carotenoids like capxanthin and capsurubin. The inner tissues and seeds contain the pungent chemical capsaicin. 'Byadagi' chilli from Dharwad district of Karnataka and 'Tomato' chilli from Warangal district of Andhra Pradesh are nearer to quality of paprika types grown in Spain and Hungary. ASTA (American Spice Trade Association) colour value of 'Byadagi' chilly is estimated to be around 150 units and that of 'Tomato'' chilly to be around 125 units (John, 1995). The present study was initiated to evaluate the performance of 29 paprika lines under conditions of Calicut and to assess the variability among them for morphological and quality characters.

Collection of germplasm and evaluation of characters

Seeds were collected from centres of cultivation and genebanks like Asian Vegetable Research and Development Center (AVRDC), Kerala Agricultural University (KAU) and Indian Institute of Horticultural Research (IIHR). The accessions studied were PBC 436, PBC 554, PBC 1369, PBC 066, PBC 375, PBC 384, PBC 385, PBC 473, PBC 535, PBC 717, PBC 743, PBC 1347, PBC 1350, Kt-Pl-19, Kt-pl-18, CAP 1088/35, CAP 1036/35, CAP 35/95, CAP

1086/35, CAP1063/35 Arka Abir, CA-219, Modhpur, Paprika type-1, Round ornamental, Small conical, Byadagi and Cluster chilly.

The seeds were germinated in sand and transplanted after about 60 days in pots containing sterile potting mixture. Red ripe fruits harvested two months after transplanting were oven dried in paper bags. The dried fruits were powdered after removing the calyx and seeds and analyzed for colour (ASTA method-Hort and Fisher, 1971) and pungency (ISO/DIS 7543-1). Samples from two crop seasons were analysed. Each sample was replicated thrice for quality analysis. The morphological characters recorded were plant height, branching habit, leaf shape, leaf length, leaf breadth, days to flower, no. of flower/axil, flower position, days to 50% fruiting, fruit shape, fruit set, fruit length, fruit breadth, no. of locules, fruit surface character, placenta length, seed number, seed size and yield. The variability for morphological and quality characters are presented in Tables 1 and 2.

Table 1. Variability for morphological characters in the paprika germplasm

Character	Range	Genotype with lowest value	Genotype with highest value
Plant height (cm)	25 - 85	PBC 554	Byadagi
Branching habit	compact – erect		
Leaf shape	ovate – lanceolate		
Leaf length (cm)	5 - 16.5	CAP 35/95	PBC 436
Leaf breadth (cm)	3 - 6.5	CAP 35/95	Kt-pl-19
Days to flower	30 – 65	Round ornamental	PBC 385
No. of flowers/axil	1 – 3		
Flower position	Pendent – erect		
Days to 50% fruiting	50 – 90	Round ornamental	Kt-pl-19
Fruit shape	Elongate-blocky		
Fruit set	Low-high		
Fruit length (cm)	2.2 – 12.2	CAP 1086/35	PBC 384
Fruit breadth (cm)	0.62 – 4.1	PBC 743	CAP 1088
No. of locules	1-3		
Fruit surface character	Smooth wrinkled		
Placenta length	¼ - ½ fruit length		
Seed number	20 – 50		
Seed size (cm)	0.2 – 0.6	PBC 743	PBC 1369
Yield (g/plant)	2 – 300	CAP 1086/35	Round ornamental

From Table 1 it is clear that there is ample variation for morphological characters in the paprika germplasm. Early flowering (about 30 days after transplant) and fruiting was found among lines, Round ornamental, Arka Abir and CAP 1088/35, while PBC 385, Kt-pl-19 and CAP 1086/35 were laté in flowering (60 – 65 days from transplant). Early bearing is a desirable character, because in Kerala once the rainy season starts, fungal infections are very common. Early fruiting ones can be harvested before the onset of rains. Fruit shape varied from elongate to blocky. PBC 436, PBC 1369 and PBC 554 were blocky fruits types. PBC 1350, Kt-pl-19 and CAP 1088/35 had companulate fruit, while Cluster chilli, CAP 1086/35 and Small conical had triangular fruit shape and the remaining types had elongate fruit. Fruit yield was high (250 – 300 g/plant) in round ornamental, PBC 066 and PBC 384 and low in CAP 1086/35 and PBC 436 (12 – 50 g/plant).

Table 2. Variability for quality characters in the paprika germplasm

Character	Range	Lowest	Highest
Colour value (ASTA)	54 – 205	PBC 1369	PBC 385
Capsaicin content	0.19 – 0.7	Kt-pl-18	Cluster

The colour value showed variation from 54 ASTA to 205 ASTA. Lines with highest colour values were PBC 385, PBC 066 and Kt-pl-19. PBC 1369, PBC 375 and PBC 743 showed low colour values. Pungency expressed as the percentage of capsaicin was highest in cluster chilly and CAP 1086/35 (0.7 – 0.6%) and Kt-pl-18. Kt-pl-19 and Kt-pl-8 showed low pungency. Lines with high colour value (PBC 385, PBC 066 and Kt-pl-19) are given Table 3.

Table 3. Comparison of colour value, capsaicin content and yield of promising lines

Genotype	Colour value (ASTA)	Capsaicin content (%)	Yield (g/plant)
PBC 385	**205**	**0.5**	65
Kt-pl-19	**160**	**0.2**	170
PBC 066	**131**	**0.3**	300

It is concluded that significant variability exists among the twenty nine paprika lines evaluated, both in morphological and quality characters. PBC 385, PBC 066 and Kt-pl-19 are lines with high colour and low pungency. They can be used further breeding programmes to select a paprika variety suitable for Kerala.

References

Hort, A. M. and Fisher, J. H. 1971. Modem Food analysis, – Verlag, NewYork, 338-339.

John, K. 1995. Possibilities for paprika like chillies for export. Spice India. 8 : 2-7.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 91- 95, 1999

Identification of resistance sources against thrips (*Scirtothrips dorsalis* Hood) and mites (*Polyphagotarsonemus latus* Banks) in chilli (*Capsicum annuum L.*) germplasm

S. T. PRABHU & R. C. JAGADEESHA

Chilli Research Centre
Agricultural Research Station
Hanumanamatti - 581 135, Karnataka.

Abstract

Chilli is one of the important spice crops of India. The crop suffers major quantitative and qualitative loss in produce every year due to the infection of thrips and mites which cause leaf curl complex 'Murda'. The preliminary evaluation for resistance to chilli thrips (*Scirtoithrips dorsalis* Hood) and mites (*Polyphagotarsonemus latus* Banks) of 43 germplasm accessions during 1997 was carried out at Chilli Research Centre, Hanumanamatti. The data indicated some chilli accessions as promising sources of resistance. The resistance in 43 germplasm accessions ranged from 7.19 to 51.59 and 9.87 to 37.48 percent leaf curl index against thrips and mites, respectively. The chilli genotypes Pant C-1, LCA 304, LCA 312, LCA 301 and B-1-1 were found promising sources of resistance against both chilli thrips and mites. The percent leaf curl index for these genotypes against thrips and mites were 7.19 and 9.87 (Pant C-1); 12.94 and 13.66 (LCA 304); 13.69 and 15.33 (LCA 312); 14.14 and 17.75 (LCA 301) and 19.82 (B-1-1), respectively. The local check 'Byadgi kaddi' was found susceptible and recorded 34.91 and 32.37 percent leaf curl index for thrips and mites, respectively.

Introduction

Chilli thrips, *Scirtothrips dorsalis* Hood and the mite *Polyphagotarsonemus latus* Banks (Hemitarsonemus latus) are the two serious pests of *Capsicum annuum L.* (Ananthakrishnan, 1973, Amin, 1979) both in nursery and main field. Adults and nymphs of *S. dorsalis* and *P. latus* suck the sap from tender leaves and growing shoots. Affected leaves curl either upward due to feeding of mites and exhibit characteristic *"leaf curl"* symptoms. In addition, *S. dorsalis* is a vector of tomato spotted wilt (Amin *et al.*, 1981), a viral disease of chilli. The overall reduction in fruit yield of chilli due to incidence of thrips and mites is up to 34 percent. The use of pesticides for the control of major pests of chilli has not been always successful (Rao and Ahamed, 1986). In view of adverse effects of use of pesticides, the host plant resistance gets the priority in the integrated pest management for high quality (export oriented) and sustainable chilli production. The present study was undertaken in context of the high susceptibility of local cultivars to thrips and mites and to locate the better source of resistance in the available lot of chilli germplasm against these two pests so as to utilize the promising ones in further breeding programme. The preliminary evaluation results of chilli genotypes for resistance to S. *dorsalis*is were reported earlier (David and Natarajan, 1986; Sanap and Nawale, 1985; Tewari *et. al.*, 1985 and Krishnakumar *et.al.,* 1991, 1996).

Screening

Forty three chilli genotypes were included for the screening programme against thrips and mites in field under rainfed conditions during kharif 1997. Seedlings were grown in raised seed beds in a field nursery. No plant protection was undertaken both in nursery and main field against thrips and mites to facilitate the build of natural infestation. The seedlings of 35 days old were transplanted to main field in a randomized block design with three replications. A row of six meter constituting ten plants were spaced at 60 x 60 cm in each replication. The genotypes were evaluated against 'Byadagi kaddi' as a susceptible local check.

Five plants were selected at random from each of the genotype. The damage due to thrips and mites was measured by the visual rating of extent of leaf curl. The upward curling was taken for thrips and downward curling was taken for mites damage. Rating was done at 50 and 80 days of crop and the scale was as follows.

Scale of rating

Grade	percent curling
1	1 to 10
2	11 to 20
3	21 to 30
4	31 to 40
5	41 to 50
6	51 to 60
7	61 to 70
8	71 to 80
9	81 to 90
10	91 to 100

The percent Leaf Curl Index (LCI) for thrips and mites was obtained by using the following formula.

$$LCI = \frac{\text{Frequency x grade point}}{\text{No. of plants x maximum grade}} \times 100$$

Completely ripened fruits were hand picked and the dry chilli pod yield was recorded.

Tolerance to thrips and mites

The evaluated genotypes exhibited significant variation among them for the relative tolerance to thrips and mites damage. The per cent leaf curl index (LCI) for thrips was ranging from 7.19 to 51.59 as compared to 34.91 in susceptible check, 'Byadagi kaddi' (Table I). The least incidence leaf curl was recorded in Pant C1 which was also identified for thrips resistance besides LCA 304 (12.94%), LCA 312 (13.69%), LCA 301 (14.14%) and B-1-1 (19.82%).

Like wise, percent Leaf Curl Index for mites was ranging from 9.87 to 37.48 as compared to 32.37 in susceptible check 'Byadagi' variety (Table 1). The most promising genotype for mite resistance was again Pant C-1 with least percent leaf curl index of 9.87. The other promising lines included LCA 304 (13.66%), SIC 10-166 (15.23%), LCA 312 (15.33%) and LCA 301 (17.75%).

The genotypes Pant C 1, LCA 312 and LCA 301 exhibited multiple resistance to both thrips and mites. Pant C-1 was found to be superior source of resistance against both the pests.

The yield of dry chilli pods was ranging from 3.40 to 17.65 q/ha. Based on yield parameter there were several genotypes superior over check 'Byadagi kaddi' (11.26 q/ha). The resistance genotypes identified based on leaf curl index were moderate yielders. (Table 1)

Table 1. Leaf curl index of chilli genotypes for thrips and mites

Genotypes	LCI for thrips (%)	LCI for mites (%)	Dry chilli yield, q/ha
Pant C-1	7.19	9.87	7.75
LCA 304	12.94	13.66	13.49
LCA 312	13.69	15.33	12.77
LCA 301	14.14	17.75	10.06
B-1-1	19.82	21.40	11.09
CO-2	20.66	22.23	5.64
Hissar Vijay	20.85	23.24	4.11
NO 38	21.41	25.54	9.54
CO-1	23.52	21.80	12.85
GPC 69	24.56	27.22	4.56
NO 65	25.09	24.57	5.34
S 32	25.65	24.02	14.53
SNK 9	27.71	25.60	9.48
SNK 10-1	27.78	27.50	14.56

contd...

Pusa Jwala	27.84	29.57	4.65
SNK 11	27.88	28.17	8.56
GH	28.15	27.77	5.64
Jwala	28.30	23.33	7.67
LC 206	28.63	21.40	14.40
NO 8	30.03	35.87	6.90
SIC-10-166	30.12	15.23	6.37
Lam 20	31.08	21.66	9.15
G4	31.15	27.92	7.03
NO 71	31.28	29.12	17.51
DS 1	32.13	25.97	7.46
NO 21	33.54	37.48	4.00
KDSC 5-10-10	34.00	33.82	11.49
NO 74	34.27	31.33	16.44
PKM 1	34.81	37.25	9.22
Bydagi Kaddi	34.91	32.37	11.26
NO 20	34.94	26.80	3.40
NO 21	35.26	25.53	17.65
CO 3	35.93	24.83	8.72
DA 9-6-6	36.85	29.13	13.12
GPC 82	38.28	35.23	9.57
TNSP	38.40	32.60	10.36
JCA 283	39.44	25.53	8.41
SNK 8	39.71	31.53	14.27
SIC 11-179	40.22	37.10	14.24
SNK 12	40.95	36.50	16.74
NO 33	44.33	27.03	6.70
NO 70	47.01	33.63	12.90
SNK 10	51.59	36.23	14.69
Sem ±	1.00	0.92	0.75
C.D. at 5%	2.83	2.60	2.12
CV. (%)	5.72	5.89	11.88

LCI = Leaf Curl Index

References

Amin, P. W. 1979. Leaf curl disease of chilli peppers in Maharastra, India. PANS, 25 : 131-134.

Amin, P. W., Reddy, D. V. R., Ghaneker, A. W. and Reddy, M. S. 1981. Transmission of tomato spotted wilt virus, casual agent of bud necrosis of peanut, by *Scirtothrips dorsalis* and *Frankliniella schultzei*. Plant Dis. 65 : 663-665.

Ananthakrishnan, T. N. 1973. Thrips biology and control. Macmillan Company. Delhi press, Delhi, p.120.

David, P. M. M. and Natarajan, P. 1986. Evaluation of chilli accessions tolerant to thrips *Scirtothrips dorsalis* Hood. South Ind. Hort. 34 : 432-434.

Krishnakumar, N. K. 1995. Yield loss in chilli and sweet pepper due to *Scirtothrips dorsalis* Hood (Thysanopetra : Thripidae). Pest Management in Horticultural Ecosystems, 1 : 61-69.

Krishnakumar, N. K., Aradya, M., Deshpande, A. A., Anand, N. and Ramachandar, P. R. 1996. Initial screening of chili and sweet pepper germplasm for resistance to chili thrips, *Scirtothrhips dorsalis* Hood . Euphytica, 89 : 319-324.

Rao, M., and Ahamed. 1986. Screening of chilli germplasm for resistance to some important pests. Ind. Cocoa, Areca nut and Spices J. 9: 40-43.

Sanap, M. M. and Nawale, R. N. 1985. Reaction of chilli cultivars to thrips and mites. J. Maharashtra Agric. Univ., 10: 352-353.

Tewari, G. C., Deshpande, A. A. and Anand, N. 1985. Chilli pepper genotype resistant to thrips (*Scirthothrips dorsalis* Hood). Capsicum Newsl. 4:73-74.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants pp. 96- 100, 1999

Genetic resources of ginger (*Zingiber officinale* Rosc.) and its conservation in India

B. SASIKUMAR, K.V. SAJI, P.N. RAVINDRAN & K.V. PETER

Indian Institute of Spices Research
Calicut-673 012, Kerala.

Abstract

Ginger, *Zingiber officinale* Rosc. is believed to have originated in the South East Asia. Maximum variability in cultivated ginger is found in India and in the adjoining countries of South East Asia. In India, North Eastern States and Kerala are the principal regions of variability. Commercial production of ginger is also concentrated in Kerala and North Eastern States, besides Himachal Pradesh, Orissa, West Bengal, Karnataka and Maharashtra.

Zingiber is included in the tribe Hedychieae along with *Curcuma, Hedychium* and *Kaempferia* and in the series *Zingiberae* which contain only one genus *Zingiber.* About 8 species are reported from Kerala and about 24 species from India. Cultivated ginger is diploid (2n=22), however 2n=24 (?) is also reported in a putative wild type ginger from 'Ponnambalamedu' (Sabarimala Hills). This collection is distinctly different, karyomorphologically and qualitatively from the cultivated types.

There are many distinct types (trade) of ginger such as 'Wayandan', 'Kuruppampadi', 'Ellakallan', 'Krishnapuram' etc. possessing distinct quality features besides about 50 land races. Many of the local types are getting extinct due to one reason or another. Thus in order to conserve the ginger gene pool a National Ginger Germplasm Conservatory was established at IISR, Calicut. The present holding in the gene bank is 570 accessions. All the accessions are maintained in field genebank in cement tubs in duplicate and also in *in vitro* conservatory.

The accessions are being characterised for yield, quality, product diversification purpose as well as for reaction to pests.

Introduction

Ginger (*Zingiber officinale* Rosc.) is believed to have originated in the South East Asia (Bailey 1949, Parry 1969.) At present, ginger is cultivated in many tropical countries like India, China, Taiwan, Philippines, Sierre Leone, Jamaica, Fiji, Mexico, Brazil and Neigeria on a commercial scale. India is currently the major producer and exporter of ginger.

Zingiber is included in the tribe Hedychieae of Zinghiberaceae and in the series *Zingiber* which contains only the genus *Zingiber* (Mabberly, 1987). The genus *Zingiber* was divided into four sections by Baker (1880) and the cultivated ginger *Zingiber officinale*, is included in Section II. *Lampuzium*.

Baker (1880) described a total of 24 species of *Zingiber* from Indo-Malayan regions while Gamble (1925) reported seven species as found in South India *viz. Z. roseum Rosc, Z.nimmoni* Dalz, *Z. wighitanum* Thew, *Z. zerumpet* (L). Smith, *Z. neesanum* (Graham) Ramamoorthy Syn. *Z. macrostachyum, Z. cernum* Dalz, *Z. purpurem* Rosc. (Syn. *Z. cassumunar),* and *Z. officinale* Rosc.

Many ginger cultivars (local races) mainly identified by their locality of cultivation/collection are prevalent in India. Many of these cultivars are confined to particular tracts only. Most of the local races are facing extinction for many reasons such as rhizome rot disease, spread of few high yielding ginger varieties; change in cropping pattern etc. However, considerable variability in cultivated ginger is still present in Kerala and North Eastern India.

In order to preserve the genetic resources of ginger in India, the Indian Institute of Spices Research, Calicut is engaged in collecting, conserving, cataloguing and evaluating ginger germplasm, both cultivated and wild types.

Ginger germplasm at IISR, Calicut

The Indian Institute of Spices Research (IISR) has collected about 570 accessions of ginger germplasm, comprising land races, improved cultivars, mutants, polyploids, exotic cultivars and wild species from different places within and outside the country either by directly conducting specific collection expeditions/ surveys or indirectly through research/ development/extension agencies of different places/states. These collected accessions are maintained in *exsitu* genebanks at the Research Farm (in cement tubs) at Peruvannamuzhi and/or *in vitro* repository. Besides the IISR, sizeable accessions are also maintained at the National Bureau of Plant Genetic Resources Centre, Trissur and at the centres under All India Co-ordinated Improvement Project (Spices) (Table 1.)

The ginger germplasm maintained at IISR, Calicut is being evaluated for yield, yield attribute, quality features, reaction to pests and for product diversification.

Discussion

Good variability was observed for the rhizome features of ginger collected from different tracts. The rhizomes of the collections such as 'Gurubathani' and 'Bhasey' from Kalimpong (West Bengal) were very bold. Though 'Gurubathani'

Table 1. Ginger germplasm maintained at different centres

Centre	No. of accessions	Type of material conserved
Indian Institute of Spices Research, Calicut, Kerala	570	Land races (exotic and indigenous), improved cultivars, mutants, polypoids, putative wild types, related species & taxa
NBPGR Regional Station, Trissur, Kerala.	149	Cultivars, wild and related species
High Altitude Research Station (OUA&T), Pottangi, Orissa.	27	Cultivars, wild and related species
Y.S. Parmar University of Forestry & Horticulture, Solan, Himachal Pradesh.	130	"
Indira Gandhi Krishi Viswavidyalaya, Raigarh, Madya Pradesh.	18	"

maintained its boldness after one season 'Bhasey' lost its plumpy nature after a season in Kerala. Similarly the exotic introductions from Jamaica, Fiji, Japan etc. also lost their plumpy nature after one season in Kerala.

During the collection survey in Kerala, few indegenous types such as 'Ellakallan' were collected from Santhanpara in Idukki district of Kerala. Characterised by slender rhizome, 'Ellakallan' is a high oil type accession. Other types such as 'Kuruppampadi', 'Wayanadan', 'Krishnapuram'. 'Vadakkanchery' etc. are trade varieties rather than genetic varieties. A putative wild type ginger characterised by very small rhizome and dwarf stature collected from 'Sabarimala Hills' in the Western Ghats, was found qualitatively and morphologically different from the cultivated types (IISR, 1997.)

Considerable variability was observed for yield and quality traits in about 100 of the accessions studied (Table 2). Tiller number/plant had the highest variability followed by crude fibre and oleoresin. Variability was also noticed for the components of ginerol (6 & 8, ginerole) and shogaol (6 shogaol) in the oleoresin (Zacharia and Sasikumar, 1998.) Based on yield and quality analysis ginger accessions are short listed for various end uses (Table 3). Survey of the germplasm to locate resistance source against *Plyllosticta* leaf spots has failed to locate any resistant accessions though 11 tolerant lines could be located (Rao *et al.*, 1995). Survey of the ginger accession having resistance to storage pests is another area of work in progress at IISR, as storage pests are causing considerable damage to the dry ginger stored in godowns.

Table 2. Mean, range and coefficient of variation (cv%) for yield, attributes and quality traits in ginger germplasm.

Character	Mean	Range	CV%
Plant height (cm)	59.20	23.13 - 88.60	19.00
Leaf number/plant	37.14	17.00 - 52.00	18.17
Tiller number/plant	16.81	2.75 - 35.50	45.92
Leaf length (cm)	23.79	17.01 - 36.50	10.90
Leaf width (cm)	2.65	1.95 - 3.75	10.82
Days to maturity	225.92	214.0 - 235.50	13.53
Dry recovery(%)	21.70	14.00 - 28.50	14.30
Rhizome yield/plant (g)	363.12	5.50 - 770.00	39.33
Crude fibre (%)	4.31	2.10 - 7.00	23.34
Oleoresin (%)	6.12	3.20 - 9.50	21.70
Gingerol (%)	19.95	14.00 - 27.00	15.16
Shogaol (%)	4.12	2.70 - 7.50	24.35

Table 3. Ginger accessions identified for various end uses

End use	Cultivars/accessions
High yield (fresh)	Rio-de-Janeiro, Suprabha, Varada, Juggigan, Himachal, Maran, Wynad Local, Karakkal, Thingpui
Bold rhizome	Acc. 15, Acc. 35, Varada, Acc. 117, Acc. 142, Acc. 27.
High dry recovery	Acc. 27, Acc. 204, Varada, Acc. 294, Zahirabad, Jorhat Local, Kuruppampadi, Ernad, Chernad, Maran, Mowshom.
Low fibre	Varada, China, Nadia, Poona, Acc. 15. 27.
High oleoresin	Wynad, Kunnamangalam, Ernad Chernad, Nadan (Pulpally), Nadan, Acc. 57, Himachal, China, Rio-de-Janeiro.
High gingerol & shogaol	Wynad, Baharica, Kunduli, Kunnamangalam, Ambalayalan, Rio-de-Janeiro, Ernad Chernad, Swathing pui
High essential oil	Pulpally, Sabarimala, Nadan (Pulpally) Thodupuzha.
High zingiberene and (6) gingerol	Baharica, Amaravathy
Salted ginger	Acc. 35, & Acc. 27

Though good variability is observed in the ginger germplasm, the quality traits are observed to vary with soil type, cultural conditions and climate.

Eventhough sexual reproduction is lacking in cultivated ginger, there are many distinct ginger types/cultivar available in the country. Geographical spread of ginger to new places along with the movement of the settlers or 'Jhum' farmers accompanied by gnenetic differentiation into locally adapted population caused by mutation would have resulted in the evolution of cultivars in this clonally propagated crop.

References

Bailey, L.H. 1949. Mannual of cultivated plants. 2nd Edition, Macmillan & Co. Ltd., New York, USA.

Baker, J.W. 1880. Scitaminae In: Flora of British India. Vol. 6. Botanical Survey of India, Calcutta, pp. 198-264.

Gamble, J.S. 1925. Flora of the Presidency of Madras. Vol. 3 (Rep. 1961). Botanical Survey of India, Calcutta.

IISR. 1997. Annual Report 1996 - 97. pp. 112.

Mabberly, D.J. 1987. The Plant Book. Cambridge Univ. Press, Cambridge. U.K. IISR 1997.

Parry, J.W. 1969. Ginger. In: Spices. Vol. II. Morphology, History, Chemistry. London Food Trade Press. pp.49.

Rao, T.G., Sasikumar, B and Johnson, K. George. 1995. Field reaction of ginger germplasm to *Phyllosticta zingiberi*. Ind. Phytopath. 48:463-465.

Zaharia John, T. and Sasikumar, B. 1998. Variability for oil, oleoresin their components in selected ginger accessions. Nat. Sem. Potential Aromatic Plants of India- Exploration and Utilisation, 30-31 July 98, Regional Res. Laboratory, Bhubaneswar, Orissa, India. P. 55 (Abstract).

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants pp. 101- 109, 1999

Genetic resources of turmeric and its relatives in India

K. C. VELAYUDHAN, K. I. ASHA, S. K. MITHAL* & P. L. GAUTAM*

National Bureau of Plant Genetic Resources, Regional Station
Trissur - 680 654, Kerala

Abstract

A total of 1,410 accessions belonging to 32 species and 6 unidentified entities in the genus *Curcuma* have been collected from different parts of India. Out of these, 550 accessions of turmeric have been characterized and classified into 21 different morphotypes. These morphotypes have been further grouped into 6 varieties based on numerical taxonomic studies. Eighteen promising lines belonging to M-1 have been identified. A catalogue has been published. In the case of *Curcuma* species, 4 new species have been described and reported and two more are to be reported. A new classification based on the underground morphology has been made and three new sections have been identified in the subgenus *Eucurcuma*. Several species of tuberising nature have been found to be potentially useful for arrow root production. At present, a total of 807 accessions belonging to 27 species are maintained at the station.

Introduction

The genus *Curcuma* L. belonging to the family Zingiberaceae, contains about 80 species of which 40 are distributed in India (Velayudhan *et. al.*, 1994). The genus is mainly Indo-Malayan in distribution. Several species of the genus *viz.*, *Curcuma longa, C. purpurescens, C. manga, C. heyneana, C. xanthorrhiza, C. aeruginosa, C. amada, C. caesia, C. zedoaria, C. phaeocaulis* and *C. petiolata* are economically useful and some of them are cultivated in different regions in Asia. Several other wild species also have ethnobotanical importance as arrow root pro

* National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110012

ducing and medicinal plants. Turmeric (*C. longa*) is the most widely cultivated species of the genus. India is the largest producer of turmeric. The Regional Station of NBPGR at Trissur situated in humid tropical region has been given the mandate for augmenting genetic resources of rhizomatous spice crops and their wild relatives in southern region of India, in collaboration with IISR and other institutions in the country. This paper furnishes, the collection, characterization, evaluation, classification, documentation and ex situ conservation of an indigenous collection of turmeric and its wild relatives at NBPGR (RS).

Origin and distribution

Purseglove (1968) and Harlan (1975) consider Indo-Malayan origin of the genus *Curcuma* on the basis of natural distribution, cultivation and use of various species in the region. However, the fact that, out of about 80 species described so far, 40 species including many endemic species (Velayudhan *et al.*, 1994) from Western Ghats are of Indian distribution, is supportive to the Indian origin of the genus. Turmeric also occurs in certain forest pockets of Western Ghats even today. With respect to distribution of species, there is a preponderance of both tuber bearing and non-tuberising species in Western Ghats as compared to North Eastern Region of India. Turmeric is cultivated mainly in India, Thailand, Myanmar, Malaysia, Indonesia, Philippines, Sri Lanka, Nepal, Vietnam and China. It has been introduced to several African countries, Caribbean Islands, Malagasy and Central American countries. One species *C. australaiaca*, occur in Australia. In India, the crop is mainly cultivated in all the states as its agro-ecological amplitude is very wide.

Antiquity of turmeric

Ethnobotanical evidences indicate that use of turmeric in India is considered to be associated with "Shakthi" worship or worship of mother Goddes "Kaali" by the Pre-Aryans in India. It is a magic material used in 'tantric' and in black magic. As a yellow dye, it is associated with various folklore arts in connection with religious worships. Hence, Sopher's observation (1964), that the crop originated in the early stage as a magic material and as a colouring substance and later on as a medicine and as a condiment, appears to be genuine. Several species of *Curcuma* are used as a raw material for arrow root production by local and tribal people in the country from time immemorial. Some of these species are rarely observed under semi wild conditions around human habitations in plains even now. Species such as *C. aromatica* and *C. zedoaria* with medicinal properties have been found to be domesticated to a limited extent by locals in plains and tribals in forests of Kerala.

Cytology

Cytological studies on *C. longa* and its various other species by Ramachandran, (1961) supported the dibasic amphidiploid theory of the origin of the genus. Triplodisation theory of origin of turmeric by Raghavan and Venkatasubban (1943) prompted them to suggest *C. aromatica* or similar looking forms as probable progenitors of turmeric. The various reports on studies in 8 Indian species by different authors have clearly identified 6 distinct cytological entities having chromosome counts $2n = 32$, 42, 62, 63, 64 and 86 (Velayudhan *et. al.*, 1994). Further, no new cytological entities have been reported so far. Thus, the past work very clearly indicates the existence of considerable cytological abnormalities in the genus.

Exploration and collection

Extensive survey and collection of germplasm of *Curcuma* was initiated in 1977-78 by NBPGR in collaboration with Central Plantation Crops Research Institute, Kasaragod and Dr. Y. S. Parmar University of Horticulture and Forestry, Solan. Subsequently, efforts were continued by this regional station and also by other regional stations of NBPGR located at Shimla, Shillong, Cuttak and Akola, to collect the germplasm of the genus either alone or in collaboration with other institutions in their respective regions. Thus, a total of 1,410 accessions of 32 species including 6 newly described species along with six unidentified entities of the genus *Curcuma* could be assembled. The newly described entities include *C. kudagensis, C. thalakkaveriensis, C. malabarica, C. karnatakensis, C. nilamburensis* and *C. vellanikkarensis* by the station. The latter two species (Velayudhan *et. al.*, 1994) are yet to be reported. The distribution of the species collected in the exploration is furnished in Table 1. The survey indicated that there was a preponderance of cultivated and wild turmeric types and wild species in Western Ghats region in comparison with north east, north west and eastern regions of India. Out of these, 649 collections belonged to both wild and cultivated turmeric and the rest to various other species.

Table 1. Distribution of *Curcuma* Spp. in India

Sl. No.	Species without fingers on rhizome		Sl. . No	Spices with fingers on rhizome	
1	*C. nilamburensis*	Ke	17.	*C. montana*	AP
2	*C. karnatakensis*	Ka	18.	*C. brog*	NE
3	*C. cannanorensis*	Ke	19.	*C. soloensis*	NE
4	*C. lutea*	Ke/Ka	20.	*C. latifolia*	NE
5	*C. albiflora*	Ka	21.	*C. malabarica*	Ka/Ke
6	*C. oligantha*	Ke	22.	*C. zedoaria*	IND
7	*C. decipiens*	Ke	23.	*C. comosa*	NE
8	*C. vellanikkarensis*	Ke	24.	*C. caesia*	NE
9	*C. ecalcarata*	Ke	25.	*C. aeruginosa*	NE
10	*C. aurantiaca*	Ke	26.	*C. raktakanta*	Ke
11	*C. neilgherrensis*	SI.	27	*C. harita*	Ke
12	*C. pseudomontana*	SI. & M	28.	*C. sylvatica*	NE/Ke
13	*C. kudagensis*	Ka	29	*C. aromatica*	Ka/Ke
14	*C. thalakkaveriensis*	Ka	30.	*C. amada*	IND
15	*C. coriaceae*	Ke	31.	*C. amarissima* ?	NE
16	*C. longa*	IND	32.	*C. vamana*	Ke

Ke : Kerala, Ka : Karnataka, NE : North eastern region, M : Maharashtra, SI : South India, AP : Andhra Pradesh. IND India.

Classification of turmeric

In turmeric, no classification has been attempted so far in order to identify distinct varieties on the basis of above ground and underground morphology in a large population of plants representing a large geographic area. However, varieties on the basis of the place of their origin have been identified in India and roughly, 43 such varieties have been listed by Velayudhan *et. al.* (1994). Moreover, about 18 improved varieties have also been released in turmeric from various research organizations in India. In the present case, the collection represented wide eco-geographic area of India wherever turmeric is cultivated and hence classification was attempted on the basis of morphology. Characterization and evaluation of the collected germplasm in the station at Vellanikkara was initiated in 1978 and continued till 1997. In the genus, 550 accessions of turmeric and 187 accessions of 30 other wild species were subjected for detailed studies including characterization, evaluation and classification for documentation purpose. Turmeric, on the basis of morphological traits could be differentiated into 21 distinct groups called morphotypes (M) by Velayudhan *et. al.* (1994) first by a subjective method suggested by Mathews (1962). The largest morphotypic group was M-1 containing 338 accessions followed by M-15 with 59 and M-5 with 42 accessions. Morphotypes 2,3 and 4 having only 4 accessions each appeared to be very closely related to M-1. Morphotypes 7 and 8 consisted of collections having similar above ground morphology with some differences in tuber morphology and floral characters. Both these types bore tubers with fragrant flesh. Based on the numerical taxonomy analysis the 21 morphotypes were further pooled into 6 major groups based on the inter relationship between various morphotypes as per the inter and intra group CEC (coefficient of correlation) values calculated by converting the OTUs to an index based on the formular NS/NS+ND x 100 by Sneath (1962). These groups have now been described as six different varieties (Table 2) *viz*., *Curcuma longa* var. *typica* (293 acc), var. *atypica* (97), *var. camphora*, (51), var. *spiralifolia* (20), var. *musacifolia* (91) and var. *platifolia* (17), of cultivated turmeric (Velayudan *et al*, 1998). Further, in turmeric mainly, there are two distinct groups present based on the presence of typical camphoraceous aroma and turmeric aroma. The morphotypes such as M-7, M-8 and M-18 with typical camphoraceous aroma are also seed setting forms. Generally these forms may be considered to be basic genetic material for further crop improvement through conventional hybridization as reported earlier by Nambiar (1979) and Hanza George (1981). Collections belonging to morphotypes M-5, 6, 10, 15, 16, 17, 19, 20 and 21 were intermediate between those of M-1, 2, 3, 4, 9, 11, 12, 13, 14 and of M-7 and 8 for the presence of camphoraceous sweet aroma in tuber flesh. During the study period, a total of 18 accessions belonging to M-7, M-8 and M-18 representing variety-3 flowered and fruited. A crop catalogue containing 550 accessions based on 64 descriptors has also been published.

Table 2. Newly described varieties of turmeric

Intra specific group	Varietal name	Morphotypes	Accessions	Distribution
V-1	*Curcuma longa* var. *typica*	M-1, 2,3, & 4	293	Mainly South India*
V-2	*C. longa* var. *atypica*	M-5, 11,13,14, 16, 17, 19, 20, 21	97	All over India*
V-3	*C. longa* var. *camphora*	M-7, 8 & 18	51	North East India
V-4	*C. longa* var. *spiralifolia*	M-9	20	NE/NW India
V-5	*C. longa* var. *musacifolia*	M-6, 10, 15	91	NE/NW/South India*
V-6	*C. longa* var. *platifolia*	M-12	17	North East India

* Found sometimes in the evergreen and semi-evergreen forest pockets in Western Ghats

Promising lines in turmeric

In studies conducted for over ten years in connection with cataloguing of 550 accessions, 18 were found to be promising (Table 3.) without the incidence of both leaf spot and leaf blotch disease, having a curing percentage of more than 25%, better tuber aroma, better taste and giving a dry rhizome yield of > 2.5 t/ha. All these accessions were either medium or long duration and belonged to morphotype-1 which is the original "Alleppey turmeric". Morphotype wise curcumin content has varied from 1.13% in morphotype -18 to 8.60% in morphotype - 3 on dry weight basis.

Table 3. Promising lines of turmeric

S.No	IC No.	M-type	S. No	IC No.	M-type	S. No.	IC No.	M-type
01	88632	M1	07.	69977	M1	13.	88704	M1
02	88640	M1	08.	69980	M1	14.	88706	M1
03	88645	M1	09	70003	M1	15.	88707	M1
04	88646	M1	10.	70079	M1	16.	88714	M1
05	88657	M1	11.	70088	M1	17.	88725	M1
06	69974	M1	12.	88690	M1	18.	88733	M1

During 1996-97, fresh rhizome yield varied from 33.3 g/plant in IC 88887 to 75.0 g in IC-136901. Promising lines giving more than 600 g fresh rhizome weight per plant are listed in Table 4. The results showed that all the promising lines were from morphotype-1, as usual. This belonged to *C. longa* var *typica* which is synonymous to the famous "Aleppey turmeric".

Table 4. Promising accessions of turmeric

TCR No.	IC No.	Morphotype	Yield/plant (g)
84	136901	1	750.0
60	136885	1	733.3
53	136885	1	716.7
620	88693	1	716.7
30	136871	1	700.0
48	136882	1	700.0
55	136887	1	700.0
32	136872	1	666.7
59	136889	1	666.7
254	88600	1	616.7

***Curcuma* Spp.**

A total of 234 accessions belonging to 15 sessile finger bearing species (200) and 11 non finger bearing species (34) are maintained now. Few species of *Curcuma* which are very niche specific have been lost. Number of collections maintained species-wise under both groups are presented in Table 5. Lost species include *C. kudagensis*, *C. thalakkaveriensis*, *C. lutea*, *C. oligantha* and *C. albiflora* which are very niche specific and under the potted condition in plains these tend to gradually lose vigour. The former two species were described from the Western Ghats by Velayudhan *et. al.* (1990 & 1991). Further, two more species *viz*, *C. malabarica* and *C. karnatakensis* were also reported by the station, the former from coastal Kerala and the latter from Western Ghats of Karnataka. Two species, *viz*., *C. nilamburensis* and *C. vellanikkarensis* have though been described (Velayudhan *et. al.* 1998), are yet to be reported. Thus, from the past work it is apparent that more non tuberising species are present in Western Ghat region than other regions in India. *C. comosa*, *C. caesia*, *C. aeruginosa*, *C. solensis* and *G .brog* are from the North - Eastern and Eastern regions and *C. montana* from Eastern Ghats in Andhra Pradesh.

Studies carried out by Velayudhan *et. al.* (1994) on sessile finger bearing species (14 identified and 6 unidentified) of *Curcuma*, curcumin content varied from 0.14 in the case of *C. aromatica* to 2.039 in *Curcuma* sp. (No. 204). Tuberising species of *Curcuma* (13 identified and 4 unidentifed) have also been subjected for arrowroot production potential in comparison with West Indian Arrowroot (Velaudhan *et al.* 1996). The results indicated that maximum dry weight percentage of starch (8.5%) based on fresh rhizome weight was obtained in *C. aeruginosa* followed by 5.92 % in *C. harita* from Kerala as against 22% in West Indian Arrowroot. Based on the observations made at the time of collection and at *ex situ* in field genebank, a classification of Indian *Curcuma* was made (Velayudhan *et al.* 1996). Based on this classification the genus could be differentiated into two sub genera viz., *Paracurcuma* and *Eucurcuma* of Valeton, 1918. *Paracurcuma* contains two species *viz.,* C. *ecalcarata* and *C. aurantiaca* which are characterized by absence of spurs. *Eucurcuma* contains all the other with spurs on anthers. The latter could be further differentiated into 3 sections *viz.* 1. *Tuberosa, 2. Non tuberosa* and 3. *Stolonifera.* The first section contained all the finger bearing species including *C. longa*, the second section contain all species without sessile fingers and the third contained only a single species viz., *C. peethapushpa* (Mangaly & Sabu, 1993) which is the only one of its kind reported under the genus *Curcuma* and has great evolutionary significance as the sessile fingers are only modified stolons. Further, based on the flowering behavior sections 1 & 2 have been further subdivided into three sub-sections each.

Table 5. Surviving *Curcuma* Spp. at the station

Sl. No	Sessile tuberising		Sl. No.	Non tuberising	
1.	*C. amada* Roxb.	(45)	1	*C. aurantiaca* Van Zijp	(11)
2.	*C. zedoaria* Roxb.	(35)	2	*C. ecalcarata* Sijaraj & Indu	(9)
3	*C. malabarica* Vel. *et. al.*	(33)	3	*C. pseudomontana* F. Grah.	(9)
4.	*C. aeruginosa* Roxb.	(2)	4	*C. vamana* Mangaly & Sabu	(3)
5.	*C. caesia* Roxb.	(2)	5	*C. nilamburensis*	(2)
6.	*C. amarissima* Rosc.	(1)	6	*C. cannanorensis* Ansari & Nair	(1)
7	*C. solensis* Val	(1)	7	*C. karnatakensis* Amal et al.	(1)
8	*C. brog* Val.	(2)	8	*C. neilgherrensis* Wight	(1)
9	*C. latifolia* Rosc.	(2)	9	*C. vellanikkarensis*	(1)
10	*C. aromatica* Salisb	(29)	10	*C. decipiens* Dalz	(1)
11	*C. harita* Mangaly & Sabu	(13)	11	*C. coriaceae* Mangaly & Sabu	(1)
				Total	40
12	*C. sylvatica* Val.	(4)	Sl. No.	Species described by the station	
13	*C. raktakanta* Sabu & Mangaly	(6)	1	*C. kudagensis* Vel. et. al.	(1)
14	*C. montana* Roxb	(2)	2	*C. thalakkaveriensis* Vel. et. al.,	(1)
15	*C. comosa* Roxb.	(1)	3	*C. karnatakensis* Amal et. al	(1)
	Unidentified	(22)	4	*C. malabarica* Vel. et al.	(1)
Total		200		Total	4
			Sl. No.	New reports from the station	
			1.	*C. oligantha* Trim	(1)
			2.	*C. albiflora*	(1)

Conclusion

The detailed exploration, collection, characterization and preliminary evaluation studies carried out on an indigenous collection of the genus *Curcuma* resulted in the assemblage of 1,410 accession, publishing of a catalogue on 550 collections of turmeric, present holding of 807 accessions including 573 turmeric and 234 of 27 various species in the field genebank, working out a new classification for the genus *Curcuma*, description of 6 new species and identification of 21 morphotypes, 6 taxonomic varieties and several promising lines in turmeric. Several lines belonging to M-1 were promising and several of M-7 and M-8 were seed setting. The report is based on a long-term study started in 1978 which is still continuing at NBPGR, Regional Station.

References

Hanza George, 1981. Variability in the open pollinated progenies of turmeric (*Curcuma aromatica* Salib) M. Sc. Thesis, Horticultural College (KAU), Vellanikkara, Thrissur, pp. 110.

Harlan, J. R. 1975. Crops and Man. American Society of Agronomy and Crop Science Society of America, Madison, Wisconsin. p. 75.

Mathews, B. 1962. (Broadcast discussion. BBC. Network-3) See PIKE, M, Out of your senses. Listner, 67 : 250-251.

Mangaly Jose, K. and Sabu, M. 1993. A taxonomic revision of the South Indian species of *Curcuma*. (Zingiberae) Rheedea, 3 : 139-171.

Nambiar, K. K. 1979. Morpho-cytological investigation in the genus *Curcuma* L. Ph. D Thesis, University of Bombay, p. 95.

Purseglove, J. W. 1968. Tropical Crops - Monocotyledons (1 & 2 combined). English Language Book Society at Longman, London, pp. 519-528.

Raghavan, T. S. and Venkattasubban, K. R. 1943. Cytological studies in the family Zingiberaceae with special reference to chromosome number and cytotaxonomy. Proc. Ind. Acad. Sci. Ser. B, pp. 118-132.

Ramachandran, K. 1961. Chromosome numbers in the genus *Curcuma* L. Curr. Sci. 30 : 194-196.

Rao, T. G. N., Reddy, B. N. and Sasikumar, B. 1993. Turmeric production constraints in Andhra Pradesh. Spice India, 6:8-11.

Sneath, P. H. A. 1962. The construction of taxonomic groups. In: Ainsworth, G. C. and Sneath, P. H. A (eds.) Microbial Classification, pp. 289-332.

Sopher, D. E. 1964. Indigenous uses of turmeric (*Curcuma domestica*) in Asia and Oceania. Anthropos, 59 : 93-127.

Velayudhan, K. C., Pillai, V. S., and Amal raj, V. A. 1990. *Curcuma kudagensis* (*Zingiberaceae*) - a new species from Karnataka, India. J. Econ. Tax. Bot. 14 : 475-479.

Velayudhan, K. C., Amalraj, V. A. and Muralidharan, V. K., 1991. *Curcuma thalakkaveriensis* (*Zingiberaceae*) a new species from Karnataka India. J. Econ. Tax. Bot. 15 : 437-38.

Velayudhan, K. C., Muralidharan,V. K., Rana, R. S., Bhag Singh and Thomas, T. A. 1994. Genetic Resources of *Curcuma*. NBPGR Regional Station, Thrissur. Scientific Monograph No. 4 (Prepublication). p. 74

Velayudhan, K. C., Amal raj, V. A. and Muralidharan, V. K., 1996. The conspectus of the genus *Curcma* in India. J. Econ. Tax. Bot. 20 : 375-382.

Velayudhan, K. C., Muralidharan, V. K and Amal raj V. A. 1996. Arrowroot producing *Curcuma* species in India. Ind. J. Pl. Genet. Res. 9 : 175-177.

Velayudhan. K. C., Abraham, Z and Asha, K. I, 1998. Taxonomic varieties in *Curcuma longa*. (In press)

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 110- 113, 1999

Genetic variation in turmeric germplasm of Kandhamal District of Orissa

N. DIKSHIT, B. S, DABAS* & P. L. GAUTAM*

National Bureau of Plant Genetic Resources
Base Centre, Cuttack - 753 006, Orissa.

Abstract

Morphological variability was observed in 41 turmeric accessions from Kandhamal District Orissa. High degree of variation was observed for dry weight of rhizomes/plant (62.83%), fresh weight of rhizome/plant (56.81%), number of secondary rhizomes/ plant (53.19%) and number of primary rhizomes/plant (47.31%). Accession IC 210265 is found to be promising among the local types.

Introduction

Turmeric (*Curcuma longa* L.) is considered as an important condiment, dye and medicine since time immemorial. Kandhamal district in Orissa (literally, the habitat of *Kandha* tribes) is one of the districts in the Eastern Ghats where turmeric is the main cash crop. The area under turmeric in the district is 4360 ha. with an annual production of 31500 MT (1994-95). Cultivation of turmeric by tribes is an important part of a religious rite and they used to make human sacrifices in order to improve the quality and colour of the turmeric that they produced (Mally 1908). Turmeric is their chief source of income as they export it in large quantities, bartering it for grain and salt to drivers of pack-bullocks who come from Ganjam, Sambalpur,

Many local cultivars of turmeric are grown by the tribals. The present paper is an attempt to characterise some of the turmeric cultivars. A total of 29 agro-ecological niches were visited and all the 12 blocks were explored covering a total of 858 kilometers of road distance during

* National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi - 110012

November 1997. Sampling sites comprised farmers field, kitchen gardens and recently cleared forest areas. Five randomnly selected plants were tagged and field data were noted down at the collection site itself. Individual plant information on botanical name, local name, village, block, donor name, altitude, source, status, frequency, habitat, soil, colour, plant characteristics, rhizome characters and ethnicity were recorded (Tables 1&2).

Table 1. Range, mean and coefficient of variation for some growth parameters of turmeric from Kandhamal, Orissa.

Characters	Range	Mean ± SE	CV (%)
Plant height (cm)	44.5 - 167.25	118.40 ± 5.34	25.54
Leaf length (cm)	17.8 - 80.25	59.70 ± 2.28	23.25
Leaf width (cm)	3.2 - 19.5	12.99 ± 0.58	27.35
No. of leaves/plant	4.2 - 9.0	6.89 ± 0.18	16.26
No. of tillers/plant	1.0 - 3.2	1.20 ± 0.08	40.64
No. of primary rhizomes/plant	2.0 - 18.2	7.06 ± 0.57	47.31
No. of secondary rhizomes/plant	1.0 - 19.0	9.68 ± 0.88	53.19

In situ variability for morphological characters

Significant variability was observed with respect to various characters. Most of the plants were tall and vigorous and few were short and less vigorous. The foliage varied from narrow to broad and colour from light green to dark. Fingers were thick and slender and surface were either smooth or wrinkled. Mother rhizomes varied from small, medium to big sized and shape varied from small medium to big sized and shape varied from spindle, oval, round to long. Colour of rhizome were orange yellow, deep yellow or reddish yellow. Variability observed for agronomic characters and rhizome characteristics before and after curing are mentioned below.

Agronomic characters

Variability was recorded in respect of component characters like plant height, leaf length, leaf width, number of leaves per plant, number of tillers per plant and number of primary and secondary rhizomes per plant using standard statistical procedures. (Table 1) Plant height ranged from 44.5 cm (IC-210277) to 167.25 cm (IC-210324) with a mean of 118.40 cm. Leaf length showed a variation of 17.8 cm (IC-210277) to 80.25 cm (IC-210324) and leaf width from 3.2 cm (IC-210307) to 9.0 (IC-210261) having an average of 6.89. Primary rhizomes/plant as high as 18.2 and secondary rhizome/plant as 19.0 were observed in IC-210265 and IC-210281, respectively. Mohanty (1979), Phillip and Nair (1987), Muralidharan *et. al.*, (1980) also reported variability in respect of these characters in turmeric.

Table 2. Range of variation before and after curing of turmeric from Kandhamal, Orissa.

Character	Range	Mean ±SE	CV (%)	Range	Mean ±SE	CV(%)
	Before curing			After curing		
Length of mother rhizomes (cm)	2.71 - 9.59	5.54 ± 0.24	27.81	1.91 - 7.55	3.40 ± 0.18	30.69
Thickness of mother rhizomes (cm)	0.86 - 6.54	3.13 ± 0.14	29.79	0.56 - 4.65	2.02 ± 0.14	32.03
Length of primary rhizomes (cm)	2.6 -1 0.6	7.03 ± 0.26	23.69	2.44 - 6.48	4.49 ± 0.16	22.62
Thickness of primary rhizomes (cm)	1.38 - 5.49	1.90 ± 0.09	33.12	0.55 - 1.13	0.87 ± 0.03	22.61
Length of secondary rhizomes (cm)	1.30 - 5.28	3.26 ± 0.17	34.24	0.74 - 3.04	1.91 ± 0.09	30.37
Thickness of sec. rhizomes (cm)	0.75 - 2.13	1.25 ± 0.04	21.97	0.35 - 0.76	0.56 ± 0.01	14.86
Yield of rhizomes/plant (g)	25.3 -450.2	190.17 ±17.52	56.81	5.35 -106.38	37.43 ± 3.91	62.83

Observation on rhizome before and after curing

The curing percentage which is the proportion of boiled dried product to the fresh rhizome is largely a varietal character (IISR,1993). The characters like length and thickness of mother, primary, secondary rhizomes and yield of rhizomes/plant (fresh weight and dry weight) before and after curing play an important role in varietal selection. Wide range of variability was recorded in respect of rhizome characteristics studied before and after curing of germplsm (Table 2). The study indicated sufficient variation for dry weight (62.83%) followed by yield/plant (56.81%). The length of primary fingers were mostly 5.0 c.m. after curing and varied from 2.44cm to 6.48 cm among the genotypes. The curing percentage ranged from 3.22% (IC-210287 a colour less turmeric) to 29.54% (IC-210281) with a mean of 17.18%.

Geeta and Prabhakaran (1987) observed high genotypic coefficient of variation (GCV) for yield and girth of mother rhizome and plant height. In the present study, IC 210265 recorded highest yield of dried rhizomes per plant i.e. 79.67 g/plant which is even higher than Lakdong type (IC-210274-70.2 g and IC-210281-68.2 g) but less than Kasturi (Ic-210323) an improved strain. The results suggest that clonal selection of IC-210265 may be made for improving yield of turmeric. This accession being yield and quality tested to be released as a new variety.

Acknowledgement

The senior author expresses sincere thanks to Sri M.S. Padhi, Collector, Kandhamal and P.C. Pattanaik, Project Manager, IJRY, Kandhamal for providing logistic support and local guide for successful exploration programme.

References

Geetha, U. and Prabhakaran, P. V. 1987. Genetic variability, correlation and path coefficient analysis in turmeric. Agric. Res. J. Kerala, 25 : 249-254.

Mally, L. S. S. O. 1908. Annual Gazetteer of Phulbani (Kandhamal) Orissa.

Mohanty, D. C. 1979. Genetic variability and inter-relationship among rhizome yield and yield components in turmeric. Andhra Agric. J., 26 : 77-80.

Muralidharan, V. K., Velayudhan, K. C. and Thomas, T. A. 1980. Preliminary studies on the germplasm collection of *Curcuma*. Proc. Nat. Sem. on Ginger and Turmeric, Calicut, pp.55-57.

IISR, 1993. Annual Report, 1992-93. National Research Centre for Spices, Calicut. p. 92.

Phillip, J. and Nair, P. C. S. 1987. Morphological and yield characters of turmeric types. Ind. Cocoa, Arecanut and Spices J., 10 : 61-67.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 114-115, 1999

Evaluation and selection for yield in turmeric

N. CHEZHIYAN, T. THANGARAJ, M. VIJAYAKUMAR, M. MOHANALAKSHMI & A. RAMAR

Horticultural College and Research Institute
Tamil Nadu Agricultural University
Coimbatore - 641 003, Tamil Nadu.

Abstract

During '97-'98 one hundred and fifty three turmeric accessions were evaluated at the Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. The genotypes differed significantly in respect of duration and based on duration they could be grouped into short (<225 days), medium (225-250 days) and long duration (>250 days) types. About 30 accessions showed better performance with the average clump weight ranging from 700 to 980 g. The curing percentage ranged from 11 to 24 in the above types. Eight single plant selections, with yield ranging from 0.900 g to 1.950 g per clump and duration of 239 to 270 days were identified. Long duration types generally are found to be high yielders. The selections have been advanced for further testing.

Introduction

Turmeric (*Curcuma longa L)* is a major spice crop of Tamil Nadu and is widely used as a food colourant besides as a raw material in pharmaceutical and textile industries. The state is the second largest producer of turmeric in the country taking a share of 15.0 per cent by area and 21.0 per cent by production (Anon. 1997). Identification of high yielding and good quality turmeric varieties is an important aspects of turmeric programme in the state. The present paper reports the result of evaluation of 150 accessions of turmeric for yield and maturity.

The accessions were row planted and 10 plants were selected at random within the row and utilized for recording observations on plant height (cm), leaf number per plant, tiller number, duration and yield of fresh rhizome per plant. The crop was raised as per the practice in vogue.

Variability for yield and yield attributes

Data on range, mean, variance and coefficient of variation for certain characters are presented in Table 1. Plant height ranged from 27.2 to 132.0 cm with a mean of 92.38 cm. Number of tillers per plant ranged from 1.2 to 7.0 with a mean of 3 to 87. Number of leaf per plant varied from 6.2 to 16.2 and duration 214 to 290 days. Yield per plant varied from 0.05 to 1.95 kg with a mean of 0.495 kg.

In terms of coefficient of variability, yield showed the highest level (48.37%). Coefficient of variability, was moderate for plant height ((22.73%) and tiller number (28.37%).

The data on yield and related plant characters in respect of eight promising selections are furnished in Table 2. Accession 53 excelled all others in yield (1.95 kg/plant). The data also revealed that shorter the duration, lower is the yield.

Table 1. Variability for certain characters in turmeric

Character	Range	Mean	Variance	CV%
Plant height (cm)	27.20 - 132.00	92.38	480.69	23.73
Tiller number	1.20 - 7.00	3.87	1.21	22.37
Leaf number	6.20 - 16.20	12.51	3.92	15.83
Duration (days)	214 - 219.00	258.44	200.39	5.48
Yield/plant (kg)	0.05 - 1.95	0.495	0.06	48.37

Table 2. Performance of some promising selections of turmeric

Acc. No	Duration (days)	Plant height (cm)	No. of tillers	No. of leaves	Yield/plant (kg)
53	264	127.9	4.2	14.1	1.95
145	270	125.4	5.1	13.6	1.90
74	259	130.2	4.2	14.1	1.70
68	170	119.3	4.09	12.1	1.50
189	260	115.8	5.5	14.2	1.20
2	268	118.6	5.2	14.6	1.10
141	239	62.2	4.5	13.9	0.90
30	259	103.6	6.1	16.2	1.70

References

Anonymous, 1997. Spices Statistics (3rd edition) Spices Board, Cochin P. 19.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 116-120, 1999

Variation for quality components in ginger and turmeric and their interaction with environments

T. JOHN ZACHARIAH, B. SASIKUMAR & K. NIRMAL BABU

Indian Institute of Spices Research
Calicut - 673 012, Kerala.

Abstract

Ginger (*Zingiber officinale* Rosc.) and turmeric (*Curcuma longa* L.) are two important spices valued for its colour, pungency, aroma and taste. Ginger oil and oleoresin are both used in many pharmaceutical, industrial and culinary preparations. Curcumin, the yellow pigment from turmeric has wide application as a natural colourant. From among the 90 ginger accessions evaluated, accessions with high oleoresin, low fibre, high oil and high gingerol were short listed. Out of 60 turmeric accessions evaluated for curcumin content, 18 were found to possess more than 6% curcumin.

Multilocational trials carried out at Calicut, Moovattupuzha (Kerala), Coimbatore (Tamil Nadu), Jagatial (Andhra Pradesh) and Solan (Himachal Pradesh) to study the effect of location on chemical quality indicated that agroclimatic variation influences curcumin content significantly. Ginger trials at Brahmavar (Karnataka) indicated that fibre content can be affected by soil stature. Planting turmeric in May and harvesting in November yield about 30% more curcumin compared to regular harvest at full maturity.

Introduction

Ginger (*Zingiber officinale* Rosc.) and turmeric (*Curcuma longa* L.) are used as a main ingredient in many Indian dishes. The rhizomes of ginger and turmeric are used as the spice of commerce. The items prepared from ginger are raw ginger, dry ginger, bleached dry ginger, ginger powder, ginger oil, ginger oleoresin, gingerale, ginger candy, ginger beer, brine ginger,

ginger wine, ginger squash, ginger flakes etc. Some of the popular cultivars known in ginger are Maran, Himachal, Wayanad local, Nadia, Bajpai and Kuruppampadi. Some of the exotic types are Rio-de-Janeiro, Taffingiwa, Jamaica and China. The improved cultivars are Suprabha, Suruchi, Suravi and Varada (Govindarajan, 1982, Sasikumar *et. al.*, 1996).

The main products from turmeric are turmeric powder, turmeric oleoresin and the yellow pigment curcumin. The popular cultivars in turmeric are Alleppey, Erode, Duggirala, Nizamabad, Cuddappa and Rajapuri. Many improved cultivars are also available in turmeric. Some of the prominent ones are Roma, Suroma, Ranga, Rasmi, Rajendra Sonia, Suvarna, Suguna, Sudarshana, Prabha and Prathiba.

Though chemical constituents like essential oil, oleoresin , gingerol (pungent principle), curcumin etc. are secondary metabolites high variability is observed in these constituents in both, ginger and turmeric (Zachariah *et. al.*, 1993, Shamina *et. al.*, 1997, 1998). An attempt is made in this paper to elucidate this variability available in these two major spices.

Study details

Ginger and turmeric accessions collected from different parts of the country were used for the study. These were planted in beds in a randomised block design with two replications. The rhizomes were harvested at full maturity as indicated by complete drying of aerial vegetative parts. Dry ginger is prepared by scraping off the outer skin of cleaned, harvested rhizomes and then dried in sunlight for 10-12 days to a moisture level of 10%. Turmeric rhizomes were cleaned, cured by boiling in water for 1-1 ½ hrs and dried in sunlight to a moisture level of 10%. Oleoresin was extracted by cold percolation of the comminuted sample with acetone and percentage was computed gravimetrically (ASTA 1968). Essential oil was extracted from the powdered sample employing hydrodistillation technique (ASTA 1968). Crude fibre was estimated using ASTA method (1968). The maturity study in turmeric was carried out by planting turmeric in June and harvesting at different durations such as November, December, January and February.

Discussion

Oleoresin and oil content of selected ginger germplasm accessions are given in Table 1. Among the accessions evaluated oleoresin content ranged from 4 to 8.9%. The essential content ranged from 1.5 to 3.0%. This establishes the fact that like the variation in yield and other parameters the secondary metabolites also very considerably. Shamina *et. al.*, (1997) have shown that variability exists in isozyme polymorphism and other primary and secondary metabolites. Table 2 enumerates the level of low and high fibre among the ginger accessions. Crude fibre is very critical in ginger quality. Low fibre types are preferred for fresh ginger preparations and high fibre types are preferred for dry ginger, oleoresin etc (Govindarajan, 1982). This again reveals that the country has good diversity to have types for both purposes.

It is interesting to note that the crude fibre content of ginger varies with soil type and agroclimatic factors. Table 3 gives the percentages of crude fibre in six cultivars

Table 1. Ginger accessions with high oleoresin and essential oil.

Accession	Oleoresin (%)	Accession	Ess. oil (%)
110	8.9	418	3.0
582	7.6	399	3.0
236	6.8	389	3.2
388	6.8	205	3.0
414	6.7	110	3.2
6	6.2	236	3.1
3	6.4	104	3.0
		296	2.9

Table 2. Low & high fibre containing ginger accessions

Accession	Fibre (%) (low)	Accession	Fibre (%) (high)
419	3.2	105	5.0
386	3.2	29	5.5
415	2.9	296	5.9
200	3.3	236	5.6
110	3.0	205	5.8
336	2.2		

at two locations, one in Kerala and the other in Karnataka (Bamhavar). It is quite well known that the ginger grown in North-Eastern States are plumpy in nature and if the same cultivars are cultivated in Kerala its plumpy nature diminishes and it acquires more fibre (unpublished data). A similar trend was observed in the ginger accessions grown at Bramhavar in which the fibre content is almost half compared to that of Kerala.

Table 3. Variability in fibre content at two locations

Cultivar	Crude fibre (%)	
	Kerala	Karnataka (Brahmavar)
Wayanadan	5.7	3.7
Thingpui	5.5	3.1
Karakkal	5.7	3.5
Maran	6.1	2.9
Himachal	3.8	3.2
Tura	6.3	3.7

Turmeric is mainly utilized for its colour. The natural yellow pigment present in turmeric is curcumin. Many industries crystallize it and export. It is used as a natural colourant in baked foods, pharmaceuticals and other preparations. It is also used as antioxidant and antinflamatory agent. Table 4 lists some of the high curcumin accessions available in the germplasm. The curcumin content in the germplasm ranged from 3.0 to 8.0%. Industry prefers turmeric with more than 5.5% curcumin.

It has already been shown by many workers that the secondary metabolites are synthesized much early. In turmeric the synthesis of curcumin starts as early as 120 days after planting and reaches optimum at 180-190 days after flowering (IISR 1997). A study carried out at IISR, Calicut

Table 4. High curcumin turmeric accessions

Accession	Curcumin (%)
249	8.0
351	8.0
290	8.0
325	7.0
329	7.0
330	7.0
356	7.0
257	7.0
237	7.0
160	7.0

showed that if turmeric is planted in June and harvested in November it yield 30% more curcumin per kg compared to regular harvest at full maturity (Table 5). The relative reduction in curcumin content in the later stage of the plant can be attributed to accumulation of starch and fibre.

Table 6 shows that curcumin content at Coimbatore is about 40% less compared to Calicut and Moovattupuzha. This again establishes the fact that curcumin is highly dependent on location and other agroclimatic conditions and influenced by genotypes. In Kerala the peak growing season of turmeric is flanked by heavy monsoon during June-August while in Coimbatore the rainfall is hardly 100-150 mm during the same period. This may be the reason for the less synthesis of curcumin during the period at Coimbatore. It has also been reported that the dry recovery of turmeric is relatively high in Coimbatore compared to locations in Kerala.

In short the paper illustrates the fact good variability is available in ginger and turmeric the chemical constituents vary due to agroclimatic conditions and cultural practices.

Table 5. Effect of early harvesting on curcumin content

Variety	June – Nov	June – Dec.	June – Jan	June – Feb
Alleppy	9.5	8.0	7.4	7.0
Suvarna	6.0	3.8	3.5	3.5
Suguna	8.5	7.0	6.0	5.8
Sudarsana	8.5	6.7	6.0	5.5

Table 6. Effect of different location on curcumin content

Variety	Curcumin (%)		
	Coimbatore	Calicut	Moovatupuzha
Acc. 363	4.6	6.5	6.0
Prabha	5.5	7.0	7.3
Suguna	4.4	6.5	4.8
Alleppey	5.5	6.4	6.0
Prathiba	4.1	7.2	6.8
Sudarsana	4.5	5.8	6.0

References

Govindarajan, V. S. 1982. Ginger – chemistry, technology and quality evalutation. CRC Critical Reviews on Food Science and Nutrition. 17 : 96.

IISR. 1997. Annual Report 1996 – 97. p. 125.

Sasikumar, B., Johnson George, K. and Ravindran, P. N. 1996. IISR Varada – a high yielding ginger (*Zingiber officinale* Rosc.) variety. J. Spices & Aromatic Crops, 5 : 34 – 40.

Sasikumar, B., Johnson George, K., John Zachariah, T., Ratnambal, M. J., Nirmal Babu, K and Ravindran, P. N. 1996. IISR Prabha and Prathiba – two new high yielding and high quality turmeric (*Curcuma longa*) varieties. J. Spices & Aromatic Crops 5 : 41–48.

Zachariah John, T., Sasikumar, B. and Ravindran, P. N. 1993. Variability in gingerol and shogaol content of ginger accessions. Indian Perfumer, 37 : 87–90.

Shamina, A., John Zachariah, T., Sasikumar, B and Johnson George, K. 1997. Biochemical variability in selected ginger (*Zingiber officinale* Rosc.) germplasm accessions. J. Spices & Aromatic Crops, 6 : 119–127.

Shamina, A., John Zachariah, T., Sasikumar, B. and Johnson George, K. 1998. Biochemial variation in turmeric (*Curcuma longa* L.) accessions based on isozyme polymorphism. J. Hort. Scie. & Biotec. 73 : 479–483.

American Spice Trade Association (ASTA) 1968. Official Analytical Methods. American Spice Trade Association. New York.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 121-130, 1999

Tree spices – biodiversity, conservation and utilization

B. KRISHNAMOORTHY, J. REMA & P.A. MATHEW

Indian Institute of Spices Research,
Calicut – 673 012, Kerala.

Abstract

Tree spices refer to spices originating from tree crops. Seventeen tree spices are grown in India, the commercially important ones being nutmeg, clove, cinnamon, cassia, allspice, cambogia, kokam, tamarind, pomegranate and curry leaf. Tree spices are a major source of flavoring and therapeutic agents. The variability available in these crops is limited and also many species are being endangered and hence conservation of the genetic variability is very important. Collection and conservation of the biodiversity in tree spices has been one of the major mandates of Indian Institute of Spices Research, Calicut and the germplam conservatories at IISR, Calicut consist of 1140 accessions of tree spices. This paper deals with the biodiversity of tree spices available in our country, their conservation and utilization for crop improvement.

Cinnamon

The truc cinnamom, *Cinnamomum verum* Bercht. & Presl., (Syn. *C. zeylanicum Blume*), (Lauraceae) commonly known as Sri Lankan cinnamon, is an evergreen tree reaching a height of 6-15m, with bisexual flowers. Cinnamon of commerce is the dried bark of *C. verum*. It is indigenous to Sri Lanka, which produces the largest quantity and best quality of cinnamon. Seychelles and Malagasay Republic are the other major cinnamon producing countries. Cinnnamon was first introduced into India from Sri Lanka by the British during the 18th century and is cultivated in Kerala, Karnataka and Tamil Nadu, and is more prevalent in the hilly regions of Western Ghats. The oldest cinnamon plantation is the Anjarakandy estate (250 acres approximately) in the

Cannanore district of Kerala, which was planted by British.

The genus *Cinnamomum* consists of about 250 species comprising evergreen trees and shrubs; distributed in the Asiatic mainland to Formosa, the Pacific Islands and Australia. Hooker (1886) reported 25 species from the Indian subcontinent mainly from Western Ghats. Gamble (1925) reported 12 species of *Cinnamomum* from the Western Ghats and adjoining areas while Kostermans (1983) listed 13 species from different parts of south India. The diversity in *Cinnamomum* is mainly species diversity. As most of the species occur only in the wild, semi-domesticated genepools of *Cinnamomum* do not occur. Owing to severe deforestation there is every possibility of some species becoming extinct in the near future. Western Ghats are considered as secondary centre of origin of *C. verum*. In a cluster analysis of the south Indian species, *C. verum* was found to be more closely related to *C. malabatrum* Burn (f) Bl. (Shylaja 1984). The wild population of *Cinnamomum* are in real threat due to indiscriminate bark extraction from them. *C. malabatrum*, *C. macrocarpum*, *C. riparium* and *C. nicolsonianum* are especially vulnerable.

High coefficient of variation for dry and fresh bark yield per plant, bark oleoresin, leaf oil, bark oil, leaf size index and percentage recovery of bark was observed. Association analysis for nine characters in cinnamon revealed significant correlation of fresh weight of bark and leaf oil with dry bark yield. Bark oil was negatively correlated with leaf oil (Krishnamoorthy *et al.*, 1992a). Based on quality analysis, nine cinnamon lines have been identified as elite lines and based on comparative field evaluation of clonal progenies of these lines, two lines have been released as national varieties, *viz.* Navashree and Nithyashree. (Krishnamoorthy *et al.*, 1996a) Navashree has high and stable regeneration capacity (6-7 shoots per year), high bark recovery (40.6%), high yield (average yield 56 kg/ha in the first four harvests) in addition to excellent quality attributes (bark oil 2.7% with a very good cinnamaldehyde content – 73%, bark oleoresin 8%, leaf oil 2.8%). Nithyashree also has good and stable regeneration capacity (4-5 shoots per year) high yield (average yield 54 kg/ha in first four year harvests) coupled with excellent quality attributes (bark oil 2.7%, bark oleoresin 10% and leaf oil 3% with a very good eugenol content – 78%).

A study on seedling progenies of the above nine elite lines revealed a clear variation in the performance of the progenies (Krishnamoorthy *et al.*, 1991a). Four different flush colours were noted among the cinnamon collections, *viz,* pure purple, purple dominated with green, green dominated with purple and pure green. The colour of young leaf flushes of cinnamon was found to be related to its quality. Krishnamoorthy *et al.*, (1988) reported that the ratio of plants having young leaf flushes with purple and purple pigmented ones to green ones was 1:1. Plants with purple leaf flushes recorded about 29% more bark oil, compared with green flushes, showing that flush colour may be taken as a criterion for selection of quality seedlings at the nursery stage. Anthocyanin glycosides present in the cinnamon flushes are cyanidin xyloside and cyanidin galactoside.

Chinese cassia

False cinnamon is obtained from *C. cassia* (L.) Bercht. & Presl. (Syn. *C. aromaticum* Nees). It has originated and being cultivated in China. Its bark is used for flavoring food and beverages and also used in pharmaceutical preparations and perfumery. Indian consumers prefer this to true cinnamon. The bark of *C. cassia* is coarser and thicker with more intense aroma than true cinnamon. The presence of islands of sclerenchyma in the pericyclic region is a characteristic feature of certain species including *C. verum* and *C. cassia.* Raphides and prismatic crystalline inclusions occur in the bark cells. These raphides occur sparsely in *C. verum* and *C. cassia* and are abundant in wild cinnamon, *C. malabatrum* (Shylaja, 1984). Bark characters are useful in the detection of adulteration of true cinnamon with wild cinnamon.

The conservatory of tree spices at IISR, consists of seedling progenies of 26 Chinese cassia lines collected from Sri Kundara Estate, Valparai. Quality analysis of these accessions revealed a high coefficient of variability for bark oil and leaf oil (28.1%, and 30.1% respectively) but the pungency and flavor of the accessions were more or less uniform as indicated by the cinnamaldehyde content. Bark oil ranged from 1.2 to 4.9%, leaf oil 0.4 to 1.6 and bark oleoresin 6 to 10.5%. The leaf and bark oils possess cinnamaldehyde as the major constituent and few accessions C_1, D_1 and D_3 were selected for further evaluation, considering the overall chemical and flavor profile and regeneration capacity. Air layering has been reported with 88 and 50 percent rooting during July and November, respectively, with 100 per cent field establishment (Krishnamoorthy & Rema 1994a). Semi hardwood cuttings could be rooted by treating with IBA (500ppm).

The conservatory of *Cinnamomum* at IISR, Calicut includes besides *C. verum, C. cassia, C. camphora* (an economically important tree yielding camphor oil), a lemon grass oil smelling *Cinnamomum* spp. collected from Munar (Idukki Dt.) *C. malabatrum, C. perrottettii, C. wightii, C. macrocarpum, C. sulphuratum, C. riparium* and *C. tamala.* Upgrading cinnamon quality through interspecific hybridisation between *C. verum* and *C. cassia* is envisaged at IISR.

Nutmeg

Nutmeg (*Myristica fragrans* Houtt.) is as important tree spice, yielding two spices, namely, the nutmeg (dried kernel of the seed) and the mace (dried aril surrounding the seed). It is an evergreen, conical tree reaching a height of 10 meters, belonging to Myristicaceae. This primitive family has about 18 genera and 300 species. *Myristica* is the most primitive genus of the family. The tree is typically dioecious, with male and female flowers on different trees. Occasionally, male trees carrying a few female flowers are observed. Hermaphrodite trees having bisexual flowers are rarely noticed. Nutmeg is indigenous to the Moluccas islands in Indonesia. Semi-domesticated genepools of *Myristica* species do not exist as most of these species occur in the wild. Nutmeg is cultivated in Ernakulam, Trichur, Kottayam and Trivandrum districts of Kerala and also in few areas in Tamil Nadu, Karnataka, Maharashtra, Goa, Andhra Pradesh, North East and Andaman and Nicobar islands.

The oldest nutmeg populations in Kerala are in Kalady and Pala and are reported to be >150 years old. Nutmeg is usually grown on river banks as it grows luxuriously in silts deposited by rivers. Nutmeg is reported to be wind pollinated. Inflorescence is branched raceme in male and simple cyme in female. The male inflorescence has more number of flowers (up to 10) while female is less (up to 3).

The germplasm collections at IISR include a tree bearing 1-4 seeds per fruit, an endangered species, *M fatua* var *magnifica* and few elite lines. A preliminary analysis of genetic variability in 28 trees (14 years old) indicated some variability for fruit number per tree only. Correlation analysis revealed a significant negative correlation of fruit number per tree and mace weight. However, seed weight had a positive significant correlation with mace weight (Krishnamoorthy *et al.*, 1991b).

In a more systematic study on genetic variability of nutmeg, progenies from 16 mother trees of different localities (five progenies for each mother tree), lack of adequate genetic variability was evident for many of the important attributes. This particular study revealed that even though morphological variation exists for leaf shape, canopy shape etc. in nutmeg populations, exploitable genetic variation of crop improvement in nutmeg is lacking (Krishnamoorthy *et al.*, 1996b).

Progeny evaluation aims in analyzing breeding behavior of certain elite trees for sex ratio and prepotency so that such promising trees are selected for seed/scion collection. Significant differences were observed among the populations for plant height, number of main shoots, number of years for flowering, fruit weight and ratio of mace weight to seed weight. The Phenctypic Coefficient of Variation is more than the Genotypic Coefficient of Variation, indicating the role of environment in the expression of these characters. Non additive genetic factors are attributed for the variations due to the comparatively low estimates of heritability and genetic advance of these traits. Mace weight to seed weight ratio has a very high heritability and very good genetic advance. Hence selection for this trait may be very effective. Non significant variation was observed for canopy size, number of erect shoots, number of fruits, girth etc. This may be due to the narrow genetic pool introduced into India, from which the present day population evolved. Therefore there is an urgent need to introduce genetic variability.

In another study of sex segregation, out of 90 progenies, 40 were males, 45 females and 5 bisexuals. Identification of sex at seedling stage is a pressing problem. Sex determination based on size and shape of calcium oxalate crystals of leaves was reported, but the crystal pattern was clear only in adult trees (Krishnamoorthy *et al.*, 1992b). Study of seedling characters like sprout colour, days for germination, leaf shape, size, venation etc. led to the conclusion that none of these traits can be taken as a guide to sex the nutmeg seedlings.

Few nutmeg accessions (A9/4, A9/20, A9/22, A9/25, A9/79, A9/86, A4/12, A4/22, A4/52, A11/29, A11/70) were identified as promising. A super clonal selection A9/4 is in the pre release stage. Another bold accession A9/69 and a 'bald type' are of importance. Epicotyl grafting (Mathew and Joseph, 1982) is the mostly widely adopted propagation technique in nutmeg. Epicotyl grafting could be carried out on cultivated species of nutmeg, *M. fragrans* (Krishnamoorthy and Mathew, 1985) or wild species, *M. beddomei* and *M. malabarica* (Mathew and Joseph 1982).

At present, the crop improvement programme is limited to the selection of mother trees (elite trees), based on high yield and regular bearing habit, both from germplasm conservatory of IISR, Calicut and farmer's fields by periodical surveys and multiplying their progenies.

Clove

The clove of commerce is the dried, aromatic, fully grown but unopened flower buds of *Syzygium aromaticum* (L.) Merr. & Perry (Syn. *Eugenia caryophyllus* (Sprengel) Bullock & Harrison) (Myrtaceae). Genus *Syzygium* Gaertn. has spread to many tropical countries. The important species of *Syzygium* occurring in the Western Ghat forests are *S. aromaticum, S. cuminii, S. fruticosum, S. jambos, S. zeylanicum, S. travancoricum* and *S. jambolana.*

Flowers are hermaphrodite, borne at the terminals in trichotomous panicles, with 3 to 20 flowers/panicle. Floral biology of cloves favours self pollination. Self pollination is reported to be more probable mechanism for pollination in clove, as maximum pollen viability and stigma receptivity are attained simultaneously (Nair *et. al.*, 1974). However, flowers are frequently visited by ants, thrips and bees, suggesting possibility of transferring the pollen from the anther to stigma of same flower or cross pollination.

Genetic base of clove in India is narrow because the original number of introductions was few. Clove tree appears to be uniform type and no distinct varieties/cultivars have been recognized. It is also known that the tree population in Zanzibar and Madagascar are also rather uniform, but in Indonesia, 3 types are distinguished. These types differ in tree habit, leaf size, clove size and colour. In India, differences have been observed in the tree shape, bearing habits, cropping season yield, colour, shape and size of clove.

Surveys were conducted in the major clove growing areas of Tamil Nadu and Kerala and a total of 220 accessions were added. Special efforts were made to identify and collect diverse types from Ashamboo hills, the southern most hills of India, where clove was first introduced. Surveys were conducted in major clove growing areas of Tamil Nadu and Kerala and total of 35 elite trees had been identified (Krishnamoorthy and Rema, 1992c).

The distinctly diverse collection of clove includes three morphological variations *viz.*, dwarf and bushy types, accessions with exceptionally bold and thick clove buds (king clove) and narrow leaved variants (Krishnamoorthy and Rema, 1994b), whereas a reddish purple petioled Zanzibar type from Zanzibar island and one from Sri Lanka are the only introductions at present. A dwarf gene source in clove has important breeding value in developing dwarf genotypes with compact canopy size. Seed and seedling characters of progenies of 14 elite clove trees revealed no appreciable variation for 100 fruit weight, 100 seed weight, fruit breadth, fruit length, seed breadth, seed length, germination span, germination percentage, root and shoot length and number of leaves of seedlings at 40 days after sowing, one and two years old plant height among the progenies of elite lines at the seedling stage (Krishnamoorthy and Rema, 1994c).

At present, the crop improvement programme in clove is limited to the selection of mother trees based on their regular and heavy bearing nature by surveying clove growing tracts, besides selection in germplasm. Recently with the introduction of dwarf gene source in the conservatory, it is proposed to develop a dwarf, bushy and early bearing tree with bold cloves. This would favour easy harvest and other cultural operations. High oil yielding accessions would be beneficial for the distillation of oil. Breeding trees with high leaf oil and bud oil would also be advantageous, but it is not easy to achieve these aims due to the lack of wide variability in the population. The only way is to introduce further variability from Zanzibar and Indonesia and then initiate a cross breeding programme. Clonal propagation of selected mother trees, avoiding a juvenile phase may result in a breakthrough in productivity. A technique for vegetative propagation by approach grafting has been standardized (Rema and Krishnamoorthy, 1994).

Allspice

Allspice (*Pimenta dioica* (L.) Merr.) also known as Jamaican pepper, is indigenous to West Indies and tropical America. The flavour of allspice resembles a mixture of cinnamon, clove, nutmeg and black pepper. The dried unripe but mature berries of *P. dioica* is the spice of commerce. Leaves are aromatic and are used in the distillation. The berries are used for the preparation of essential oil and oleoresin. In India, the plant is reported to be grown in some gardens, especially in Bengal, Bihar and Orissa. It is said to grow well in Bangalore and in the hilly districts of Mysore, along the river vallies. There are a few allspice trees available in Nagarcoil, Kallar, Burliar and Horticultural Research Station, Ambalavayal. In IISR, Calicut there are 160 trees and all spice trees flower and yield from their third year of planting well in Appangala, a higher elevation place in Karnataka.

Allspice is a small evergreen tree. Flowers are small and white with a peculiar aroma. They are present in groups of cymes. They are structurally hermaphrodite, but reported to be functionally dioecious. Studies on seed viability at Regional Agricultural Research Station, Ambalavayal revealed that allspice seeds can be stored without much loss of viability on ripe berries upto 3 weeks after collection from the tree and there is considerable reduction in viability after weeks and the seeds become non viable after 3 weeks (Devadas and Manomohandas, 1988). Allspice could be rooted through cuttings and layerings.

Dwarf, semidwarf types and very high yielding trees have been identified from the farmers' fields and they are multiplied by approach grafting, as in addition to yield, attention has to be paid to breed trees with low branching habits to facilitate easy harvesting. Resistance to diseases, particularly leaf rot needs to be located. Flowering and fruit rot in plains are very poor and is a major handicap in taking up any breeding work on this crop in plains. Drenching the tree basins with 1gm a.i. paclobutrazol during October gave profuse flowering in the next two flowering seasons in the Experimental Farm of the IISR at Peruvannamuzhi (Krishnamoorthy, *et. al.*, 1996c). Spraying a combination of 50 ppm of IAA and 5ppm of BAP on these flower buds, 20 days after their initiation gave abnormally big sized fruits, more number of seeds per fruit (upto 20) and bold seeds with a good viability (Krishnamoorthy *et al.*, 1995).

Cambogia and Kokam

Cambogia (*Garcinia gummi-gutta* (L.) Robs) (Syn. *G. cambogia* (Gaertn) Desr.) is an evergreen tree grown for its dried rind (pericarp of the under ripe fruits) which is a popular spice used as a substitute for tamarind in cookery. The dried rind of *G. indica* (Thouars) Choisy known popularly as kokam, a related species of *G. gummi-gutta*, is also used as a spice in cookery.

The genus *Garcinia* has around 200 species of which 17 is endemic to India. *G. gummi-gutta* and *G. indica* are native to India. *G. gummi-gutta* is cultivated in Goa, Karnataka, Maharashtra, Tamil Nadu and Kerala. *G. indica* is planted in Southern Maharashtra and the Nilgiris but occurs wild in evergreen forests of W. Ghats. Cambogia and kokam are dioecious and hence lot of variation exists in the seedling progenies. Bisexual forms occur and can be propagated by soft wood grafting.

The kokam of commerce is the dried rind of the fruit. The fruits have an agreeable flavor and a sweetish acid taste, commonly used in lieu of tamarind, and also for preparing syrups and squashes. The fat from seed (kokam butter) is used in the preparation of ointments and pharmaceuticals. The fruits are harvested when ripe and processed by drying. For this the fruit is cut open and the inner flesh portion containing the seed is removed. The rind (50-55% of the whole fruit) is repeatedly soaked in the juice of the pulp during drying. The dried product constitutes the kokam of commerce. Kokam is used to make an attractive red, pleasant flavored beverage. The rind contains 2-3% natural colour pigments and is a good source of natural colourant. The rind also contains hydroxy critic acid (about 15%) and is used as an adultrant on various food preparations. IISR has collected 17 accessions of *G. gummi gutta* and 2 accessions of *G. indica*.

Garcinia is a tropical plant, moderate sized or large tree with rounded crown, horizontal and drooping branches, leaves dark green, shining and elliptic obovate, bark deep brown and rough. Plant flowers in hot season and fruits ripes in rain. More or less globular and of the size of the orange, 60-77mm in diameter, the yellowish or reddish fruits have 7-13, deep longitudinal furrows, not extending to the apex which is smooth, depressed and often mamilate. The orange or yellow pericarp is very thick, fleshy seeds as many as the grooves of the fuit are 19 cm long, oval, depressed, surrounded by a copious, juicy, red or white, aril, testa pale brown. NBPGR, Vellanikkara maintains 54 accessions of *G. gummi-gutta*, 7 of *G. indica*, 2 of *G. xanthochymus*. Few accessions are found to be promising.

Tamarind

Out of 52 spices under the perview of Spices Board, tamarind stands 5th in terms of export value. Tamarind (*Tamarindus indica* L.) is one of the most common trees in India. Fruit is a rich source of tartaric acid (8-18%) and ascorbic acid (3 mg/100 mg). It is a monotypic genus indigenous to tropical Africa and growing widely in S.E. Asia and sub-tropical regions of India. It is one of the common and important spices used in many of the Indian dishes. The oxalic acid content in tamarind helps in digestion and when used in cool drink is said to bring down body temp. Tamarind thrives well in acidic/saline soil as well as in degraded soil. It is eommonly grown from seeds, but air layering is reported to be 90% successful. Tamarind is generally classified based on colour and taste of the pulp as sweet and red pulp. TNAU has released a high yielding, early bearing line PKM-1. It has 39% pulp recovery and yields 260 kg ripe fruits/tree. Pulp is sweet. A local variety Urikampuli with fruits of 20 cm length is a selection from village in Dharmapuri, Tamil Nadu. There is one more selection popular in Cumbum, Madurai District.

Generally, seedlings come to bearing in the 5th year and continue to yield for 100 years or more. Each adult tree will yield on an average 100 kg fresh tamarind pulp/year.

The total production of tamarind pulp in India is 3 lakh MT out of which 10 to 12000 tonnes exported to different countries mainly in 4 forms *viz.* fresh, dry, seed powder and paste.

The tree is semi-evergreen, about 20m high with erown of dropping branches. Trunk is stout, with grey scaly bark, leaves alternate, paripinnate, inflorescence in small terminal dropping raceme, 5-10 cm long, bisexual. An investigation carried out on 300 genotypes of tamarind suggests that the number of primary branches, trunk volume, pod length, seed and pulp yield are the best selection criteria for improvement of tamarind. Acidity of pulp, fibre content etc. are the other criteria to be considered.

High degree of variation was found in size and quality of fruits. Tamarind exhibits long duration of flowering, extending from March to August. Wide variation in the onset and completion of flowering of the trees has led to the grouping of trees as early season, mid season and late season types.

Inspite of profuse flowering, there is heavy flower and fruit drop resulting in low yields. High % of fruit set and retention was found in mid and late flowering types as compared to early flowering ones. Severe moisture stress, insufficient pollination, low reserve food materials within the tree and self incompatibility factors were associated with low fruit set. Seedling trees are erratic in bearing and have the alternative bearing tendency. It is also low in yield and takes very long prebearing period. But recently grafts have gained momentum as they have compact growth with early and regular yield. The grafts come to bearing in third or fourth year after planting.

Forty genotypes of tamarind collected by the Department of Forestry, Government of Karnataka has been evaluated for their yield and quality parameters. Results revealed that NTI-19 and NTI-14 were found to be promising and these two selection have been proposed for release under the names DTS-1 and DTS-2

(Dharwad Tamarind Selection) respectively.

Conclusion

The analysis of variability patterns in three of the major tree spices-cinnamon, nutmeg and clove-reveals an interesting pattern. Unlike in cinnamon, the exploitable genetic variability in nutmeg, clove and allspice is rather limited. Cinnamon, although indigenous to Sri Lanka, occurs rarely in Western Ghats and this region can be considered as the secondary centre of origin of this crop. Further, the main mode of propagation of the species has been through seeds. The germplasm material of the present study includes collection from the earliest introduction (planted at Anjarakandy Estate, Cannannore, Kerala) as well as from subsequent introduction from Sri Lanka done in 1976 and 1979 (105 Sri Lankan progenies of 13 accessions). On the contrary, the clove and nutmeg populations studied have evolved from a narrow genepool of the original introduction in the 18th century. Thus the entire spectrum of genetic variability in these two crops is centered around these few source trees; there was no further introduction. More further, in perennial tree crops such as clove and nutmeg, there was not much scope for natural selection to act after its introduction to India. Variability exist in cambogia, kokam and tamarind which should be collected intensively, conserved and evaluated.

Cultivation of cambogia, kokam, clove and nutmeg is spreading to more and more areas in India. Planting materials are generated from the existing population. Even though seed propagation is practiced in clove, nutmeg is mainly propagated through vegetative means at present. This will be suicidal for a crop on the threshold of genetic vulnerability.

References

Devadas, V. S. and Manmohandas, T. P. 1988. Studies on the viability of allspice seeds. Ind. Cocoa, Arecanut and Spices J. 11: 99.

Gamble, J. S. 1925. Flora of the Presidency of Madras Vol. 2. Bot. Survey of India, Calcutta (reprint 1967).

Hooker, J. D. 1886. The Flora of British India Vol. 5. Bishen Singh Mahendrapal Singh, Dehradun (Reprint, 1973).

Kostermans, A. J. G. H. 1983. The South Indian Species of *Cinnamomum* Schaeffer (Lauraceae). Bull.Bot. Surv. India. 25 : 90-133.

Krishnamoorthy, B., Gopalan. A and Jose Abraham. 1988. Quality parameters of cinnamon (*Cinnamomum verum*) in relation to flush colour. Ind. Cocoa, Arecanut Spices J. 12 (2) : 38.

Krishnamoorthy, B., Krishnamoorthy, K. S. and Rema. J. 1995. Increase in fruit and seed size and seeds per fruit in allspice (*Pimenta dioica* L. Merr.) By hormonal application. J. Spices & Aromatic Crops 4 : 162-163.

Krishnamoorthy, B and Mathew, P.A. 1985. Epicotyl grafting in nutmeg using *Myristica fragrans* as rootstock. Ind. Cocoa Arecanut Spices *J*. 9 : 50-51.

Krishnamoorthy, B., and Rema. J. 1992c. Elite Clove trees – a survey report.

Spice India, 5 : 2-6.

Krishnamoorthy, B. and Rema. J. 1994a. Air layering in cassia (*Cinnamomum aromaticum* Nees). J. Spices Aromatic & Crops, 3 : 48-49.

Krishnamoorthy, B. and Rema. J. 1994b. Three promising morphological variants in clove (*Syzygium aromaticum* (L.) Merr. and Perry) from Tamil Nadu, Ind. J. Spices & Aromatic Crops, 3 : 168.

Krishnamoorthy, B and Rema, J. 1994c. Characterization of seedling progenies of elite lines of clove. Ind. Cocoa, Arecanut spices J. 18 : 82-84.

Krishnamoorthy, B., Rema, J and Peter, K. V. 1996c. Tree spices breeding in Kerala. Proceedings of the Seminar on Crop Breeding in Kerala. January 25, 996., Department of Botany. University of Kerala, Kariavattom (Ed.) Dr. P.I. Kuriachan). pp : 101.

KrishnamoorthY, B., Rema, J. and Sasikumar, B. 1991a. Progeny analysis in cinnamon. Ind. Cocoa Arecanut Spices J. 14: 124-125.

Krishnamoorthy, B., Rema, J., Zachariah, T. J., Jose Abraham and Gopalam, A. 1996a. Navashree and Nithyashree – two high yielding and high quality cinnamon verum Bercht. & Presl.) selections J. Spices Aromatic Crops, 5 : 28-33.

Krishnamoorthy, B., Sasikumar, B., Rema, J. 1996b. Genetic variability and of sex in nutmeg (*Myristica fragrans* Houtt.). J. Plantn. Crops 24 (Supplement) 468-472.

Krishnamoorthy, B., Sasikumar, B., Rema, J., Gopalan, A. and Abraham, J. 1992a. Variability and association studies in *cinnamomum* (*Cinnamomum verum)* J. Spices & Aromatic Crops, 1 : 148-150.

Krishnamoorthy, B., Sasikumar, B., Rema, J., Sayed, A. A. M. and Abraham, J. 1991b. Variability and association in nutmeg. Ind. Cocoa Arecanut and Spices J.14 : 121-122.

Krishnamoorthy, B., Zachariah, T. J., Ravindran, P. N. and Gopalan, A. 1992b. Identification of sex of nutmeg seedlings based on morphological and chemical characters. J. Plantn. Crops 20. (Supplement) : 194-199.

Mathew, P. A. and Joseph. J. 1982. Epicotyl grafting in nutmeg (*Myristica fragrans* Houtt.) J. Plantn. Crops. 13 : 147-151.

Nair, R.B., Sadanandan, A. K. and Unnithan, K. R. G. 1974. Floral biology and breeding of clove (*Eugenia caryophyllata* Thumb.), J. Plantn. Crops. 1 (Suppl.) : 28-29.

Rema. J and Krishnamoorthy. B. 1994. Vegetative propagation of clove *Eugenia caryphyllus* (Sprengel) B & H. Trop. Agri. 71 : 144-146.

Shylaja, M. 1984. Studies on Indian Cinnamomum – A study on the major species occurring in Kerala, India. Ph.D. Thesis Submitted to University of Calicut, Calicut.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 131-133, 1999

Genetic resources of *Garcinia* species at NBPGR Regional Station, Trissur, Kerala, India

Z. ABRAHAM, S. K. MITHAL & P. L. GAUTAM*

National Bureau of Plant Genetic Resources, Regional Station Trissur - 680 654, Kerala.

Abstract

A programme on collection of germplasm of *Garcinia* species was initiated in 1987 by NBPGR at Vellanikkara, Trissur, Kerala. At present 54 accessions of *G. gummi-gutta,* 7 *G. indica,* 2 *G. xanthochymus,* 2 *G. mangostana* and 2 unidentified species are maintained in the field genebank. Accession NIC 5062-2 of *G. gummi-gutta* is early bearing and three accessions of *G. indica,* IC 136687-2, IC 136685-1, IC 136682-2 are found to be promising.

Introduction

The genus *Garcinia* is distributed in the tropics of the old world, chiefly Asia, with approximately 200 species, and in India 36 species occur. Malaysia and Africa with large number of endemic species appear to be the two main centres of development of the genus *Garcinia.* India is endowed with 15 endemic species and 3 endemic varieties. Out of these, 7 species and 2 varieties are confined to Western Ghats, 7 species to Andaman & Nicobar Islands and 1 species and 1 variety to North East India (Singh, 1993, Srivastava, 1994). In India, 3 important species *viz., G. gummi -gutta* L. N. Robson, *G. indica* (Thouars) Choisy and *G. mangostana* L. are cultivated. *G. gummi-gutta* is found wild in evergreen or semi-evergreen forests of Western Ghats upto 1800m in Maharashtra, Goa, Karnataka, Kerala and also the shola forests of the Nilgiris, Tamil Nadu. *G. indica* occurs wild in the evergreen forests of Western Ghats in Maharashtra. *G.*

* Director, NBPGR, Pusa Campus, New Delhi – 110 012.

mangostana is successfully cultivated in very small areas in Kerala and Tamil Nadu for its delicious fruits termed as "queen of tropical fruits" and believed to have originated in West Malaysia.

Collection and conservation

Systematic exploration and collection surveys were conducted to collect germplasm of *Garcinia* species, and the accessions collected as seedling progenies are maintained as perennial trees in the field genebank of NBPGR at Vellanikkara, Trissur, Kerala. At present a total of 54 accessions of *G. gummi-gutta*, 7 *G. indica*, 2 *G. xanthochymus*, 2 *G. mangostana* and 2 unidentified species are maintained in the field genebank.

Evaluation

Observations were made on six flowering trees of *G. gummi-gutta* and ten *G. indica* and the significance of types identified is reported here.

Garcinia gummi-gutta

Farmers of Kerala recognize 7 local named varieties of *Kodampuli*, (Table - 1). Six accessions flowered and 3 set fruits. Irregularity in flowering and fruiting was observed. Bisexual and male trees exist. Male trees are early to flower (7 years) compared to bisexual, which takes 8-10 years for flowering and fruiting. NIC 5062 has set fruit in the 8th year of planting and is found to be an early bearing type.

Garcinia indica

Ten trees in 5 accessions of *G. indica* flowered, out of which 5 were male, 4 female and one bore one fruit in the first year of flowering and in subsequent years bore only male flowers. There is considerable variation in yield and other characters studied among these 10 trees belonging to 5 accessions. From the commercial point of view, based on subsequent fruiting, fruit yield varied from 2041 to 2791 g, fruit number from 123 to 179, yield of dry fruit rind from 325 to 480g, 100 dry rind weight from 264 to 281g, weight of 100 dry kernels from 25.28 to 40.70g. IC 136687-2, IC 136685-1 and 136685-2 were promising, lines in terms of fruit yield and 100 dry kernel weight, fruit number and yield of dry rind and 100 dry rind weight respectively.

Since *G. xanthochymus* and *G. mangostana* did not flower yet, characterization was not attempted.

Conclusion

There is great demand for the dried pericarp of *G. gummi-gutta*, hence, study on yield of dry pericarp and finding out ways and means of improving it is necessary. As the seeds also contain fat, this resource is worth exploiting for edible oil purposes. The fruit pulp of *G. indica* imparts a natural red colour in water. This natural colour can replace coal tar dyes now being used to colour food products. *G. gummi-gutta* and *G. indica* can be exploited for various products of commercial importance and hence there is an urgent need for the collection, conservation and evaluation of germplasm from all the regions of occurrence of *Garcinia* species, for identifying elite lines and for further utilization.

Table 1. Local named varieties of *Garcinia gummi-gutta* in Kerala

Name	Locality
Varikkappuli	Karuvatta (Kollam) & Nattakom (Kottayam)
Koozhappuli	Karuvatta (Kollam) & Nattakom (Kottayam)
Vadakkanpuli	Vadakkunthala & Panmana (Kollam)
Thottupuli	Thevalakara (Kollam)
Aripuli	Manjapuzha (Pathanamthitta)
Thenpuli	Kallaad (Kozhikode)
Kaachampuli	Kanichal (Kannur)

References

Singh, N. P. 1993. Clusiaceae. In:Flora of India. Vol-3 : Portulacaceae - Ixonanthaceae. B.D. Sharma and M. Sanjappa (eds), Botanical Survey of India, Calcutta, pp. 86-151.

Srivastava. S. K. 1994. *Garcinia dhanikhariensis* (Clusiaceae), a new species from Andaman Islands, India. Nordic J. Bot. 14 : 51-53.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 134-139, 1999

Strategy for conservation and availability of medicinal plants

K.C. DALAL, P.P. JOSHI, K. MANDAL & P.U. PANDIT

National Research Centre for Medicinal and Aromatic Plants Boriavi, Anand, Gujarat - 387 310.

Abstract

Medicinal and aromatic plants need immediate attention of researchers, conservationists and planners. Conservation strategy and selection of appropriate plants need to be priority based on nature of the species, threat status, demand etc. Depending on export figures for conservation and research will not be correct always. List of medicinal plants used for various ailments and requiring research support is given.

Introduction

Conservation of medicinal plants assumes great significance to ensure their continued availability. Indigenous demand should be given priority over export while formulating strategies. There are over 200 species of medicinal plants in the country that have been assessed as critically endangered and vulnerable in the wild.

Indigenous demand be given priority over export

By exporting Isabgul (*Psyllium*) husk (to 35 countries) and seed (to 17 countries) during April-Oct. 1997, the country earned Rs. 88.0 crores and Rs. 6.5 crores, respectively in foreign exchange. The amount was Rs. 8.43 crores for Senna leaves and pods. (Table 1.)

Export values for all plants and plant products, except Isabgul, Opium poppy and Senna are low, fluctuating, scanty, sometimes contradictory and because of strong resentment by exporters, number of plants and their products which are banned for export is often subsequently downwardly revised. Moreover, illegal export of banned items cannot be effectively checked. Thus except Isabgul, as far as medicinal plants are concerned export figures cannot be our sole or a major criterion in prioritizing and choosing plants for germplasm collection and conservation and developing their agro-technologies.

Table 1. Export details of crude drugs for the period of April-October 1997

Crop- Botanical name - Family	Total qty, kg.	Total value Rs.in lakhs
Belladona roots-*Atropa belladona*-Solanceae	8,720	4.78
Cubebs-*Piper cubeba*-Piperaceae	12,093	7.72
Ipecac dried rhizome of roots-*Cephalis ipecacunha* or *Psychortia ipecacuanha*-Rubiaceae	33,221	21.4
Zedoary roots-*Curcuma zedoaria*-Zingiberaceae	10,730	1.8
Other than Ginseng roots	20,61,037	1362.0
Belladona leaves-*Atropa belladona*-Solanaceae	5,530	1.2
Chirata-*Swertia chirata*-Gentianceae	1,21,258	101.0
Poppy, flowers+unripe head of dried poppy *Papaver somniferum*-Papaveraceae	23,193	26.0
Psyllium (husk)-*Plantago ovata*-Plantaginaceae	1,09,20,811	8793.0
Psyllium seeds-*Plantago ovata*-Plantaginaceae	10,68,921	649.2
Sarsaparilla-*Hemidesmus indicus*-Asclepiadaceae	10,220	1.7
Senna leaves & pods-*Cassia angustifolia*- Fabaceae	31,73,232	843.0
Takmaria-*Impatiens balsamina*-Balsuminaceae	2,13,619	47.0
Neem leaves/powder-*Azadirachta indica* or *Melia azadirachta*-Meliaceae	180	0.2
Gymnema powder-*Gymnema sylvestre*-Asclepiadaceae	8.284	50.0
Garcinia-*Garcinia indica*-Guttiferae	19,690	114.2
Others	18,21,411	847.0
Saps & extraction of opium-*Papaver somniferum*-Papaveraceae	1,00,791	2296.0
Betel leaves -*Piper betle*-Piperaceae	6,46,481	115.0

Source: CHEMEXCIL, Ministry of Commerce, Govt. of India

Botanical characteristics of medicinal plants requiring conservation on priority basis

The medicinal plants of the country are literally dying to be conserved. There are over 200 species that are assessed as critically endangered and vulnerable in the wild.

Therefore, in setting up priorities of conserving medicinal plants, wild plants with small populations should be given greater priority over plants that are already in cultivation. Among wild plants priority should be given to perennials over annuals. Furthermore, plants that are extracted for their roots and barks should receive special attention. Meanwhile, the future of medicinal plants that are harvested for their leaves, flowers and fruits is to a certain extent relatively safe and they become endangered if only they are sensitive to habitat disturbances.

Plants being conserved and studied in ICAR system for developing their agro-technology and which have been put under the categories vulnerable/threatened are (therapeutically useful part is given in bracket). *Commiphora mukul* (gum), *Chlorophytum borivillianum* (tuber), *Gentiana kurroo* (root), *Gloriosa superba* (root), *Holostemma annulare* (root), *Valeriana jatamansi* (root) and *V. wallichi* (root).

Plants which need to be conserved and studied are given in Table 2.

Why decentralized strategy is essential?

Therapeutically useful plants which are being used and are expected to be used as per ISMs and local health traditions prevailing in various agro-climatic zones of the country during different *Ritus* (Hemant, Shishir, Vasant, Grishma, Varsha and Sharad), both for cure and prevention (considering seasonal variation and effect of their own *Prakiti* i.e. constitution, in aggravating one or more *Doshas-Vata, Pitta* and *Kapha*) should be identified and given priority for conservation.

Recently, contiguous agro-climatic zones, having similar soil, climatic, physiographic and cropping patterns have been combined so as to decrease 126 agro-climatic zones identified by ICAR (under the NARP programme) to a manageable number of 60, in addition to the 2 zones representing Andaman-Nicobar and Lakshadweep Islands. For each these 62 agro-climatic zones, there is need to develop conservation strategy for those medicinal plants which are locally preferred for ISMs and by herbalists.

The occurrence of different *Ritus* vary from one region to another and plant species prevailing in different agro-ecological zones differ considerably. But different plants may have same mode of action (against same *Dosha*). For example 'Kalmegh' (*Andrographis paniculata*), found in many parts of India mimic the activity (against *Pitta Parakop*) of 'Chirayta' (*Swertiachirata)* found only in the Himalayas.

Unique role of the national agricultural research system for conservation of medicinal plants

National Agricultural Research System (NARS) can play the requisite pivatol role in conserving (and developing agro-technologies) and make available in a decentralized manner, quality raw materials of medicinal plants as per the requirements of the community based PHCs located in various agro-climatic zones of the country.

The All India Co-ordinated Research Project on Medicinal and Aromatic Plants (AICRP on M & AP) under ICAR has eleven centres in the country. However, AICRP on Agroforestry has unskewed distribution of its centres. Thus wherever appropriate, AICRP on M&AP and AICRP on Agroforestry can collaborate for the cause of the nation.

Source of funding for conservation and research on medicinal plants-suggestion

Government Department

A large part of the budget should come from the Government departments since most of the work planned may not be of immediate benefit to commercial users and the activities will remain of concern to long term social and therapeutic benefit to the poor.

As suggested above, the pivatol role and responsibility for conservation and availability of medicinal plants should be and ought to be primarily of NARS and this needs to be emphasized and insisted upon to non-agricultural departments of the government by ICAR, so that efforts of other departments (if any) on conservation and developing agro-technology be channelized through ICAR, and coordinated effort becomes possible.

Commercial user groups

Till now commercial user groups have hardly provided funds for conservation of medicinal plants, although they have been almost freely collecting them from nature for over a century. i.e. since they evolved to their present modern form in the country. These groups can fund specific projects and can work in partnership mode, so as to ensure that quality raw material for manufacturing herbal medicines indeed continue to remain available in abundance in the future.

Integrated approach for conservation-urgent need

China emphasized their own traditional health care system, which is evident from the fact that traditional medicine still retains a 40% share of the medicine market nation wide. China cultivates medicinal plants in 4,60,000 hectares and it enjoys the lion's share in world market. They are able to achieve this supremacy by establishing a close working relationship among field scientists, pharmacologists and clinicians. In India if we do not care nature would stop supplying these invaluable ingredients of our essential use. The situation is becoming grave with the disturbances like biopiracy. This is one more reason why we need to learn how to collaborate with non-agricultural institutions.

Table 2. Plants useful in traditional system of medicine and need to be conserved.

Botanical name & Common name	Part used
Acorus calamus L. (Herb) Sweet flag	Rhizome
Adhatoda vasica Nees, (Shrub)	Leaves, root
Aegle marmelos Corr. (Tree) Bael tree,	Fruit, root bark
Albizzia lebbeck Benth. (Tree) Indian walnut	Bark, gum, seed, root bark.
**Artemisia annua* L. (Herb)	Whole plant.
Azardirachta indica A. Juss. (Tree), Neem tree	Leaves, bark, gum, flower,
Bacopa monnieri Pennell (Herb), Thyme	Leaves, stem, whole plant
Boerhavia diffusa L. (Herb) Spreading Hog-weed	Root
Butea monosperma Kuntze. (Tree) Flame of the forest	Leaves, bark, gum, flower,seed
Cassia acutifolia Delile. (Sub-shrub) Alexandrian Senna.	Leaves, fruit
Centella asiatica Urban. (Herb) Inidan Penny wort	Leaves. whole plant
Cinnamomum zeylanicum Blume (Tree) Cinnamom.	Bark
Convolvulus plauricaulis Choisy	
Crataeva nurvala Buch-Ham (Tree)	Fresh leaves, bark, root bark
Cissus quadrangularis L. (Climber)	
Tedible stemmed vine,	Leaves, young shots
Eclipta alba Hassk. (Herb)	Leaves, plant Seeds
Elettaria cardamomum Maton (Herb)	Seed
Embelia ribes Burn. f. (Shrub)	Bark, flower, fruit, seed, root
Eugenia jambolana Lam. (Tree) Jambolan	Leaves bark, fruit, seeds
Gymnema sylvestre R. Br. (Climber)	Leaves, root
Hibiscus rosa-sinensis L. (Shrub) Shoe flower	Leaves, root, floweer
Holarrhena antidysenterica Wall (Tree)	Bark, seed

Lawsonia alba Lam. (Shrub)	Leaves, bark, flowers
Momordica charantia L. (Climber) Bitter gourd	Leaves, fruit, root
Phyllanthus amarus Schum. & Thonn. or *P. niruri* Auct. (Herb)	Leaves, stem, root
Picrorhiza kurroa Royle. (Herb)	Root
Pterocarpus marshpium Roxb. (Tree) Inidan Kino tree	Leaves, bark, gum
Santalum album L. (Tree) Sandal tree,	Wood, oil from heart wood
Saussurea lappa C.B. Clarke (Herb) E. Kuth	Root
Semecarpus anacardium L. (Tree) Marking nut tree	Bark, gum, nut
Streblus asper Lour. (Tree) Siamese Rough Bush.	Milky juice, bark, root
Terminalia arjuna W.& A. (Tree)	Leaves, bark, fruit
Terminalia bellerica Roxb. (Tree) Belliric Myrobalan.	Fruit , kernel
Terminalia chebula Retz. (Tree) Chebulic Myrobalan.	Fruit, bark
Thymus vulgaris L. (Shrub) Common thyme.	Whole plant
Tribulus terrestris L. (Herb) Land caltropis, Puncture vine.	Fruit
Tripterigium wilfordi	Root bark
Urginea maritima Baker (Herb) Red squill	
Vitex negundo L. (Shrub)	Leaves, fruit, root
Zingiber officinale Rosc. (Herb) Ginger	Rhizome

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 140- 149, 1999

Bioconservation : Concern and strategy for medicinal and aromatic plants

J. R. SHARMA

Central Institute of Medicinal and Aromatic Plants Lucknow – 226 015, Uttar Pradesh.

Abstract

India is a 'gene-rich' country where plant genetic resources (PGR) including medicinal and aromatic plants (MAPs) abounds in nature. Its botanical panoply comprises over 45,000 species (~12% of global flora) including 15000 flowering plants. Currently, ca. 1500 species are being used in traditional system of medicine, but only 38 (including 22 exotic) species are used in modern medicine. Similarly, out of 1300 species of known aromatic value, only 42 (including 22 exotic) species are now exploited by essential oil industry. However, indiscriminate and over exploitation of wild resources coupled with frequent destruction of natural habitats, has caused an unprecedented national crisis of genetic erosion. Unchallenged biopiracy by MNCs under the umbrella of TRIPs of WTO has added salt to the injury. This has aroused an intense concern for developing a national policy for biodiversity (including MAPs) conservation. Thus in order to address the objectives of CBD and safeguard the national heritage, particularly for high value MAPs, as of now, 7 Biosphere Reserves, 75 National Parks and 421 Gene Sanctuaries have been developed and made operational under the *in situ* conservation strategy. Further, 3 National Gene Banks and 16 Herbal Gardens for MAPs have been established under *ex situ* (both *in vivo* and *in vitro*) conservation strategy. Several institutions and universities have also been involved in PGR related activities including biotechnological applications. To make the PGR conservation more purposeful, the germplasm have been utilized to develop superior cultivars for cultivation. Thus, more than 40 vars. in 18 MPs and nearly 60 in over 22 APs have so far been developed in India.

Furthermore, fore developing a clear and sound national PGR conservation and IPR policy to protect our national flora and interest of native community and technologists alike, some positive options have been enumerated in this presentation. Nevertheless, there remain some crucial but unresolved questions related to this burning issue that need to be addressed meticulously.

Introduction

Biodiversity entails all biological (living) entities occurring as an interacting system in a habitat/ecosystem. Plants constitute a very vital component of biodiversity, collectively referred to as plant genetic resources (PGR). Thousands of genetically unique forms/biotypes (gene pool/germplasm) have evolved over millions of years in each plant species. According to an estimate, approximately 2,50,000 to 3,00,000 plant species on earth have hitherto been chronicled (Swaminathan 1993). Out of these, only 30 plant species have so far been exploited by man for food etc. There has been virtually no addition to this list for the last over 10,000 years (Khoshoo 1995). However the number of medicinal and aromatic plants (MAPs) which constituted the viable component of human health care at one time or, another is above 80,000 (Kumar *et. al.*, 1997). They occur most preponderantly in tropical and subtropical countries, India being one of the richest countries in the world for MAPs.

India's richness of biodiveristy (PGR)

India is a 'gene-rich' country. Although its total land area is only 2.4% of the whole world, it accounts for 8% of the total global biodiversity. Out of the 126188 species/biota described from India (Khoshoo, 1995), plant species apportion around 45000 (~ 12% of the global flora) including 15000 (~ 16% of global wealth) flowering plants. It stands tenth among the PGR rich countries and one of the world's top 12 megadiversity nations. Out of the 18 'hot spots' in the world, two are in India – Eastern Himalayas and Western Ghats, both with very high degree of endemism. Furthermore, India is bestowed upon with remarkably diverse agro-ecological conditions. This offers an immense possibility of introducing and naturalizing new exotic plants. A large number of such MAPs have been introduced in India.

For the last nearly 5000 years, around 6000-7000 plant species and currently about 1500 have been exploited under the traditional system of medicine, i.e. Ayurveda in India (Bhatnagar, 1997). However, the number of indigenous plants that are used in modern medicine is very small (Sharma 1998). Only 38 major medicinal plants (27 native + 11 exotic) are now exploited by pharmaceutical industry (Table 1) Similarly, among the rich botanical panoply of India, 1300 plants are known for their aromatic values. But only 42 plant species (20 native + 22 exotic) are being currently exploited by essential oil industry (Table 2).

Table 1. Plant species under use in India for modern drugs

1. *Artemisia annua**	14. *Digitalis lanata**	28. *Rauvolfia serpentina*
2. *Asparagus officinalis*	15. *D. purpurea**	29. *Secale cereale*
3. *Atropa belladonna*	16. *Dioscorea deltoidea*	30. *Solanum khasianum*
4. *Cassia angustifolia**	17. *D. floribunda**	31. *S. lanciniatum*
5. *Catharanthus roseus*	18. *Duboisia myoporoides**	32. *S. viarum*
6. *Cephaelis epecaunha*	19. *Glycyrrhiza glabra**	33. *S. xanthocarpum*
7. *Chrysanthemum cinerariefolium**	20. *Humulus lupulus**	34. *Swartia chirta*
8. *Cinchona officinalis*	21. *Hyoscyamus muticus**	35. *Taxus baccata*
9. *Coleus forskohlii*	22. *H. niger*	36. *Trigonella foenum-graecum*
10. *Commiphora mukul*	23. *Panax pseudo-genseng*	37. *Valeriana officinalis*
11. *Costus speciosus*	24. *Papaver somniferum**	38. *Withania somnifera*
12. *Datura metel*	25. *Picrorrhiza kurroa*	
13. *D. stramonium*	26. *Plantago ovata*	
	27. *Podophyllum emodi*	

* Exotic (introduced)

Table 2. Major aromatic plants used by essential oil industry in India

39. *Abelmoscus moschatus*	53. *Cymbopogan martinii*	68. *Ocimum basilicum**
40. *Acorus calamus*	54. *C. pendulus*	69. *O. canum*
41. *Apium graveolens*	55. *C. winterianus**	70. *O. gratissimum**
42. *Artemisia annua**	56. *Cyperus scariosus*	71. *O. sanctum*
43. *A. pallens*	57. *Eucalyptus citrodora*	72. *Pelargonium graveolens**
44. *A. vestita*	58. *E. globulus*	73. *Pogostemon cablin**
45. *Bursera delpechiana*	59. *Humulus lupulus*	74. *Rosa damascena**
46. *Canaga odorata**	60. *Jasmium grandiflorum*	75. *Rosmarinus officinalis**
47. *Cedrus deodara*	61. *Lavandula officinalis**	76. *Salvia sclarea**
48. *Chamomilla recutita**	62. *L. intermedia**	77. *Santalum album*
49. *Cinnamomum camphora**	63. *Mentha arvensis**	78. *Skimmia laureola*
50. *Cymbopogan citratus**	64. *M. citrata**	79. *Tagetes minuta*
51. *C. flexuosus*	65. *M. gracilis**	80. *Vetiveria zizanioides*
52. *C. khasianus*	66. *M. piperita**	
	67. *Mentha spicata**	

•.Exotic (introduced)

Parallel to this biodiversity, India also possesses a mutually supportive rich cultural diversity supplemented by equally rich traditional wisdom of very successful time-tested local knowledge of the medicinal properties of native flora.

Need for bioconservation : the concern

India has been robbed of its valuable plant genetic wealth through bioplundering by 'gene-poor' but 'technologically rich' countries in a systemic manner over decades. Situation is very much alarming in case of herbal drug plants where multilocational corporation (MNCs) get raw materials collected indiscriminately through some unscrupulous local agencies leading to rapid gene erosion. The problem of such genetic erosion became so acute for *Dioscorea deltoidea, Rauvolfia serpentina, Coptis teeta,* etc. that Govt. of India had to place an embargo decades ago on their collection from wild, which remains in place today. *Aconitum* Spp. and *Picrorrhiza kurroa* are the recent addition to such critically endangered species as per the 'Red Data Book of Indian Plants'.

The wealth of PGR is alarmingly depleting with remarkable alacrity due to habitat destruction. Each day, a minimum of 140 plant species/biotypes are becoming endangered and some 30,000 are condemned to extinction every year (Paroda, 1994). If the modification, fragmentation and destruction of natural habitats and the process of over-exploitation of natural plant genetic resources continue, at least 25% of the rest of world's plant species (including MAPs) will be lost for ever in the next few decades (Meyers 1990). India is no exception.

Still further, under the new regime of the World Trade Organization (WTO), there is anacute danger of biopiracy for many valuable medicinal plants, such as Himalayan yew (*Taxus baccata*), serpent wood (*Rauvolfia serpentina*), coleus (*Coleus forskohlii*), turmeric (*Curcuma longa*), neem (*Azadirachta indica*), *Piper, Tylophora* and recently *Gymnema sylvestre.*

MAPs conservation and strategy

Growing awareness of mounting losses of PGR, MAPs in particular, stimulated several institutions/universities in India to undertake collection, conservation and exploitation of MAPs in the past. A turning point came in the year 1992 after the 'Earth Summit' – the CBD when vigorous activities relating to PGR commenced as follows:

1 *In situ* conservation

In order to protect habitats/ecosystem, based on survey data, Ministry of Environment and Forests have identified 14 Biosphere reserves: 7 of them (Table 3) have already been made operation (Rana, 1995).

Besides, India's protected area network comprises 75 wild life National Parks (fully protected) and 421 Wild Life Sanctuaries (Semi-protected), both covering an area of ca. 140676 km^2, though the Wild Life Institute of India has recommended them to be increased to 148 and 503 (4.6% of total geographical area), respectively.

2 *Ex – situ* conservation

Under the custodial management of MAPs, both *in vivo* and *in vitro* conservation of PGR have earnestly been taken up by several institutions in India. Central

Table 3. *In situ* (ecosystem) conservation in India : Biosphere reserves

Biogeographic regions	Biosphere reserves	Area covered (km^2)	States involved
Himalayan highlands	Nanda Devi	1560	Uttar Pradesh
Burma Monsoon	Nokrek	80	Meghalaya
Bengalian	Manas	2837	Assam
Rain Forest	Sundarbans	9630	West Bengal
Coromandel	Mannar Gulf	555	Tamil Nadu
Malabar	Nilgiri	5520	Karnataka, T.N and Kerala
Andaman & Nicobar Islands	Great Nicobar	885	A & N islands

Source : Rana (1995)

Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow is the leading partner together with National Bureau of Plant Genetic Resources (NBPGR), New Delhi; National Research Centre for Medicinal and Aromatic Plants (NRC-MAP), Anand; and Tropical Botanic Garden Research Institute (TBGRI), Trivandrum. Some other important institutes/universities are RRL, Jammu; RRL, Bhubaneshwar; NBRI, Lucknow; NDUAR, Faizabad and CCSHAU, Hissar. About 2000 accessions belonging to 300 MAP species at CIMAP more than 250 at NBPGR and variable number of collections at different institutes/ labs/universities are being maintained *in vivo* and *in vitro*. Three National Gene Banks – at CIMAP, NBPGR and TBGRI have recently been established for MAPs by the Department of Biotechnology. India acts rightly as the Coordinator of G-15 genebanks for MAPs.

Besides, Ministry of Agriculture has initiated setting up 16 Herbal Gardens in different states of India, namely AP (APAU, Hyderabad), Assam (AAU, Jorhat), Bihar (RAU, Pusa), Gujarat (GAU, Anand), Haryana (CCSHAU, Hissar), HP (YSPUHF, Solan), Karnataka (UAS, Bangalore), MP (JNKVV, Jabalpur), Maharashtra (MPKV, Rahuri), Orissa (OAU, Bhubaneshwar), Punjab (PAU, Ludhiana), Rajasthan (RAU Bikaner), TN (TNAU, Coimbatore), UP (NDUA & T, Faizabad), and WB (BKV, Nadia) aiming at to maintain at least 30 herbs and 35 MAPS's , beside 25 trees and 38 shrubs/ vines in each garden. An NGO – Foundation for Revitalization of Local Health Traditions (FRLHT) has also set up a chain of 45 Herbal Parks in Karnataka, Kerala and Tamil Nadu with Danish aid to conserve MAPs in India.

In vitro conservation of MAPs has been in progress mainly at two institutions : NBPGR, New Delhi and CIMAP, Lucknow. The National Facility for Plant Tissue Culture Repository (NFPTCR) at NBPGR has developed protocols for regeneration and short/medium term storage of as many as 15 species (*Allium, Dioscorea, Curcuma, Zingiber, Piper, Rauvolfia, Saussurea, Tylophora, Picrorrhiza, Posgostemon, Coleus, Podophyllum* and others) of medicinal and aromatic plants (Chandel, 1995). Different kinds of biotechnologial manipulations are in progress at CIMAP also for *Allium govarinum, Aconitum heterophyllum, Atropa belladonna, Duboisia myoporoides, Glycyrrhiza glabra, Hyoscyamus albus, H. muticus, Mentha arvensis, Picrorrhiza kurroa, Panax quinquefolium, Rauvolfia serpentina, Rheum emodi, Solanum sarrachoides. Valariana wallichii* and *Withania somnifera* (Sharma and Kumar, 1996).

3 Utilization of MAPs germplasm

Cultivation is an efficient way of PGR conservation. However, though all medicinal plant species must be domesticated and conserved *in vitro* and/or *in vivo* not all but

Table 4. Improved varieties of important medicinal plants developed at different R & D Institutes in India

Medicinal plant Spp.	Varieties developed
Asparagus officinalis	SL-831
Artemisia annua	Asha
Cassia angustifolia	Sona, ALFT-2
Catharanthus roseus	Nirmal, Dhawal
Chrysanthemum cinerariefolium	Hansa, Jhelum
Commiphora mukul	Marusudha
Dioscorea floribunda	S-3, S-2-58, FB -1, Arkaupkar
Datura metel	RRL (Purple), RRL (Green)
Glycyrrhiza glabra	Mishri
Hyoscyamus niger	Aela, Aekla, IC-66
H. muticus	NP 41, HMT-1
Papaver somniferum	Shweta, Shyama, Sanchita, Sujata, Shubhra, Vivek, Kirtiman, Trishna, Rajhans, NBRI-3, Jawahar Afim-16, Udaipur opium
Plantago ovata	Jawahar Isabgol, Gujarat Isabgol-1, Gujarat Isabgol-2, Niharika
Rauvolfia serpentina	RS-1
Solanum khasianum	RRL-20-2, RRL-SL-6
S. viarum	Glaxo, IIHR 2n-11, Arka-sanjivini, Arka-Mahima
S. laciniatum	EC-113465
Withania somnifera	Jawahar, Asgandh

Table 5. Improved varieties of important aromatic plants developed at R & D Institutes in India.

Aromatic plant spp.	Varieties
Chamomilla recutita	Vallary
Cymbopogon flexuosus	Pragati, Cauvery, Krishna, SD-68, OD-19, OD-440, RRL-38, RRL-57, RRL-50, RRL-86, RRL (B)-1, RRL (B)-28, Jorlab L-2, GRL-1
C. pendulus	Praman, RRL-16
C. nardus	RRL-5
C. citratus	RRL-9
C. Khasianus x *C. pendulus*	CKP-25
C. winterianus	Manjusha, Mandakini, Bio-13, JorLab C-2, RRL-Jor-3 1970, RRL (B) – 15
C. nardus var. *confertiflorus x*	
C. Jwarancusa	Jamrosa (RRL-82)
C. martinii var. *motia*	Trishan, Tripta, PRC-1, RRL (B)-77, IW-31245
C. khasianus	RRL-14
Jasminum grandiflorum	Pitchi
Lavandula officinalis	Shere-Kashmir
Mentha arvensis	MAS-1, Kalka, Gomti, Himalaya, Koshi, Shivalik, EC – 41911, Hariti
M. spicata	MSS-5
M. gracilis	MCAS-2, Arka, Neera
M. citrata	Kiran
M. piperita	Kukrail
Ocimum gratissimum	Clocimum-1, Clocimum –21, Thymocimum
O. canum	RRL-OC-11, RRL-OC-12
Pelargonium graveolens	Bipuli, Awantika
Rosa damascena	Noorjahan
Vetiveria zizanioides	Sugandha, Dharini, Gulabi, Kesari, Pusa Hyb-7, Hyb-8.

only some economically viable species should be cultivated. Then, for cost-effective cultivation and ensuring uniform, sustainable and high quality produce of raw materials, the role of genetically improved cultivars cannot be over emphasized. Hence, utilizing the available germplasm as base, a large number of improved cultivars have been developed in several medicinal and aromatic plants at different R &D institutions in India (Sharma, 1998, Sharma and Kumar, 1996). Thus, more than 40 improved varieties in 18 medicinal plant and over 60 in 22 aromatic plant have so far been developed in India (Tables 4 & 5)

A vast number of MAPs are now maintained in our gene banks, where new genes for quality, biotic/abiotic stress, disease/pest resistance, etc. can be located and incorporated into the new or existing cultivars through genetic transformation by biotechnological approaches.

National PGR policy : Some positive options

The 'gene-poor but technology-rich' nations continue to rob valuable PGR of 'gene-rich but technology poor' countries, like our. The advent of biotechnology and the TRIPs regime of WTO has hastened the process. But the situation is much more alarming in case of medicinal plants where unscrupulous native agencies, at the behest of formidable MNCs, are surreptitiously involved in indiscriminate collection from wild of raw materials leading to the loss of national genetic wealth. In order to arrest this trend, some positive options for developing a holistic national policy on the biodiversity conservation are enumerated here below.

1. Strengthening *in-situ* and *ex-situ* conservation of PGR for sustainable utilization.
2. Developing regional and national inventories based on survey and identification. Exploring the possibility of establishing a 'National Biodiversity Foundation' manned by taxonomists, statisticians, software specialists, may be thought off.
3. Strengthening national and regional repositories of PGR not only with infrastructure but also with facilities for evaluation and re-evaluation.
4. Formulating R & D policy including cooperative training programs for education and public awareness on biodiversity, soft ware development for bioinformatics and electronic networking.
5. Eliciting cooperation of local communities, farmers, universities/colleges, NGOs, private sector, etc. in the conservation programmes. Viable alternatives of livelihood of tribal and native peoples must be arranged *a. priori*
6. Protecting farmer's right by formulating a suitable policy on access to PGR, especially high value MAPs based on prior informed consent (PIC) and mutually agreed terms (MAT) for sharing of benefits. An MoU between U.S. multinational M/s Merck and Costa Rica private organization, National Biodiversity Institute (In Bio) in a case in point (Menon, 1994). Indonesia and Kenya have followed suit. Empowering elected *Panchayats* or other such

local bodies as the agencies to issue licences for plant collection may hold promise in this context.

7. Enacting a suitable law on intellectual property rights (IPR) related to plant breeder's right and farmer's right and to transgenic materials so as to safeguard the national heritage, lest we face the same fate of MNC's patenting of our important traditional medicinal plants, such as turmeric, neem *Piper, Gymnema* and *Tylophora*.

Following are some posers which are crucial to the burning issue of PGR conservation and utilization.

1. Can developing countries, like India afford biotechnology for PGR conservation?. Tremendous amount of cost on development of infrastructure, consumable and sophisticated human resources is involved. So far, successes have not been commensurate with the cost involved in India.
2. Can we patent or use the germplasm introduced and naturalized long ago in India?. Majority of internationally important MAPs were introduced from abroad. The country of their origin may also react as we react now for ours.
3. Under the IPR laws, what should be the right of public funded research organizations? Unlike in west, most of the scientists/intellectuals belong to public sector R & D institution in India?
4. How can a patent right be granted to a gene which has been implanted through genetic transformation in an improved cutlivar developed by another plant breeder? Such transfer shall be misplaced if made in any wild stock.

Appropriate response to these posers might clear out anxiety and harness the national strategy for conservation and sustainable use of medicinal and aromatic plants.

References

Bhatnagar, P. 1997. Marketing and trade of medicinal plants. Sustainable Forestry 11 : 4-11.

Chandel K. P. S. 1995. Biodiversity conservation and use through *in vitro* strategies. In: Plant Germplasm Conservation : Biotechnological Approaches. NBPGR, New Delhi, pp. 23-36.

Khoshoo, T. N. 1995. Census of India's biodiversity : Tasks ahead. Curr. Sci. 69 : 14- 17.

Kumar. S, Shukla Y. N, Lavania U. C, Sharma, A and Singh. A. K. 1997. Medicinal and aromatic plants: Prospects for India. JMAPS, 19 : 361-365.

Menon, U. 1994. Biodiversity and biotechnology. In: ISPGR Dialogue 1993, NBPGR, New Delhi, pp. 102-105.

Meyers, N. 1990. The Gala Atlas of Future Worlds. Robertson McCarta Ltd., London.

Paroda. R. S. 1994. Is global conflict on plant genetic resources justified? First Dr. B.P. Pal Memorial Lecture 1993. In: ISPGR Dialogue 1993. NBPGR, New Delhi, pp. 185 - 200.

Rana, R. S. 1995. Conservation of plant genetic resources in India. In: Plant Germplasm Conservation : Biotechnological Approaches, NBPGR, New Delhi, pp. 1-16.

Sharma, J. R. 1998 Medicinal and aromatic plants in India. Curent status and challenges ahead. Maeer's Mit Pune J. (In Press)

Sharma, J. R. and Kumar. S. 1996. Biotechnology and genetic improvement of medicinal plants. In: Supplement to cultivation and Utilization of Medicinal Plants, RRL, Jammu, pp. 753-768.

Swaminathan, M. S. 1993. Genetic diversity – Safetynet for small farmers and food stocks for biotechnologists. Paper presented at ISPGR Dialogue 1993, New Delhi, p. 4.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants pp. 150- 152, 1999

Local capacities in conservation and development for enhancing genetic diversity of medicinal plants

M. KADER MOHIDEEN & K. SEKAR

Department of Horticulture
Annamalai University
Annamalai Nagar – 608 002, Tamil Nadu.

Abstract

Medicinal plants of mangrove vegetation in the east coast area are highlighted and their conservation strategies are discussed.

Introduction

The conservation of genetic resources is both a matter of insurance and investment. This is necessary not only to sustain and improve production in agriculture, forestry, horticulture etc., but also to keep future options open as a buffer against harmful environmental changes. It is rather difficult to predict what species would become useful to us at a later date. But, it is well known that only a minute proportion of the world's plant resources have been investigated for their value as medicines and pharmaceutical products. Modern medicines depend heavily on them.

Of late, there is a growing awareness of the importance of natural environment and a serious concern that resources essential for human development and survival are being depleted and destroyed at an alarming and increasing pace. Habitat destruction and extension of agriculture to forest areas and gradual diversion of forest land for non-forestry uses promotes species extinction. In developing countries, the threat to biosphere reserves comes from human communities who perceive protection as being in conflict with their economic survival.

This paper is based on our experience in the mangrove ecosystem which is predominant in the east coast area.

Ecological and economical value of mangroves

The term 'Mangroves' refers to an assemblage of different flowering plants that tolerate and grow in saline brackish water areas like creeks, backwaters, estuaries and deltas. The mangroves offer shelter to the juveniles of a wide variety of marine organisms, notable among them being shrimps. The second most important ecological value is its ability to trap and bind material so that soil erosion in areas bordering mangroves is greatly abated.

Economic values are still several more, ranging from production of timber, tannin, wax, fodder, medicinal raw materials, honey etc. Besides, mangroves are easily available to brackish water fish and shrimph culture. The inherent high productivity of the ecosystem helps in the enhancement of harvestable yield with relatively low investments.

Our survey in this area revealed that this mangrove vegetation harbours, a large number of traditional medicinal plants of immense value. The data gathered from a local traditional medical practitioner is presented below.

1. *Boerhaavia diffusa* (Nyctaginaceae). In Tamil it is called as 'Mukkarati'. The root extract is used to relieve body pain. It is highly useful to remove the dead child from the mother's womb without much pain.
2. *Cassia auriculata* (Fabaceae). In local vernacular is popularly known as 'Avaram poovu'. It is used as laxative. The tender leaves are very harsh in taste. A decoction made out of its leaves mixed with some spices are reported to cure diabetes and also gastric problem.
3. *Clerodendron inerme* (Verbenaceae). It is popularly known as 'Sangam kuppi' 'Pea kizhathi'. Leaf extract is used to cure several diseases.
4. *Croton sparsiflorus* (Euphorbiaceae). It is called as 'Chithamanakku'. The plant extract is used as a general health drink and is also reported to cure boils and skin rashes (Thirugnanam, 1993).
5. *Excoecaria agallocha*(Euphorbiaceae). It is popularly known as 'Thillai' plant, the tender leaves and the latex are used to cure many diseases including rheumatisum, leprosy, bone fractures and several other diseases.
6. *Lippia nodiflora* (Boraginaceae). It is popularly known as 'Poduthalai'. It has succulent leaves and is used for curing indigestion and gastric disorders.
7. *Passiflora calcarata* (Passifloraceae). Leaves are used for curing teeth problems. It has been reported to cure damages even upto the root.
8. *Suaeda monoica* (Chenopodiaceae). It is popularly known as 'Umari'. Crushed leaves are applied over rashes and also used as anti alergy agent for many diseases.
9. *Tylophora indica* (Asclepidaceae). It is used for curing asthma. Local people insert the twig into the nose, the irritation caused by this induces sneezing and there by accumulated phlegm are easily removed. It is also used as antimicrobial agent.

Conservation strategies

The broad based conservation strategies are discussed based on the following three tenets (Louise Sperling, 1994).

Tenet 1. *Farmers have genetic expertise*

Base line studies in the mangrove areas

show that farmers have considerable experience in managing local paddy diversity. Farmers regularly experiment with new varieties, frequently altering them to suit their soil types and planting association. Farmers normally select cultivars according to preference and performance variables. However, many of the desired attributes are not easily integrated in a formal framework of crop improvement.

Tenet 2. *Development threatens conservation of genetic resources*

New varieties are often accused of pushing out local varieties, which ultimately threaten the existing genetic base. Our experience in the mangrove areas also shows that the popular varieties of paddy, which are being grown in larger areas have virtually thrown out the traditional local cultivars to a level of extinction. It is suggested that there is considerable room for technical creativity in developing strategies to broaden and strengthen local diversity. Land race enhancement, user involvement in selection, disease/stress resistant component introduction, maintenance and multiplication of local cultivars are some the options to broaden and strengthen local diversity.

Tenet 3. *Farmers can save seed*

The farmers in the area desperately hold on to the remnants of their seed for its perpetuation. However, the poor are particularly "seed stressed" with about half buying 100% of their seed requirements during the major season. The purpose of saving seed is to guard the diversity of genetic material. If farmer seed systems are to be made more genetically stable, the informal seeds system has to be enhanced so as to strengthen its "living seed banks".

In the study area, though it is rich in medicinal and other economically useful plants, the area is getting reduced due to improper land use, unscrupulous felling of trees for house construction and for fuel and cattle grazing.

The mangrove vegetation which usually thrives well in brackish waters, are getting affected due to raise in salinity aggravated by disturbances in the river mouth. It has been estimated that reduced natural perpetuation has also resulted in extinction of some species.

Thus, farmers who have the expertise of conserving those which are useful to overcome some problems and to get a sustainable benefit, can act as an effective partner in genetic diversity conservation and development. It is suggested the farmers would definitely play a significant role in conservation if, the skill, knowledge and attitude are enhanced; The relationship between all partners in conservation are strengthened and dynamic and productive conservation strategies are aimed.

References

Louise Sperling. 1994. In: Breeder's and Farmer's Rights background papers (eds.) M.S. Swaminathan and Vineeta Hoon. CRSARD, Madras.

Thirugnanam, S. 1993. 'Mooligai Maruthuvam' Selvi Publishers, Trichy, Tamil Nadu.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants pp. 153- 200, 1999

Diversity, distribution, uses and conservation of medicinal plants in the north western Himalayas

J. C. RANA, B. D. SHARMA & P. L. GAUTAM*

NBPGR Regional Station
Shimla - 171 004, Himachal Pradesh.

Abstract

Over 80% of the world's population rely on local health practitioners and traditional medicines for their primary medical needs. The north-west Himalayas ranging from Kashmir to Kamoun provide a matchless wealth of highly priced and quality medicinal herbs and are known as a sacred heaven of potent medicinal herbs. A magnificent diversity of plant resources exists in this region but this wealth is lost due to continuous loss of forest land, uncontrolled grazing and unscientific collection by local herbal vendors and commercial enterprises. The damage is especially serious when bark, roots, seeds and flowers- all essential for species survival are removed. The preservation of medicinal diversity is, therefore, of prime importance and demands national concern. The best way to conserve the medicinal diversity is to follow a holistic approach of conservation as no single method of conservation is optimal for all situations. Medicinal plant diversity and distribution in the North Western Himalayas detailed in this paper and strategies for conservation of this plant wealth is discussed .

Introduction

The use of plants as a source of medicine has been well discussed in Rigveda which is supposed to be the oldest (4500 - 1500 B.C.) repository of human knowledge and since then plants are occupying an important place in curing ailing human. Over 35,000 to 70,000 species of higher plants possess medicinal properties all over the world of which about 7,500 plants species have been used in all the four systems of indigenous medicines *viz. Ayurveda, Unani, Siddha* and Homeopathy.

A large number of medicinal plants used in Indian System of Medicine have registered fast growth of raw materials. Most of these have shown consistency in drug value on clinical testing and are increasingly utilized as essential ingredients of classical drugs. Prominent among these are *Taxus baccata* and *Gingo biloba*, very slow growing temperate shrubs, yielding taxol and ginkgoside-B. These phytochemicals are prescribed in the treatment of ovarian and breast cancer, and for Platelet Activating Factor (PAF) in certain condition of brain tumour. Artemisin from *Artemisia annua* is another high-value plant material useful in controlling malignant malaria. It is low in toxicity, affects the membrane structure of *Plasmodium berghii* and kills the parasite. Podophyllotoxin from *Pododphyllum peltatum* amd *P. hexandrum* command similar high market value in the treatment of several conditions of brain tumours. The root and rhizome of *Picrorhiza kurroa* have shown a strong and specific liver toning property, which has also improved gastrointestinal and bile disorders and *Phyllanthus amarus* is another plant having hepatoprotective and curative properties. *Bacopa monnierii* is useful in memory restoratiôn. The gel of *Aloe barbadensis* has a sizable market in the cosmetics industry for arresting aging of skin and its ability to protect from ultraviolet rays.

Looking at the wonderful medicinal diversity and its direct and indirect values it appears that north-western Himalayas hold promise and hope to its habitants as well as people of the Indian subcontinent. This region due to its variable topographical setup of land forms, variation in climate and soils have resulted into a mosaic of biodiversity in general and medicinal plant in particular. Depending upon the different altitudes, the diversity, distribution and uses of medicinal wealth of this region is given below:

Table 1. Medicinal plants diversity below 800 m. MSL (Foot hills)

Scientific name	Local name	Natural habitat and plant description	Uses of the plant
Abrus precatorius L.	Gunja, Rati	On hedges and bushes in exposed areas, deciduous climber, leaves abruptly pinnate, with many pairs of leaflets, flowers pink, pods turgid, seeds usually scarlet with a black spot or sometimes pure white.	The roots and leaves are astringent, sweet, emetic and alexeteric. Seeds are acrid, bitter, purgative, abortifacient and aphrodisiac. Also useful in skin disease, asthma.

Abutilon indicum L.	Atibala, Kanghi	Weed of waste places, a hairy under shrub with golden yellow flowers. Leaf & stem is rich in mucilage.	Infusion of roots good for leprosy, leaf decoction is useful in toothache. Seeds are used in urinary troubles, paste of leaves used for healing boils and wounds.
Acacia catechu (L. f.) Willd.	Khair	Occur as medium sized deciduous tree in the forests, leaves bipinnately compound leaflets 30-50 pairs, flowers pale yellow, pods shiny with a triangular beak at the apex and narrowed at the base.	The bark is useful in conjunctivitis and haemoptysis, heartwood is bitter, astringent, acrid, cooling. The kath is acrid, thermogenic, digestive, appetizer, depurative and tonic.
Adhatoda vasica Medic.	Basuti	Common in wasteland and forests, a small gregarious evergreen bushy shrub with shorter internodes, flowers sub sessile in dense, white with red or yellow, throat.	Roots are anti-viral and leaf antispasmodic. Leaf decoc-tion is given in cough, asthma, bronchitis and diptheria, root is good in fever and dysentery.
Aegle marmelos (L.) Lorr.	B i l , Vilabh	In dry forests, semi-cultivated lands, a medium sized armed deciduous tree with straight, sharp, axillary thorns, leaves trifoliate, flowers greenish white, fruits globose, woody berries embedded in orange brown sweet gummy pulp.	The ripe fruits are astringent, sweet, aromatic, cooling, febrifuge, laxative and tonic, and are good for the heart and brain and in dyspepsia. Also given in chronic constipation.
Ageratum conyzoides L.	Vish-dodi	Weed of waste place and of cultivated fields, a softly hairy annual weed, leaves opposite hairy on both sides, flowers blue in heads.	The leaves are styptic and antidysenteric and are commonly used for haemorr-hoides, wounds and sores. Juice of leaves applied in fresh cuts and wounds and sores.

Albizia lebbeck (L.) Willd.	Siris	In moist forests, also cultivated, medium to large size tree about 20m in height, flowers white fragrant, characteristic pale yellow pods,	Bark is astringent, bitter, acrid, expectorant, useful in vitiated conditions of *Pitta* amd *Kapha*. Flowers are useful in chronic cough and bronchitis. Seeds are useful in inflammations, skin disease, leprosy, leucoderma.
Aloe barbadensis Mill.	Kuar, Grith kunari	Generally seen in the backyards, a coarse perennial with short stem, shallow root system, leaves fleshy in rosettes, often crowded with horny prickles on the margins, surface pale green with irregular white blotches, flowers yellow or orange.	The juice is used in dyspepsia, burns, colic, hepatopathy, skin diseases. The elio is used for helminthiasis in children and is a purgative, anthelmintic. Also used for local application in painful imflammations, chronic ulcers, on head in fever and as tonic.
Amorphophallus campanulatus (Roxb.) Blume ex Dence.	Suran	In the backyards, forests, some times cultivated, a stout herbaceous plant with underground hemispherical depressed dark brown corm, petiole stout 60-90 cm long, mottled spathe campanulate fruits red berries, 2-3 seeded.	The corm are acrid, astringent, irritant, carminative, liver tonic. Also used in anthralgia, elephantiasis, anemia and general debility. Corm decoction is also given in asthma, dysentery and piles.
Argemone mexicana L.	Bhatbhant	Although introduced from America but naturalized as weed in waste place and road sides, a prickle annual with yellow latex, flowers large bright yellow.	The roots are useful in skin diseases, leprosy, all types of poisoning, constipation. Leaves are useful in cough, and wounds. Latex is useful in dropsy, jaundice, conjunctivitis, burning sensations.

Asparagus racemous Willd.	Satavar	In the forests, a tall climbing under shrub, branch lets triquetrous, spines, recurved, cladodes 1-3 cm long, flowers white, fragrant, berry red.	The root is sweet, aphrodisiac, laxative, expectorant, tonic, useful in kidney and liver diseases, scalding urine, and gleet.
Bacopa monnieri (L.) Pennell.	Brahmi	In wet and swampy places, a prostrate, juicy, succulent, annual herb leaves entire fleshy, flowers pale blue or whitish, seeds minute, numerous.	The whole plant is used and is astringent, cooling, laxative, intellect promo-ting, anodyne, carminative, cardiotonic. Useful in biliousness, neuralgia, flatu-lence, leprosy, leucoderma and hoarsness, elephantia-sis, sterility and fever.
Barleria cristata L.	Tedrulu	Wild in forests, an annual herb, more or less hairy, densely hairy at the nodes, leaves elliptic oblong, hairy on both sides, flowers in axillary and terminal short dense spikes, sepals nerves running into the marginal spines.	Seeds are used as antidote for snake bite and as purgative. Seed oil is used in rheumatism. The roots and leaves are used to reduce swellings and an infusion in cough.
Boerhaavia diffusa L.	Itsit, Punrava	Weeds of gardens and waste places, diffused branched herb, large root, fusiform, cylindrical, leaves broadly ovate, green above and white beneath, flowers very small short stalked.	Root decoction is good for jaundice, bronchitis, expectorant, and well known for diuretic properties, leaf juice is used in opthalmia and eye wounds, emetic in large doses.
Bombex ceiba L.	Simbal	In the forests, a tall deciduous tree with a straight buttressed trunk, bark grey or brown covered with conical prickles, flowers red appearing when the tree is bare of leaves, seed black embedded in long white wool.	The roots are cooling, stimulant, tonic, demulcent. The gum is astringent, stimulant, aphrodisiac and tonic.

Butea monosperma (Lnak). Taub.	Plash, Plaah	In deciduous forests, medium sized tree, very conspicuous when in flowering, flowers bright orange red, fruits pods, single seeded.	The bark is astringent, aphrodisiac, appetizer, digestive and tonic. It is useful in dyspepsia, diarrhoea, bone fractures and rectal diseases, flowers are sweet, cooling, aphrodisiac, diuretic, leprosy, skin disease. Gum known as *Bengalkino* is useful in diabetes, hyperacidity and general debility.
Calotropis gigantea (L.) R. Br.	Madar (safed)	In dry waste places, a large hard milky shrub, leaves, branches, inflorescence covered with soft white hairs, flowers lilac, rosy or purple, seed with abundant white coma.	The dried whole plant is good tonic and expectorant. The powdered root promotes gastric secretions and useful in asthma, bronchitis. In large doses it is purgative and emetic.
C. proscera R. Br.	Aak	Shrub, weed of waste land and along railway fields, tracts, nallas and agricultural lands.	Flowers are used in cough, cold and asthma. Root bark is used in skin diseases and dysentery. Latex used in toothache, put around wound to draw pus.
Cardiospermum halicacabum L.	Kanphuti	In the hot areas, a pubescent or nearly glabrous climbing annual, leaves ternately bi-compound, flowers white, seeds black with large white aril.	Used against rheumatism, arthritis and obesity.
Cassia fistula L.	Amaltas, Alli	In the deciduous forests and semi-cultivated lands, a moderate sized handsome tree, leaves pinnately compound, leaflets 4-8 pairs, flowers bright yellow in lax pendulous racemes, fruits 3-60 cm cylindrical pods.	The flowers are bitter, acrid, expectorant and demulecent and are useful in dry cough and bronchitis. Fruits are sweet, cooling, emollient, and purgative.

Cassia tora L.	Ealu., Railu	On waysides and waste places, on hills of low elevations, a herbaceous weed, leaves pinnatley compound, leaflets three pairs, septate pods, 15-25 cm long, sutures very broad.	The leaves and seeds are acrid, laxative, liver tonic, useful in skin diseases, flatulence, cough and bronchitis, roots used as antidote. Seeds are pickled.
Celastrus paniculatus L.	Sankhrain Malkangni	On the hilly slopes, a large climbing shrub, with long slender elongating branches which are reddish brown covered with white lenticels; flowers greenish white in terminal drooping panicles, fruits bright yellow when ripe, exposed brown seeds with orange red aril.	The bark is abortifacient, brain tonic. Leaf sap is good antidote for opium poisoning,; seeds are useful in abdominal disorders, headache, fever and for stimulating the intellect and sharpening the memory.
Centratherum anthelminticum L. O.	Braham-seer, Kali zeeri	As a weed, a tall robust, stout,annual, leaves long, lanceolate, coarsely serrate, flowers purplish in subcorymbose head, fruit achnes, 10 ribbed, pappus reddish, inner pappus long.	The fruits are bitter, anthelmintic, expectorant, depurative, useful in hiccough, cough, asthma, leucoderma, specific for round and thread worms.
Centipeda minima (L) A Braun. & Asch.	Nakchhiknni	In wet places, prostrate herb, stems numerous, spreading form the root, leaves numerous, subsessile, heads globose, solitary, subsessile,	Seeds and plant are used in syphills, constipation and cholera. The oil is said to be used in lumbago. Boils paste applied for toothache.
Centella asiatica L. Urban.	Madook-prani, Brahmi	On moist soils along bunds and canals, a slender herbaceous creeping perennial with rooted and long internodes, leaves broadly cordate; flowers pink.	The plant is bitter, cooling, cardiotonic, nervine tonic, carminative, diuretic, and useful in insomnia, cardiac debility, abdominal disorders, hoarseness, hiccough and amentia.

Cinnamomum tamala (Buch. Ham.) Nees ex. Fberm.	Gudpatraj, Tejpat	In the forests, a moderate sized evergreen tree, leaves simple, opposite, 3-nerved from base to apex; flowers pale yellowish in axillary and terminal, fruits ovoid, fleshy, supported by enlarged perianth tube.	Leaves are useful in cardiac disorders, helminthiasis, colic, hypertyalism, diarrhoea, rectal pains, and splenopathy.
Cissampelos pareira L.	Patindu	Wild in forests, a climbing shrub, pubescent or subglabrous, leaves peltate, slightly broader than long, cordate, flowers minute yellowish, drup subglobose, hairy, red.	Roots are used in diarrhoea, urinary troubles and valuable stomachic, also act as antidote for snake bite and scorpion sting.
Citrulus colocynthis (L.) Schred.	Indrayan, Gokhru	Wild in and around cultivated fields in warm areas, an extensively trailing annual herb with bifid tendrils, woody tender shoots, leves deeply divided, flowers monoecious, yellow, colrolla pale yellow, fruit globose, seeds pale brown.	The leaves are used for treating uteralgia, mammillitis, visceromegaly in children; fruits are cooling, carminative, antipyretic, and are useful in tumours, ascites, leucoderma, asthma, bronchitis and jaundice.
Clerodendrum infortunatum L.	Bhant	In forests or open places near villages, a large gregarious shrub, leaves large, ovate, entire or denticulate, hairy on both sides, flowers white, tinged with pink in terminal panicles.	The leaves are useful in helminthiasis, abscesses, tumours, leprosy, cough, bronchitis, intermittent fever and skin diseases.

Cordia dichtoma Forst. f. Syn.	Lasoora	In and around backyards and cultivated fields in warmer hilly areas, a medium sized tree with short crooked trunk, leaves simple, entire or slightly dentate, flowers white, small in lax terminal or axillary cyme, fruits drupes, yellow brown or pink when ripe.	The bark is useful in dyspepsia, fever, burning sensations; leaves are aphrodisiac and used in gonorrhoea. The fruits are sweet, cooling, emollient, purgative, and are useful in skin diseases, hyperdipsia, burning sensations, pectoral diseases, chronic fever and ring worms.
Croton tiglium L.	Jamal-ghota	Wild or cultivated in gardens, a small evergreen tree with ash coloured smooth bark, leaves oblong to ovate, membranous, yellow green, seeds smooth, testa black.	The seeds are drastic purgative, vermifuge and are useful in abdominal disorders, constipations, psychological disorders an dropsy. Also used as antidote for snake bite.
Cryptolepis buchanani Roem, & Schult.	Dudli, Krishan saariba	Wild in the deciduous forests, also found on hedges, a twining shrub, leaves elliptic oblong, green above, white beneath. Follicles 5-10 cm long, straight, rigid, divaricate,	Latex is used in cuts, fissure on soles, plant is also used in rickets.
Curculigo orchioides Gaertn.	Kali musli	In moist and shady places, an herbaceous tuberous perennial with a short root stock, bearing several fleshy lateral roots, leaves simple, crowded on the short stem, flowers bright yellow, fruits capsules, seeds black deeply grooved in wavy lines.	Rhizome is used as tonic, aphrodisiac, in piles and jaundice, leucorrhoea, backache, diarrhoea, colic and gonorrhoea.

Cuscuta reflexa Roxb.	Akash bel	Leaflets twining, yellow coloured parasitic herb, common on trees, bushes along roadsides.	Plant is purgative, used in sores, fall of hairs, stem is antibilious and also used on gouts.
Cymbopogon citratus (DC) Stapf.	Lemon-grasss Gandhghass	Grown in fields and gardens, a tall tufted perennial with a short rhizome, leaf blades linear, margin rough, whitish on upper sides, flowers in spikelets, fertile spikelets reddish.	The plant is aromatic, antihelmintic, laxative, and is useful in flatulence, gastric irritations, anorexia, bronchitis, sprains and fever. Local people also prepare tea of its leaves.
Cyperus rotundus L.	Nagarmotha	As a weed in damp and moist places, a perennial glabrous herb with elongated slender stolons bearing hard black fragrant tubers; leaves numerous narrowly linear, flat, one nerved.	The tubers are used in stomachic, diarrhoea, and as aphrodisiac, epilepsy, renal and vesical calculi, cough, intermittent and malarial fever and general debility.
Dalbergia sissoo Roxb. ex DC	Sheesham	Wild along roadsides, in gravelly river beds, leaves alternate, bifarious, imparipinnate, very downy when young, leaflets 3-5, distant, alternate, flowers sessile, yellow, fruits pods.	Bark is used in cholera, skin diseases, troubles of anus and ulcers, decoction of leaf in eye diseases and gonorrhoea.
Datura metel L.	Datura	In waste lands, gardens, roadsides, whole plant densely clothed with greyish tomentum, leaves 15-20 cm long, ovate lanceolate, acute, flowers white tinged with green below..	Leaves are used in swellings, rheumatism, flowers in asthma. Seed decoction in opthalmia, purulent discharges from the ear. Root boiled in milk & milk with butter administered in insanity.

Dioscorea bulbifera L.	Tardi, bashi kand	Wild in forests also cultivated, tuberous herb, variable, bulbils numerous, brown warted, stem twining to left, leaves alternate, ovate, lobes rounded, deeply cordate at the base.	Tubers are used in piles, syphills, dysentery and ulcers. The tubers are also applied to ulcers after being dried and powdered.
Diplocyclos palmatus (L.) Jeffrey	Shiv-lingi	On hedges and bushes, a slender much branched tendril climber, leaves simple, deeply cordate at the base, flowers yellow, fruits globose smooth berry, brick red when ripe with white lines.	The plant is anti-inflammatory, foetid, blood purifier and tonic. It is useful in cough, flatulence and general debility. Seed powder given to help conception in women. Whole plant used in paralysis of tongue and enlarged spleen.
Dodonea viscosa L.	Mehndu	In open slopes at lower elevations. commonly planted as hedge, evergreen shrub, the leaves are viscid, leaves alternate, sessile, oblong lanceolate flowers small yellow.	Leaves are sudorific, used in gout and rheumatism, wounds and swellings, bark for fomentations.
Eclipta alba Hassic.	Bringraj	Common in waste places and fields, strigose slender herb with rooted nodes, leaves opposite with appressed hairs on both sides, flowers white in heads, ray florets.	Plant is used in chronic skin diseases, tetanus. It is good for blackening and strengthening of the hair, for stopping haemorrhages and fluxes, seeds good for increasing sexual vigour, roots used in wound in cattle.
Emblica officinalis Gaertn.	Aonla	In deciduous forests and on hill slopes, a medium sized tree with thin light grey bark exfoliating in small thin flakes, leaves simple, distichous, look like pinnate leaves, fruits globose fleshy, with six vertical furrows.	The fruits are useful in vitiated conditions of 'tridosha', diabetes, cough, flatulence, peptic ulcers, erysipelas, anemia, emaciation, jaundice, leucorrhoea, cardiac disorders, intermittent fever and greyness of hair.

Euphorbia hirta L.	Chhoti Dudi,	As a weed in plains and lower elevations, a small branched prostrate herb, leaves simple, opposite, rounded at the apex, stalk very short, fruits capsules.	Plant is used in asthma, chronic cough, cardiac debility. The latex is said to be useful in acne vulgaris.
E. nerifolia L.	Dudli Thuhar	Wild on rocky hills, a large fleshy, glabrous, branched shrub, leaves fleshy, nerves visible in transmitted light, fruits trilcoccus, seeds greenish brown.	It is useful in gastropathy, bronchitis, asthma, dyspepsia, leprosy rheumatism and ulcers. The milky juice is useful in earache and ophthalmia.
E. royleana Boiss.	Chhuh, Thor	On exposed rocky slopes in hotter parts, cactus like shrub with whorled thick and fleshy branches having sharp stipular spines, leaves small, sub-sessile, deciduous.	The roots are anodyne, purgative and stomachic and are useful in earache ,colic and constipation. The latex is useful in rheumatism, dropsy, gout, deafness, cathartic, and anthelmintic.
Evolvulus alsinoides L.	Sankh-puspi	In exposed areas, a small, hairy, diffused perennial herb, leaves simple, alternate, densely clothed with appressed silky hairs; flowers light blue, styles two distinct from the base, each divides again once thus producing 4-styles.	It is useful in bronchitis, asthma, epilepsy, dysentery, diarrhoea, falling and greying of hair and intermittent fevers and general debility.
Ficus benghalensis L.	Bat, Barh	A very large tree with wdely spreading branches and many aerial roots, leaves simple, alternate, often in clusters at end of branches, broadly elliptical, fruits in pairs, globose, brick red when ripe. The fresh cut surface is pink or flesh colored and exude plenty of latex.	The aerial roots are useful in obstinate vomiting and leucorrhoea, softening of limbs bones due to vit. D deficiency. The buds are useful in diarrhoea and dysentery; fruits are refrigerant and tonic,; latex in neuralgia, rheumatism, lumbago, inflammations of nose and cracks of soles.

F. racemosa L.	Gular, Umar	A large sized spreading laticiferous, deciduous tree, leaves dark green, ovate or elliptic. Figs are smooth, orange, dull reddish or dark crimson when ripe, have pleasant smell like cidar apple.	The roots are useful in treating dysentery; bark is antidiabetic, and useful as a wash for wounds, highly efficacious in threatened abortions, also recommended in uropathy. The ripe fruits are useful in menorrhagia and haemoptysis. The latex is aphrodisiac and used in haemorrhoids.
F. religiosa L.	Pippal	Wild as well as cultivated, a large deciduous tree with few or no aerial roots, shiny green leaves, the apex produced into a linear-lanceolate tail, fruits in pairs, globose, purplish when ripe.	The bark is aphrodisiac, and an aqueous extract of it has an antibacterial activity against *Staphylococus aureus* and *Escherichia coli.* A paste of powdered bark is a good absorbent for inflammatory swellings, and good for burns, the dried fruits pulverised and taken in water cures asthma.
Flacourtia indica (Burm. f.) Merr.	Kangu	In scrub forests and rocky hills, a small deciduous thorny shrub, leaves simple elliptic, glabrous, flowers greenish yellow, fruits globose dark purple, juicy pulp and hard endocarp.	The roots are used in aphthae, pruritus, neuropathy and psychopathy. The leaves are useful in pruritus and scabies. The fruits are appetizer, digestive and diuretic.
Gloriosa superba L.	Kalihari	In low jungles, a herbaceous tendril climber with underground cylindrical white tuberous rhizome, leaves sessile, alternate, ovate-lanceolate with tips prolonged into spiral tendrils, flowers showy, at first greenish, later becoming yellow, and finally scarlet or crimson.	The rhizomes are useful in inflammations, scrofula, parasitic skin diseases, promoting labour pain and expulsion of placenta. In large doses it is highly poisonous.

Glycyrrhiza glabra L.	Mulathi	Cultivated in the sub-Himalayan tract, a tall perennial under shrub, leaves compound, flowers violet in racemes, pods oblong to linear, seeds reniform.	The part used is dried underground stems and roots has characteristic pleasant taste, a decoction of root is good for treating gastric ulcers, wash for falling and greying of hair. It is emetic, tonic, diuretic and expectorant.
Gymnema sylvestre (Retz.) R. Br.	Gunmar Merasinghi	In dry forests, a woody climber with pubescent young parts, leaves simple opposite, flowers small yellow in umbellate cyme, fruits slender.	The plant is emetic, liver tonic, stomachic, stimulant useful in jaundice, renal and vesicle calculi, conjunctivitis, and leucoderma. Leaves when chewed paralyse the sense of taste for sweet and bitter substances for sometimes.
Helicteres isora L.	Marorphali	Wild in forests and scrub jungles, a large shrub with grey bark, young shoots covered with stellate hairs, leaves simple, alternate, serrate, flowers red, fading to lead colour, fruits green brown beaked, cork screw like 5 follicles.	The root and bark are expectorants and are useful in colic, empyema, diarrhoea, and dysentery. The fruits are useful in ophthalmitis, colic, flatulence, wounds and diabetes.
Holarrhena antidysenterica Wall.	Kutz, Kayor	Wild in forests, a small latciferous, deciduous tree, abundant milky white latex, leaves simple, opposite, flowers white, fruits long, narrow, fruits long narrow, cylindrical.	The bark and seeds are useful in amoebic dysentery, diarrhoea, asthma. Leaves are used in chronic bronchitis, boils, ulcers and dysentery.
Indigofera tinctoria L.	Nil	In the forests, a branching shrub, leaves with 7-13 leaflets, tender branches blush red, flowers red or pink, fruits pale greenish cylindrical pods with 10-12 seeds.	The whole plant is useful for promoting the growth of hair and in gastropathy, cardiopathy. Juice from leaves is useful in hydrophobia. An extract of the plant is good for epilepsy and neuropathy. Plant possess anti-toxic property.

Jatropha curcas L.	Jablota, Phari erand	In the forests and along roadsides, a large deciduous soft wooded shrub with sticky juice, leaves alternate, broadly ovate, flowers yellowish green, fruits ovoid, black, splitting into three, 2-valved cocci seed dull brownish black.	The latex is styptic, purgative, haemostatic, and is good for wounds and ulcers. The seeds are powerful purgative, anthelmintic. The oil obtained form root has strong anthelmintic action, applied externally in rheumatism and paralytic affections.
Kalanchöe spathula (Poir) DC	Kali-ndru Lsug-dhu	In the ravines, a succulent perennial glabrous herb, younger parts reddish speckled with white, leaves opposite, the extremities of the lateral nerves furnished with rooting vegetative buds.	The leaves are useful in menorrhagia, cut and wounds, discoluration of skin, boils, scalds, corn, vomiting and acute inflammations.
Lantana camara L. var. *aculeata*	Phoolnu	A native of tropical America, but now naturalized a troublesome weed, a scrambling evergreen, strong smelling shrub, with stout recurved prickles, leaves opposite, scabrid on both sides, flowers orange. Often white to red in heads, fruits fleshy drupes.	The plant is useful in tetanus, epilepsy and gastropath. Decoction of fresh roots is good for gargle for odontalgia and in all types of dysentery. Infusion of leaves good for eruptions and eczema.
Leea indica Burm.f. Merr.	Kurkurjihiva	In evergreen forests, a shrub with umerous tough branches, leaves very large, glabrous, dark brown when dry, flowers white in large branched corymbose cyme, fruits black berries.	The roots are useful in diarrhoea, dysentery, colic, and ulcers. The young leaves are digestive and are applied to head in vertigo.

Lepidium sativum L.	Haloon	In the gardens cultivated as culinary vegetable, an erect glabrous annual, leaves entire, flowers white, small in long raceme, small pods, notched at the apex with two seeds/pod.	The roots are useful in secondary syphills and tenesmus. The leaves are stimulant and antibacterial. The seeds are useful as poultice for sprains and in leprosy, lumbago, scurvy and seminal weakness, asthma and cough.
Leucas aspera (Willd.) Link.	Dronapuspi	As a weed on waste lands, as erect diffused much branched annual, leaves sub-sessile, entire or crenate, flowers pure white, small in dense terminal or axillary whorls.	The leaves and flowers are useful in colic, dyspepsia, chronic skin eruptions, cough and catarrh in children. The juice of the leaves is highly recommendable as an eye drop in encephalopathy due to worm infestation in children and as nasal drop in catarrh.
Mallotus philippensis MuellArg.	Kamal	In evergreen and deciduous forests, a small tree, leaves alternate, longer than broad, entire or shortly serrate, red glandular beneath, fruits globose, three lobed capsules cover with dense reddish brown glandular pubescence.	The glandular hair of fruit useful in verminosis, constipation, flatulence, wounds, ulcers, cough, renal and vesicle calculi, ring worm and other parasitic affections.
Matricaria chamomilla L	Babuna	Wild in the fields, a glabrous, aromatic herb, leaves 2-3 pinnatisect, heads solitary, ligules white much linger than bracts.	The root is stimulant, tonic, carminative, flowers tonic to brain, enriches the blood, aphrodisiac and diaphoretic, oil is analgesic.

Melia azadirachta L.	Darek	Often cultivated, a moderate sized tree, leaves bi- or tripinnate opposite, serrate, acuminate, flowers lilac, fragrant, staminal tube very conspicuous, purple, fruits ellipsoid-globose.	The roots are useful in cephalgia, leucoderma, diabetes, urethrorrhea and uteralgia after delivery. The leaves are useful in hysteria, scrofula, splenomegaly, and cardiac disease. The seeds are useful in helminthiasis, typhoid fever, pain in pelvic region and uropathy.
Mentha arvensis L.	Podina	In the moist places, an erect aromatic herb with suckers, leaves simple, opposite, flowers lilac in axillary distant whorles, fruits nutlets, smooth.	The leaves are useful in arthralgia, halitosis, indolent ulcers, flatulence, peptic ulcer, vomiting, diarrhoea, cough, jaundice and fever.
Mucuna prurita L. DC.	Gajal bel, Kaunc	Among hedges and bushes. A slender climbing annual, leaves trifoliate, broadly ovate, pubescent above, densely clothed beneath, flowers purple, fruits turgid pods, densely clothed with pale brown irritant bristles.	The leaves are aphrodisiac, anthelmintic and tonic. The seeds are useful gonorrhoea, sterility, and general debility. The hairs and flowers are vermifuge. The roots are diuretic and tonic.
Murraya koenigii Sprang,	Gandalu Karipatta	Wild in forests and along road sides, a small aromatic tree with dark green foliage, leaves imparipinnate, leaflets alternate, gland dotted and strongly aromatic, flowers white, fruits sub- globose berries and purplish black when ripe.	The roots, bark and leaves are useful in hyperdipsia, pruritus, leucoderma, anore-xia, flatulence, diarrhoea, dysentery, inflammations and foul ulcers.

Musa paradisca L.	Kela	Cultivated, a tall herb with aerial pseudo stem drying after flowering, leaves oblong narrowed at base; flowers unisexual at the base.	The tender leaves are useful in scabies, inflammation, blisters and burns. The fruits are emollient, aphrodisiac, antiscorbutic, demulecent and tonic. The ashes obtained by burning the plant are antiscorbutic, anthelmintic and stomachic and are useful in heartburn, hyperacidity. Flowers are good for dysentry, diabetes, ascites and dropsy. The infloresenece axis is very specific in renal and vesicle calculi.
Nyctanthes arbortristis L.	Harsinghar	Cultivated in the garden, a hardy large shrub, with grey or greenish rough bark, leaves simple, opposite, flowers small, white with bright orange corolla,, fruits capsule.	The leaves are useful in abstinate sciatica, dyspepsia, chronic fever, asthma, brocnchitis. The seeds and flowers are very useful in baldness, and greyness of hair, scurvey and affections of scalp.
Ocimum basilicum L.	Babhri	Wild in fields and waste lands, a pubescent herb, leaves elliptic-lanceolate, entire or faintly toothed, flowers white, pink or purplish, nutlets pitted, mucilaginous when wetted.	The leaves are thermogenic, appetising, digestive, carminative and expectorant and are useful in anorexia, flatulence, dysentery, parasitic affections, migraine, malaria and fever.
O. sanctum L.	Tulsi	Cultivated, an erect much branched undershrub, with red or purple branches, leaves simple, opposite, minutely gland dotted, fruits nutlets, smooth, not mucilaginous when wetted.	The plant is stomachic, diphoretic, expectorant, and useful in cardiopathy, asthma, bronchitis, hiccough, genito-urinary disorders.

Oroxylum indicum Vent.	Tatplanga, Arlu	Deciduous forest in moist places, a medium sized tree with soft light brown bark, corky lenticels, leaves very large, 2-3 pinnate with 5 or more pairs of primary pinnae, leaflets 2-4 pairs, ovate, flowers lurid to reddish purple, fruits flat up to 1 m long tapering at both ends.	The roots are useful in dropsy, sprains, neuralgia, cough, dyspepsia, flatulence, colic, and dysentery. The leaves are stomachic and anodyne, and are useful in splenomegaly, ulcers. The tender fruits are expectorant, carminative and useful in cough, bronchitis and leucoderma.
Phyllanthus amarus L.	Bhoomiamla	As a weed in cultivated fields and waste places, a branching annual herb with slender spreading leaf bearing branchlets, leaves numerous, flower yellowish, greenish or whitish, fruit depressed globose smooth capsules underneath branches.	The plant is cooling, astringent,diuretic and useful in gastropathy, jaundice, dysentery, diseases of the urino-genital system, scabies, ulcers and wounds.
Piper longum L.	Mug, Pipli	In evergreen forests, a slender aromatic climber, rooting at the nodes, leaves alternate, lower ones broadly ovate, all entire, smooth; flowers solitary spikes, fruits berries.	The dried spike are useful in anorexia, dyspepsia, flatulent colic, epilepsy, gonorrhoea, haemorrhoids, hiccough, asthma, and gout.
Pistacia integerrima Stewart ex. Brandis	Kakadasingi	In the forests, a medium sized tree, leaves pinnatley compound, leaflets lanceolate, flowers small in lateral panicles. Galls produced on leaves are pale greenish, horn shaped, hollow, twisted, coriaceous when young and later hard.	The galls caused by insect *Dasia aedifera* are useful in asthma, cough, dysentery, diarrhoea, vitiated condit-ions of triodosa, irritablity of stomach, pharyngitis. Also effective in children for diseases at the time of teething.

Plantago major Forssk.	Isabgul	Cultivated, a very short stemmed softly hairy annual, leaves simple, narrowly linear, finely acuminate, usually 3 nerved, flowers small, in cylindrical or ovoid spikes, fruits ellipsoid.	The seeds are refrigerant, emollient, mucilaginous, diuretic, laxative, aphrodisiac, useful in constipation, gastritis, chronic diarrhoea, dysentery, duodenal ulcers and general debility.
Plumbago zeylanica L.	Chitrak	Wild in forests, a perennial shrub with semi-woody striate stems, leaves simple, alternate, flowers white, calyx ribs covered with bifarious glands, corolla tube longer than calyx.	The roots are useful in dyspepsia, inflammations, appetizer, in muscular pains, leprosy and skin diseases, cough and elephantiasis. Leaves used as antirheumatic.
Portulaca oleracea L.	Kulfa	As a weed, a succulent prostrate herbaceous annual with green or purple stems, swollen at the nodes, quite glabrous, leaves simple, fleshy, flowers bright yellow, clusters, seeds numerous.	The stem and leaves are sour, thermogenic, alexeteric, vulnery and tonic and useful in tumerou, cystalgia, blood purifier, gonorrhoea, diseases of liver and spleen.
Pseudarthria viscida L.	Salaparni	In the lower hills, a perennial viscid diffuse undershrub, clothed with whitish hairs, leaves 3 foliate, flowers purplish or pink, fruits pods, covered with sticky hairs, seeds 4-6 compressed.	The roots are emollient, digestive, nervine tonic, diuretic, cardiotonic, rejuvenating, tonic and are useful in tuberculosis, neurasthenia, cardiopathy, gout, hyperthermia, and general debility.
Psoalea coryliflоia L.	Babchi	As weed in waste places, an erect herbaceous annual with grooved and glanddotted stems and branches, leaves simple, broadly rounded and mucronate at the apex, clothed with white hairs, flowers blue, fruits small pods.	The seeds are bitter, laxative, stomachic, stimulant, aphrodisiac, diuretic and are useful in leucoderma, ulcers, mucomembranous disorders. It is a good hair tonic.

Randia dumatorium Lamk.	Radda	A large shrub, with strong straight nearly opposite, decussate spines, leaves ususally fascicled on the suppressed branches, obovate, obtuse, calyx densely hairy, corolla white to yellow, fruits like small crab apple.	The fruit is heating, aphrodisiac, purgative, useful in chronic bronchitis, pain in muscles, leucoderma, grounded pulp of the fruits esteemed as domestic remedy for fever and other ailments which children are subject while teething.
Rauvolfia serpentina Benth. Ex Kurz.	Sarpagandha	As forest undergrowth, a erect shrub or under shrub with red pedicels and calyx, leaves three in whorl, glabrous bright green above, flowers white, fruits purplish black when ripe.	The root is highly reputed for hypertension and is useful in stranguary , fever wounds and colic. The decoction of root is used to increase uterine contractions. The juice of leaves used for removal of opacities of the cornea.
Ricinus communis L.	Arandh	Cultivated and found run wild, a perennial bushy, soft wooded small tree, leaves palmately lobed with 7 or more serrate lobes, flowers monoecious in terminal, fruits globose, capsules covered with green and fleshy prickles.	The roots are carminative, purgative, useful in gastropathy, ascites, bronchitis. The leaves are diuretic and anthelmintic and for bathing and fomentations in vitiated conditions of *vata,* especially in rheumatoid arthritis, urodynia and arthralgia. Seeds poultice used in arthralgia.
Sapindus mukorossi Gaertn.	Reetha	A medium sized deciduous tree, bark somewhat rough, leaves 25-50 cm long, leaflets 5-8 pairs, opposite, lanceolate, flowers small white or purple, fruits indehiscent carpels, pale brown, wrinkled before falling, seeds globose, black.	The fruits are used in salivation, epilepsy, and chlorosis, and are expectorant, solution of the fruits is a remedy for cutaneous diseases. Berries contain a fairly large amount of saponin.

Sida cordata (Burm.f.) Borssum	Naga-bala	A weed on road sides and waste places, a diffused hairy herb, with long slender trailing branches, leaves long petioled, cordate to roundish, flowers yellow, seed brownish.	The entire plant is used. roots are useful in uropathy and arthritis, bark of root is used for leucorrhoea, leaves good for diarrhoea, flowers and ripe fruits are useful in relieving burning sensation and promoting strength.
S. rhombifolia L.	Bala	As a weed in waste places, erect, minutely hairy, branches undershrub, with intricate branches, leaves short petioled, obovate, truncate, flowers yellow, fruits enclosed in persistent calyx.	The roots and leaves are emollient, cooling, aphrodisiac, strengthening and promote sexual vigour and vital factors and are useful in vitiated conditions of *tridosha* and arthritis.
S. spinosa L.	Mahabala	In the hotter parts, a small erect, grey, pubescent branched undershrub, the young shoots being covered with soft, grey stellate down, leaves stiff minute spiny, flowers pale yellow to cream white, axillary and solitary on slender peduncles.	The roots are diaphoretic, aphrodisiac and tonic and useful in debility, fever, swellings and in irritability of the bladder; leaves are emollient and refrigerant and useful in gonorrhoea, gleet and scalding urine.
Solanum indicum L.	Bari Kantkari	In the waste places, a much branched very prickly undershrub, leaves simple, large ovate, sparsely prickly on both sides, flowers blue, fruits globose; berries, reddish or dark yellow.	The roots are digestive, carminative, demulescent, expectorant, cardiotonic and useful in odontalgia, flatulence, diarrhoea, flatulence, cough, cardiac disorders, leaves and fruits are digestive, laxative and antibacterial, and are useful in ringworm.

S. nigrum L.	Makoy	As a weed, erect, branched, annual herb, leaves ovate or oblong, sinuate toothed, fruits purplish black or reddish berries.	A decoction of the plant depresses the central nervous system and reflexes of the spinal cord and has influence on the cardiac activity and in the regulation of blood pressure. The decoction of berries and flowers is useful in cough, erysipeals, rat bite, bronchitis, diarrhoea and hydrophobia. The leaves used as poultice for gouty joints, leaves and fruits are especially important as cure for stomach ulcers.
S. xanthocarpum Schrad. & Wendl.	Chhoti kantkari	As a weed in dry situations, a prickly diffused bright green perennial undershrub, spread close to the ground, covered with straight, yellowish white prickles, flowers blue to purple, fruits globular drooping berry, yellow or white with green veins, surrounded by the calyx.	The plant is anthelmintic, stomachic,expectorant, stimulant, useful in dental cares, arthralgia, cough, asthma, urolithasis, cardia disorders, epilepsy and catarrh.
Sonchus olraceus L.	Milk thistle, Dudhi	Weed in waste lands, herb with a perennial creeping root stock, leaves and stem hairy and yield latex upon injury, leaves radical, small teeth, flowers pale yellow heads.	Gum is used as hydragogue, cathartic, root and leaf used as tonic and febrifuge.

Sphaeranthus indicus L.	Mundi	In damp localities, a spreading aromatic herb with glandular hairy stem and branches with purple or pink flowers, stem with toothed wings, leaves alternate, toothed, flowers in close terminal, ovoid heads.	The juice extracted from the plant is used in epilepsy, hemicarnia, jaundice. Paste of herb mixed with oil is good for pruritus and painful swellings. The powered leaf is good for skin diseases and nervine tonic. The flowers are highly esteemed as alterant, refrigerant and tonic.
Spilanthes acmella Murr.	Akrkara	Wild in the hills, more or less hairy herb, leaves opposite, ovate, acute, heads long ovoid, yellow.	Flowers used as antidontalgic, mosquito larvicidal, seeds promote salvination.
Stephenia glabra (Roxb.) Mierr.	Rajpatha	Branches fistular, leaves herbaceous membranous, braodly ovate, broad, peduncle 4-8 cm, flowers on filiform, sepals and petals 3, fruiting umbels with ray, drupes obovate.	The acrid root is used medicinally in sylhet. It is also used in pulmonary tuberoculosis, asthma, dysentery and fever.
Taraxacum officnale Weber.	Dudhal	In the open slopes of hills, a perennial herb with thick tap root and abundant milky juice in all parts, leaves radical, sessile, toothed, flowers yellow in ligulate heads, fruits glabrous achenes, spiny on the upper half with white pappus hairs.	The plant is aperient, liver tonic,diuretic, antibacterial, stimulant and tonic and useful in chronic ulcers, tuberculosis, colic, flatulence, stiff joints, insomnia, hypochodria, jaundice, biliary and other hepatitic disease and general debility.

Terminalia arjuna (Roxb. ex DC) Wight & Arn.	Ashok	A large evergreen tree with butressed trunk and spreading crown with drooping branches, bark grey outside, flesh colored inside, flaking off in large flat pieces, leaves simple, pale dull green above, pale brown beneath, flowers white.	The bark is cooling, aphrodisiac, cardiotonic, antidysenteric, urinary astringent, expectorant and tonic, useful in fractures, urethrorrhea, leucorrhoea, diabetes, internal and external haemorrhages, cirrhosis of liver and hypertension
T. bellirica (Gaertn.) Roxb.	Bahera	In deciduous forests, a large deciduous buttressed tree, leaves simple, alternate, long petioled, crowded about the extermities of the branches, broadly elliptic, margin entire, flower pale greenish with offensive odour, fruits ovoid grey drupes, narrowed into a very short stalk.	The bark is mildly diuretic, and useful in anaemia and leucoderma. The fruits are useful in cough, bronchitis, insomnia, dropsy, cephalagia, ulcers and general debility. The mature dry fruit is constipating and useful in diarrhoea and dysenetery. The oil of seed is trichogenous and useful in dyspepsia and greyness of hair.
T. chebula Retz.	Harad	In deciduous forests on dry slopes, a moderate sized to large deciduous tree, leaves ovate, elliptical with a pair of large glands at the top of the petiole, flowers yellowish, fruits ellipsoidal or ovoid drupes, yellow to orange, seeds yellow.	The fruits are astringent, digestive, diuretic, febrifuge and tonic, useful in triodosa, gastropathy, anorexia, heptopathy, cough, epilepsy, cardiac disorders, stomatitis, neuropathy and general debility.
Tinospora cordifolia (Willd.) Mierr.	Giloe, Guljain	In the forest around trees, a extensively spreading glabrous, perennial deciduous twiner with succulent stem, dark greenish mucilaginous below the skin and papery bark, leaves simple, flowers yellow in lax racems, fruits drupes, red.	The stem antiperiodic, antiemetic, appetizer, stomachic, expectorant, aphrodisiac, rejuvenating, glacto-purifier and useful in burning sensation, hyperdipsia, stomachalgia, fevers, erysipelas, cough, jaundice, seminal weakness and uropathy.

Tribulus terrestris L.	Gokhru, Bakhra	Weed along road sides, a prostrate herb, spreading branches, and silky villous young parts, leaves abruptly simple, pinnate, opposite, flowers bright yellow, fruits 5-angles spinous tuberculate woody schizocarp.	The roots and fruits are cooling, diuretic, emollient, appetizer, alterant and useful in renal and vesical calculi, anorexia, ulocace and general weakness; leaves are useful in gonorrhoea, gleet, ulitis, menorrhagia, and weakness. Ash of plant good for external application in rheumarthritis.
Tylophora asthmatica W & A.	Anathmool	In hedges and garden, a slender tough laticiferous climber with long fleshy roots, leaves simple, opposite, somewhat fleshy, flowers in umbels, fruits fusiform, follicles tapering to a fine point at the apex.	The roots and leaves are sweet, emetic, diaphoretic, antiviral, useful in asthma, bronshitism, whooping cough, hydrophobia, cancerous tumours and murine leukaemia.
Vernonia cinerea Less.	Sahdevi	As a weed, a erect annual herb, leaves simple, alternate, ovate or lanceolate, shortly mucronate, irregularly toothed, flowers many, pinkish violet, in small heads, silky on the back.	The roots are useful in diarrhoea, cough, fever, and skin diseases. The leaves are useful in humid herpes, eczema, ringworm, and elephantiasis. The flowers are useful in conjunctivitis. The plant possesses anticancerous activities and good for cancerous malformations.
Vitex negundo L.	Bana, Nirgundi	On waste lands, an aromatic large shrub, leaves opposite, exstipulate, long petioled and digitately 3-5 foliolate, the middle one longer, fruits 4 seeded drupes, black when ripe.	The roots are useful in cephalgia, otalgia, arthritis, cough and malarial fever. Leaves in sprains, orchitis, gout, otorrhoea, inflammations and ulcers. The bark is odontalgia and ophthalmopathy. The flowers are used in cholera fever.

Withania somnifera Dunal.	Ashvagandha	In waste places, an erect undershrub, leaves ovate, flowers greenish to lurid yellow, fruits globose berries, orange coloured when mature, the fleshy roots pure white inside when broken.	The tuberous roots are somniferous, stimulant, thermogeneic, aphrodisiac, diuretic and tonic and useful in insomnia, tissue building and nervous breakdown. The leaves are recommended in fever, painful swellings and opthalmitis. A paste of the roots and bruised leaves are applied to carbuncles, ulcers and painful swellings.
Wodfordia fruticosa Kurz.	Dhoain	Along the road sides, a branched beautiful deciduous shrub, reddish brown bark, leaves simple, opposite, entire, ovate to lanceolate, flowers numerous, brilliant red in dense.	The flowers are refrigerant, stimulant, depurative, styptic, anthelmintic, antibacterial, corrective to urinary pigments, useful in diarrhoea and dysentry, and foul ulcers, important ingredient in *Arishtam*, and *Asavam*, and are highly valued as a stimulant in pregnancy.
Xanthium strumanium L.	Chhota-goghru, Zanaeera	In the waste places, annual, unarmed, stem stout, rough with short hairs, leaves long, broadly triangular ovate, acute, often 3 lobed, fruits clothed with hooked prickles.	The root is tonic and useful in strumous diseases. Fruit is considered cooling and used in smallpox, whole plant possess diaphoretic and sedative properties.
Zanthoxylum alatum Roxb.	Tirmir	An armed shrub, with dense glabrous foliage and straight prickles on stems, leaves compound, often bearing pink prickles, leaflets 5-11, dark glossy green above, pale beneath, seeds solitary, globose, shining black.	The bark and fruits are useful in odontalgia, cephalagia, diabetes, wounds, stomatopathy, pharyngopathy, cardiac debility and general debility.

Table 2. Medicinal plants diversity between 800-1800 meter (Mid-hills)

Scientific name	Local name	Natural habitat and plant description	Uses of the plant
Acorus calamus L.	Bach	Weed of marshy places, an aromatic herb with creeping branching rhizome, leaves bright green, acute, thickened in the middle, margins waved, spadix 5-10, obtuse.	The rhizome is pungent, laxative, diuretic, improves appetite, alexiteric, tonic to the brain, toothache and general weakness. Used to allay distressing cough and dysentery.
Asparagus adscendens Roxb.	Sansfai	Scandant prickly shrub in forests, leaves reduced to chaffy scales and spines, flowers fragrant on the naked nodes of the main shoots, fruits globular, pulpy berries, roots tuberous succulent, fascicled at the stem base.	The tuberous roots are used as demlucent and tonic, said to be useful in diarrhoea, dysentery, and general debility.
Berberis lycium Royle.	Kashmal	In the hills, an evergreen shrub, twigs pale yellow, bark deeply furrowed, leaves lanceolate, with spinous teeth, pedicles slender green, fruits ovoid, blue.	Extract from roots and lower portion of stem is used in opthalmia and fever, mild laxative, tonic, piles. Berries considered as coagulant.
Calicarpa macrophylla Vahl.	Priyangu	In the sub-Himalayan tracts, an erect shrub, leaves simple, opposite, white tomentose beneath, flowers rose coloured, fruits white drupes.	The flowers and fruits are useful in rheumatoid arthritis, burning sensations, cephalagia, foul ulcers, diabetes and general weakness. Leaves are useful in gout and arthralgia.
Centella asiatica L.	Mandookprani	In marshy places, a slender creeping, perennial fairly aromatic herb, rooting in the nodes, leaves cordate, toothed, flowers minutes in clusters of umbels.	A crude extract of the plant is wound healer, plant decoction is used as tonic, and in leprosy and tuberculosis.

Chenopodium ambrisoides L.	Sugandh-bastrek	In the waste places, a tall erect much branched aromatic herb, with camphoraceous odour, leaves oblong lanceolate, obtuse, sinuate-dentate, flowers minute clustered.	The plant is used in petoral complaints, nervous affections, compression cough, and also recommended for the expulsion of dead foetus, inflorescence used as anthelmintic.
Coix lacrymajobi L.	Gurlu, Samkru	Warm and damp areas, an annual, tough grass, wild and cultivated, with basal rooting nodes, leaves linear lanceolate, midrib stout, ligule narrow, fruits sub-globose, bluish grey, smooth, polished tear shaped grains.	The roots are used in menstural disorders and strangury. The seeds are used as tonic and diuretic. Also used as diet drinks for invalids and for pnuemonosis diseases.
Dioscorea deltoidea Wall.	Tardi	On hedges and in shrubberies. Deciduous, leafy, twining herbaceous perennial, irregular, ligneous tuber, stem glabrous, leaves reticulate, ovate, cordate base, acuminate, flowers small clusters.	Tubers used for washing woolens, contain diosgenin a starting material for the manufacture of steroids. Leaves are used as febrifuge.
Digilatis purpurea L.	Hritapatri	Cultivated or found as escape in the hills, a biennial herb, bear a rosette of leaves in the beginning, leaves ovate to lanceolate, flower tubular-campanulate, purple yellow.	Leaves are used as cardiac stimulant. Plant is used as bitter tonic. It is diuretic and useful in dropsy and renal obstructions, very selective in burns.
Habenaria intermedia D. Don.	Viridhi	In the open slopes, a tuberous terrestrial herb, leaves 3-5, ovate-oblong, acuminate with sheathing leaf base, flowers large greenish white, petals white, ovary slightly twisted.	The tubers are refrigerant, emollient, intellect promoting, aphrodisiac, appetizer, rejuvenating and tonic. Useful in hyperdipsia, fever, cough, and asthma.

H. edgeworthi Hook. F eex Collet.	Ridhi	In the open slopes, a tuberous terrestrial herb, leafy stem covered with hairs, flowers yellowish green deflexed in buds in cylindrical inflorescence, lip bright yellow.	The tubers are refrigerant, emollient, intellect promoting, aphrodisiac, appetizer, rejuvenating and tonic. Useful in hyperdipsia, fever, cough, and asthma.
Hedychium spicatum Ham. Ex Smith	Kapoor kachri	In the open grass lands hills, rhizomatous herb, leaves reaching 30 cm, oblong, glabrous, spike up to 30 cm, flowers white, capsules glabrous, globose.	The root stock is astringent, useful in inflammations, asthma, foul breath, laxative, tonic, to the brain, stomachic and stimulant.
Origanum vulgare L.	Sathra	Wild in forests, erect aromatic herb with tuberous roots, leaves ovate, obtuse or subacute, flowers pinikish white, crowded in clusters terminating branches.	Volatile oil is used as tonic, stimulant, diarrhoea, colic, bronchitis and whooping cough. Applied externally in rheumatism, toothache, and earache.
Parmelia perlata (Huds.)	Chadila, Pathar phool	On rocks of hills and tree trunks, the vegetative body of this lichen is flat, growing in rosettes or irregularly spread over the substratum giving the appearance of flowers.	The plant is useful in wounds, sores, boils, cephalgia, leprosy, hepatodynia, cardiac debility, cough, fever, amenorrhoea and seminal weakness.
Physalis minima L.	Rasbhari	As a weed, a herbaceous, leaves simple, alternate, ovate, shallowly toothed, flowers yellow, fruits green round berries.	The plant is useful in *Pitta*, burning sensations, splenomegaly, ascites, colic, cough, bronchitis and pruritus.
Potentilla neplensis Hook.	Bazrdanti	In the open slopes, a perennial herb, stem hairy from a woody root stock, leaves long stalked, leaflets 3-5, teeth large, flowers dark crimson, or rose colored, achenes hairy.	The root is considered depurative, the ashes applied with oils to burns. Also used as antidontalgic, and spasmolytic.

Prinsepia utilis Royle.	Bakhel	In the forests, a deciduous shrub, branches green, armed with stout axillary thorns, leaves lanceolate, narrowed at both ends, flowers white in short axillary racemes. Flowers fleshy drupes, purple when ripe.	The shrub yields an oil used as rubefacient and as an application in rheumatism and pains from the over-fatigue.
Punica granatum L.	Daru	A large deciduous undershrub, often spinescent branches, leaves opposite, shining above, bright green beneath, flowers scarlet red, mostly solitary, seeds angular with red, pink or whitish fleshy testa.	The roots are good for tapeworm, and for strengthening gums. The flowers are styptic to the gums and its extract very specific for nose bleeding. The fruits are useful in anaemia, hyperdipsia, fruits rind is good for dysentery, and gastralgia. The seeds are stomachic, diuretic and cardiotonic.
Pueraria tuberosa DC.	Bidarikand, Salodh	A large spreading tuberous, herbaceous twiner with very large tuberous roots, leaves 3 foliate, leaflets broadly ovate, silky beneath, flowers blue or purplish, fruits membranous, flat, jointed pods clothed with long silky brown hairs.	The tuberous roots are sweet, refrigerant, emollient, aphrodisiac, rejuvenating, emetic, cardiotonic, alterant and expectorant and useful in arthritis, cardiac debility, pharyngitis, cough, spermatorrhoea and general debity.
Smilax china L.	Chob-chini	A hard tendril climber sparsely prickled with thick tuberous rhizome, leaves simple, alternate, elliptic, prominently nerved, flowers many, fruits red berries.	The rhizomes are useful in syphillis, leprosy, skin diseases, epilepsy, insanity, fever, strangury, seminal weakness and general deblity.

Solanum dulcamara L.	Kakmachi	A pubescent herb, leaves ovate or oblong, lobed at the base, flowers purple, fruits berry red when ripe.	Berry is alterative, diuretic, and disphoretic, stem is antirheumatic, twigs are narcotic, and resolvent.
Thalictrum foliolosum DC.	Mameeri	In the hills, a tall perennial rigid herb, leaves exstipulate, pinnately decompound, panicles much branches, flowers polygamous white, pale green dingy purple, achenes small.	Tonic with slight purgative action, improve eye sight, good in toothache, in acute diahorroea, in piles and discolouration of the skin.
Viola odorata L.	Banafshah	Perennial stock short, branches knotted with the remains of old leaf stalks, leaves in radical, broadly cordate; flowers nodding, bluish purple, scented.	Leaves laxative, emollient, diaphoretic and antispasmodic. Flowers used to cure skin affections. Whole herb is also used to cure cough and cold.

Table 3. Medicinal plants diversity between 1800-2500 m (High hills and sub-alpine Himalayas)

Scientific name	Local name	Natural habitat and plant description .	Uses of the plant
Aconitum heterophyllum Wall.	Ateesh	Herb with white tuberous roots in sub-alpine and alpine zone, leaves more or less heteromorphous, flowers in leafy panicles, blue or violet, seeds blackish brown, roots breaks very easily, cross section very white.	The root are acrid, bitter expectorant, digestive, antiperiodic and tonic. Also useful in dysentery, diarrhoea, fever, malarial fever, haemorrhages. Highly recommended for diseases in children.
Aconitum ferox Wall.	Dudhia vish	A biennial herb with tuberous roots, wild in open hilly slopes. 60-90 cm in height, flowers blue in loose raceme, roots are dark brown externally and fracture is scarcely yellowish.	The roots are narcotic, on tasting produce tingling sensation, carminative. Useful in vitiated conditions of *Vata*, *Pitta* and *Kapha*, rheumatism, leprosy and fever.

Angelica glauca Edgew.	Chora	In the temperate hills, a glabrous herb, stem erect hollow, finely grooved, leaves usually large, 1-3 pinnate, ovate or lanceolate, sharply toothed, umbels compound, long stalked, flowers white or purple.	Stimulant and for flatulance and dyspepsia, roots as spice and condiments.
Aspragus filicinus Buch. Ham.	Sansvai	Erect, unarmed, tall herb, perennial tuberous rootstock, stem terete, leaves minute scales, flowers white, berry black, globose.	Roots used as tonic and astringent, also diuretic.
Atropa acuminata Royle. ex Lindley	Atropa	In forests shade, erect glabrous, perennial herb from a large tap root, leaves elliptic – lanceolate, acuminate, cuneate at base flowers yellow, calyx deeply lobed, berry globose.	Roots and leaves are narcotic, sedative and mydriatic, used as anydone, also used in manufacture of tincture and plasters.
Artemisia maritima L.	Kirmala	In the temperate hills, a deciduous shrub, leaves 1-5 cm long, linear obtuse, bluish green, heads 3-8 flowered, flowers yellowish.	Heads as anthelmintic, sanotin is an essential drug from the plant. Used as poultice against bite of scorpion and other reptiles.
A. vulgaris L.	Damnak	In the hills, perennial, shrubby, aromatic, stem leafy, lower leaves 5-10, ovate, lobes entire, toothed, upper leaves smaller 3-fid, heads 3-4 mm long, ovoid.	The plant has a hot, pungent taste, valuable stoamchic, antispasmodic, strong decoction used as vermifuge, infusion is also given as tonic.

A. sieversiana Willd.	Dauna	In the hills, a perennial, hoary, silky, herb, very aromatic, much larger heads, distant on the long, stem erect angled, ribbed; leaves mostly petioled, broadly ovate, bracts green hoary.	The plant is acrid, cardiotonic, tonic, improves taste, useful in leucoderma, cures *Vata* and *Kapha*, disease of spleen and heart, in hysteria etc.
Bistorta vivipara S. F. Gray		A common alpine of moist meadows, erect, glabrous, perennial herb, swollen, woody rootstock, leaves variable, crenulate, acute, narrowly lanceolate, flowers white or pinkish.	Young leaves and rootstocks are edible, tonic, astringent, decoction of herb used as gargle for soar throat and spongy gums.
Begenia ligulata (Wall.) Engl.	Pathar-chhata	In the rocky hills, a perennial herb, root stock very stout, stem short, thick, fleshy, leaves ovate, turning bright red in autumn, fringed with short stiff hairs, flowers white or pink.	The root is bitter and acrid, cooling, laxative, urinary discharges, heart diseases, bladder diseases, tonic, remove mucous from intestine, also given in dysentery.
Cichorium intybus L.	Chicory	Common place weed, perennial tall glabrous or rough herb, with milky juice, stem grooved, leaves oblong-lanceolate, radical and lower cauline, heads bright blue.	Plant is considered as tonic, emmenagogue and alexiteric, roots used in homoeopathy for liver and gall ailments.
Colchicum leuteum L.	Surajan	About 20 cm tall, glabrous herb, corm clothed with dark brown scales, leaves all radical, linear to linear-oblong, obtuse, flowers 1-2 golden yellow, 2-4.5 cm dia.	Corms used against gout and rheumatism and as external application in inflammations, contain the alkaloid colchicine- a valuable tool for cytological studies.

Corydalis govaniana Wall.	Bhoot kesi	In the forests, rootstock woody, thick crowned with withered leaf sheaths, stem erect, thumb thickness, almost leafless, or 1-2 near top, radical leaves stalked, flower bright yellow, fruits capsule.	The root is considered tonic, diuretic, alternative and prescribed in syphillitic, scrofulous and cutaneous affections.
Datura stramonium L.	Datura	Common in waste place, erect, nearly glabrous, spreading branches, leaves ovate, sinuate lobed, flowers white, corolla funnelifolium limb spreading, capsule ovoid, densely prickly, seeds black, wrinkled.	Dried leaves and flowering tops comprise 'stramonium'. It is narcotic, antispasmodic and anydone. Also employed to relieve asthma and to control salivation, muscular rigidity and tremor of parkinsonism.
Delphinium denudatum Wall.	Nirbisi	Cultivated or wild in hilly areas, a glabrous branching annual herb, leaves radical pinnatley lobed, flowers blue to grey.	The roots are useful in toothache, insanity, painful mensturation, obesity, cardiac debility, cough and asthma.
Gentiana kuroo Royle.	Kadu	A small perennial tufted, decumbent herb with stout rhizome, leaves radical or cauline, flowers blue spotted with white, fruits oblong capsules.	The rhizomes are useful in wounds, ulcers, dyspepsia, flatulence, helminthiasis, constipation, cardiac debility and fever.
Fritillaria roylei Hook.f.	Kakoli	A glabrous bulbous unbranched herb, bulb globose, leaves opposite or whorled, flowers green, chequered with dull purple, solitary and terminal nodding.	The bulbs are useful in agalactia, cough, bronchitis, seminal weakness, burning sensation, hyperdipsia, intermittent fever and general debility.

Heracleum candicans DC	Patrala	In the forests, herb, perennial, never quite glabrous, leaves serrate pilose above, upper leaves 3-partite, umbels compound, rays usually many, flowers often radiant, white or yellowish, calyx teeth linear.	The root is said to be tonic and aphrodisiac.
Inula racemosa Hook. F.	Puskar mool	A stout herb with rough grooved stem, leaves simple, alternate, rough above, densely hairy beneath, flowers yellow, many in heads, fruits slender achenes with reddish pappaus. The fresh roots brown externally, white internally.	The roots are useful in foul ulcers and wounds, hemicarnia, hepatalgia, splenagia, flatulence, cardiac debility, cardiac and bronchial asthma, brain disorders and general debility.
Lilium polyphyllum D. Don	Ksheera-kakoli	In moist shady places, a narrow bulbous herb with few narrow sub-equal fleshy scales, leaves in whorls, flowers 4-10, fragrant, dull yellowish or greenish outside, white within speckled with long purple streaks.	The bulbs are sweet, expectorant, aphrodisiac, antipyretic and are useful in agalactia, cough, bronchitis, seminal weakness, intermittent fever, rheumatalgia and general debility.
Melaxix acuminata D. Don	Jeevak	In the open hills, a short stemmed terrestrial herb with more or less pseudo bulb at the base and fibrous roots, leaves simple, flowers minute, pale yellowish green tinged with purple in terminal racemes.	The green swollen stem base covered by brown scales is useful in haematensis, fever, seminal weakness, burning sensation, emacination, tuberculosis and general deblity.

M. nucifera	Rishbhak	In the open hills, a terrestrial herb with small ovoid pseudo-bulb and fibrous roots, leaves 3-5, unequal, short petioled, flowers pale yellowish green, lip fleshy, broadly ovate.	Green swollen stem base is useful in sterility, seminal weakness, internal and external haemorrhages, dysentery, fever, burning sensation and general deblity.
Moringa oleifera Lam.	Senja	A small middle sized tree, root pungent, leaves usually 3-pinnate, rachis slender, leaflets 12-20, flowers white in large puberulous panicles, pods 30-45 cm, 9 ribbed.	*Vaids* prescribe the root as a stimulant in paralytic affections and intermittent fever, epilepsy and hysteria. Stringent to the bowls, in heart complaints, eye diseases.
Matricaria chamomilla L.	Babuna	A glabrous much branched aromatic herb, leaves 2-3 pinnatisect, segments almost filiform, heads solitary, ligules white.	The root is stimulant, tonic and carminative, flower has sharp taste and pleasant smell, tonic to the brain, enriches the blood, oil is aphrodisiac, analgesic, good for cough.
Nardostachys jatamasi DC	Jatamansi	In the alpine Himalayas, a erect perennial herb, with woody, long rootstock, covered with reddish brown fibers of the petioles of radical leaves, flowers rosy pale pink or blue, in dense cymes.	The rhizome is highly aromatic, antiseptic, anodyne, liver stimulant, diuretic, nervine tonic, intellect promoting and is useful in pectoralgia, dermatopathy, epilepsy, convulsions, neurosis, grey hair, falling of hair, hypertension and general debility.
Orchis latifolia L.	Salam panja	Erect, glabrous leafy perennial herb, 2-3 lobed, slightly flattened, tuberoid root, stem hollow, leaves oblong lanceolate, flowers rosy purple, dorsal sepals erect upto 10 cm long.	Roots are the source of salep, esteemed as arinaceous food, nervine tonic and aphrodisiac, roots mucilageous, jelly useful in dysentry, diarrhoea nad chronic fever.

Picrorhiza kurroa Royle ex Benth	Kukti Kuru	In the open Himalayas, a small hairy perennial herb with woody elongate creeping root stock, leaves spathulate, serrate, flowers white or bluish, dried rhizome is greyish brown, longitudinally wrinkled at the tip.	The rhizomes are useful in constipation, gastropathy, cardiac disorders,fever, diabetes, impurity of breast milk, and general debility. Reputed to be efficacious in dropsy.
Podophyllum hexandrum Royle	Bankakdi	Wild in forests or on hills, succulent herb, root stock creeping, flowering stem 15-45 cm, leaves 1-3, alternate long stalked, deeply lobed, flowers cup shaped, white, sometimes pink, fruit a large scarlet pulpy berry.	Rhizome and root used as purgative, hepatic, stimulant, bile expellant, bitter tonic, antidiarrhoeal, in skin diseases. Rhizome exerts destructive action on cancerous tissues.
Polygonatum cirrhifolium (Wall.) Royle	Meda	In the Himalayas. A herb with thick root-stock, leaf and grooved, Leaves in whorls of 4, linear, flowers purplish tinged with white and green, fruits black, red when ripe.	The root stock is sweet, cooling, aphrodisiac, depurative, febrifuge, expectorant, and tonic.
P. verticillatum (L.) All.	Mahameda	In the Himalayas, an erect glabrous herb with thick root stock, stem leafy, zig-zag and grooved, leaves whorled, linear, flowers white or pinkish white or pale, fruits berries red when ripe.	The root stock is sweet, cooling, emollient, diuretic, appetising, aphrodisiac, depurative, febrifuge, expectorant, tonic. Used in anorexia, seminal weakness and fever.
Rheum emodi Wall	Ravend-chinni	Common in hills, erect, robust, perennial herb from a rhizomatous base, leaves orbicular-cordate, basal ones long petioled, mostly 45 cm across, or even larger, flowers very small yellowish white, fruits broad oblong 7-8 mm.	The long and stout leafy stalk as pleasantly acidulous and sometimes used as rhubarb. Roots and rhizome is used as tonic and purgative.

Rhododendron arboreum Sm.	Burance	In the hills, a small evergreen tree bark rough, young shoots clothed with white scales, leaves crowded towards the ends of branches, lanceolate or oblong, narrowed at both ends. Flowers deep red or pale pink.	The young leaves applied for headache, flowers juice is used as summer squash.
Rubia cordifolia L.	Majith	Around the bushes in hills, prickly climbing perennial herb,with reddish roots, 4 angled rough stem and branches, leaves cordate to ovate, petioles very long, provided with sharp recurved prickles on the edges, fruits globose, purplish black when ripe, seeds two.	The roots are used in rheumatoid arthritis, pharyngitis, cough, diabetes, discoloration of skin, slow healing of broken bones, otopathy, urethrorrhea, jaundice, leucorrhoea and general debility.
Salvia moorcraftiana Wall.	Kali zadhi	Along the road sides, clothed with cottony white hairs, leaves thick, ovate or oblong, sharply toothed, flowers pale blue, lilac or nearly white.	The root is given in cough and the seeds are used as emetic and given in haemorrhoies. Poultice of leaves applied to wounds.
Skimmia laureola Sieb. & Zucc.	Kastoori patra	In the hills, an erect glabrous shrub, bark fairly smooth, blaze yellow, strongly aromatic, leaves crowded towards the end, oblong lanceolate, flower pale greenish yellow, stamens yellow, drupe ovoid red.	The smoke of the leaves purify the air, incense is also prepared from them. Essential oil is also obtained by steam distillation.

Swertia chirayita Buch.Ham.	Chirayita	In the temperate open slopes, an erect annual herb, stem robust, leaves ovate, broadly lanceolate, cordate at the base, flowers numerous, greenish yellow, tinged with purple in large leafy panicles.	The plant is useful in all types of fevers, especially chronic and intermittent fevers, gastropathy, skin diseases, dipsia, leucorrhoea, piles, leucoderma and ulcers.
Tanacetum longifolium Wall ex. DC	Drain	Erect hairy, 15-45 cm tall, perennial, leafy herb, thick root stock covered with petiole remains, leaves oblong, basal leaves long stalked, heads discoid, bright yellow.	Roots used as incense and medicine for colds. Essential oil from flower top &leaf used as vermifuge, abortifacient, in rheumatism, and chronic ulcers.
Taxus baccata L.	Thuner Talispatra	A medium sized evergreen tree, stem fluted, branches wide spreading, leaves linear, flattened, acute, dark green above, pale yellowish or rusty red below, fruits succulent, red, testa woody, embryo 6-7 cotyledons.	Leaves and fruits given for sedative and anti-spasmodic effects, remedy for indigestion and epilepsy, dried leaves used in asthma and bronchitis, wood is well known against hydrophobia. Presently much exploited for its anti cancerous properties.
Urginea indica (Roxb), Kunth	Jangli piaz	Small glabrous bulb pale, ovoid, thick, leaves appearing after the flowers, nearly flat, linear, acute, flowers dingy brown, in laxly flowered racemes, capsule ellipsoid, tapering both ends	Bulb is used as cardiac stimulant, in the preparation of *Chandni bhasma* which is used in paralytic affections, in asthma and rheumatism.
Urtica diocia L	Bichhu booti	Wild in hilly regions, robust, dioecious herb with stinging hairs on stem and leaves. Yellow galls formed in the rainy season.	Plant is used as diuretic, astringent, in jaundice, nephritic troubles, haemorrhages from kidney, uterus or nose, flowers and seeds as tonic.

Viola biflora L.	Banafashah	In the hills, glabrous, stem erect, leaves kidney shaped, crenate, stipules ovate or oblong, flowers 1-2, yellow, spur very short.	The root is emetic, flowers as an emollient, pectoral, diaphoretic and antispamodic, the leaves are emollient and laxative.
Valeriana wallichii DC	Tagar	In the Himalayas, a tufted hairy herbaceous perennial, basal radicle leaves long stalked, deeply cordate, flowers white tinged with pink in terminal corymbs, fruits oblong.	The roots are alexteric, emollient, hypnotic, carminative, hepto and cardiotonic, useful in arthalgia, convulsions, cardiac debility, dry cough, falling of hair, and splenopathy.

Table 4. Medicinal Plants diversity above 2500 m (Alpine Himalayas)

Scientific name	Local name	Natural habitat and plant description	Uses of the plant
Aconitum palmatum D. Don	Bishawa	Roots biennial, paired, tuberous, stem 2-4' high inclusive of inflorescence, stout, hollow. Inflorescence a very loose, leafy panicles, 10-20 cm long, sepals bluish or variegated white, blue and glabrous outside.	The non-poisonous root is tonic, and antiperiodic. It contains the alkaloid palmatisine.
A. deinorrhizum Stapf.	Maura Mohra	In the alpine Himalayas, roots biennial, tuberous, whitish, mother tuber wrinkled with long filiform root fibres. Stem several feet high, erect, straight, leaves 10-12 scattered, inflorescence straight racemes. Sepals blue.	The roots contain the poisonous alkaloid pseudoaconite.

Arnebia benthamil	Ratanjot	Common on open alpine slopes, erect, tall, robust, grey hair, perennial herb, stem simple leafy. Leaves lanceolate, 5 nerved, densely hispid with long hairs, flowers purplish brown or red to blackish, long shaggy bracts.	Plant is useful in disease of tongue and throat.
Artemisia dracunculus L.	Traigan	A perennial hairless herb, stems 30-60 cm high, grooved and ribbed, leaves long, stem leaves sessile, linear, sharply toothed, flowers heads almost round, pale, shining.	The aromatic leaves are credited with aperient, stomachic, stimulant, and febrifuge properties.
Bunium persicum G.D. Koch.	Kala zeera	In the alpine Himalayas, tuberous herb, tuber covered with black scales *outside, white inside*, leaves 2-3 pinnate, finely dissected, fruits yellowish brown, ridges thin.	Tubers eaten raw or as vegetable and seeds as spice. Useful carminative, allay *gripping in the abdomen*, increase.the appetite.
Carum carvi L.	Siya zeera	A biennial forming tap root, stem erect, leaves pinnate wih several pairs, sessile segments, upper leaves smaller and less divided.	Seeds used for flavoring foods, stimulation of appetite, relieving gastric discomfort, roots sometimes used as vegetable.
Crocus sativus L.	Kesar	Cultivated in the alpine region, rootstock a sheathed corm, leaves radical, narrowly linear, perianth funnel shapes, tube very slender, flowers violet, anthers yellow.	Saffron is fragrant, pungent, anthelmintic, tonic, useful in bronchitis, throat troubles, *tridosha*, leaves useful in fractures and pain the joints, also stimulant and stomachic.

Ephedra gerardiana Wall.	Somlata	In the alpine Himalayas, a low rigid dense tufted, shrub, stem woody, branchlets green, striate, smooth, flowers 4-8, female spikes usually solitary, fruits ovoid, red, edible.	Liquid extract used for asthmatic paraxyms, heart failures, decoction of roots and stems for remedy of rheumatism. Juice of berries in affections of respiratory passage.
Hippophoae rhamnoideas L.	Chharma	In the forests, a stiff densely branching shrub, bark ashy or silvery grey, twigs and young shoots densely clothed with silvery brown scales, leaves densely clothed on both surface, with silvery brown scales, fruits globose.	A decoction of plant is used for cutaneous eruptions, and also in lung complaints.
Humulus lupulus L.	Hops	In the dry temperate region, cultivate, rootstock stout, stem tall scabrid, climber, leaves cordate, toothed flower heads greenish turning yellow, style purple, anthers yellow.	The hop is tonic, stomachic, and diuretic, prevents worms, and allays the disquietude of nervous digestion, infusion is a good general tonic and sedative.
Hyoscyamus niger L.	Khoorasni-ajvain	Common in open dung laden ground, erect hairy, unpleasant smelling, tall viscid herb, radical leaves rosulate, oblong-ovate, coarsely sinuate-dentate, irregularly coarse toothed, flowers pale yellow greenish, netted with purple veins, seeds numerous.	Dried leaves and flowering tops constitute drug 'Hyoscyamus', has anodyne, narcotic, and mydriatic properties, contains chiefly hyoscyamine. Seeds paste applies locally on pains.

Juniperus communis L.	Hauber	In the forests, a dense shrub, leaves in whorls, of 3, sharply pointed, bluish white on the upper surface, flowers deciduous axillary, fruits subglobose, blue black.	The plant has a bad odour, mild astringent to bowels, antipyretic and tonic, useful in stomatitis, bronchitis, and disease of the liver and spleen.
Jurenia macrocephalla Benth.	Dhoop	Common on open slopes, often gregarious, rosette forming, ashy grey, stemless perennial herb, woody root, leaves prostrate oblong-lanceolate, pinnate, cobwebby above, white tomentose beneath, heads purple, achenes ashy grey, pappus hairy brown.	The bruised root is applied to eruptions, and a decoction is given in colic. It is also considered and given in puerperal fever.
Onosma echioides L.	Dhamni, Ratanjot	In the alpine region, a biennial, patently hispid, herb, cauline leaves, racemes elongate, often forked, flowers yellow, filaments linear, nutless long stoney, white, shining, smooth.	The plant is cooling, laxative, anthelmintic, good in eye disease, bronchitis, piles. Bruised root is used as application in eruptions. Flowers used in palpitation of heart.
Saussurea lappa Clarke.	Kuth	In the alpine hills, a robust perennial herb, leaves membranous, toothed, basal ones very large, stem leaves smaller, flowers tubular, dark blue-purple, achene compressed curves.	The root is alterative, aphrodisiac, improves complexion, cures leucoderma, itching, *tridosha*, bronchitis, tonic, stimulate the brain, antidote in snake bit.
Thymus linearis Benth.		Common on dry, rocky slopes, much branched, often tufted, very aromatic, stem hairy, creeping, leaves sessile to very shortly stalked, ovate, feebly toothed, with few long white hairs near base, flowers purplish,	Leaves and flowering tops employed for suppression of urine and menstruation and for convulsive and whooping cough. Oil useful in toothache and hair lotions.

Conservation of medicinal plants diversity

The main aim of the conservation is to ensure perpetual propagation of these resources and may also include sustainable utilization, as may be found possible. The preservation and protection of medicinal plants is, therefore, of prime importance and demand national concern. The best way to conserve the medicinal diversity is to follow a holistic approach of conservation as no single method of conservation is optimal for all situation. Both *in situ* and *ex situ* methods of conservation are necessarily the major components of any comprehensive conservation strategy. These are:

In situ conservation

Preservation and protection of genes, species, habitats and ecosystems of the natural habitats is the key element to achieve fruits of all conservation efforts. In the first form of *in situ* conservation methods, we can preserve and protect the natural habitats of plant species upon which they depend for their establishment and reproduction. Therefore, in order to strengthen the *in situ* conservation efforts the following points should be examined carefully.

- prevention of the destruction of natural habitats.
- maintenance and/ or enhancement of the population level and variability.
- prevention of collection and excessive commercial exploitation.
- areas with several endemic, rare, and endangered species, varied physiography, scientifically studied in large extent should have priority over those with fewer such elements/ features.

Second form of *in situ* conservation is in the form of biosphere reserves. They represent efforts directed to preserve the core areas of indigenous plant and animal life for posterity. These help in conserving the present and future evolving diversity and integrity of biotic communities of flora and fauna within natural ecosystems.

Presence of genetic diversity and the potential for conservation of ecosystem in its totality, richness of genetic resources and availability of legal protection freedom from human interference should be considered while selecting an area for biosphere reserve.

Third form of *in situ* conservation is in the form of scared groves. Most of the tribal and ethnic societies possess their own habitats and natural resources, beliefs and diverse ways of conservation and use of plants. These protected areas called sacred groves or the forests of god and goddess or local deity (*Devata*) which is linked with certain faiths and beliefs. These areas remain untouched, virgin forests from all outside interference and conserve the many endangered species. Any interference into it from outside is *taboo*.

Ex situ conservation

It refers to maintaining available diversity in seed genebanks, *in vitro* genebanks, cryobanks. field genebanks, botanical and herbal gardens. Among these high priority needs to be given to maintenance of collections in fields, herbal gardens and botanical gardens.

Field genebanks assures ready supply of usable material and clones can be maintained in the green house or field plantings. Field maintenance and regeneration also provides opportunity for identifying potential donor stock for future breeding programmes. However, frequent regeneration can lead to genetic erosion due to environmental hazards, mechanical failure and human error.

Botanical gardens helps in conserving rare and threatened medicinal plants and act as a temporary bridging operation. They also help in generating information on reproductive biology, seed physiology and ecology and on the techniques of propagation, maintenance and protection (Frankel and Soule, 1981). They also play an important role in reintroducing threatened species to natural environment.

Herbal gardens specialize mainly in cultivation and maintenance of medicinal plants. These gardens also act as experimental farms for breeding and selection of new cultivars in any specific species as also in the development of field production technology. They also serve as agencies to produce and supply seed samples of plant genetic resources on one hand and create public awareness by holding short term training programmes for various communities.

Seed genebanks for long term storage are important primarily because it avoids the need of too frequent regeneration of germplasm in the field and is free from all other attendant risks of field maintenance. The National Bureau of Plant Genetic Resources, New Delhi is having such facility meeting any National and International standard where an appreciable number of plants of great economic importance have been conserved. Conserving diversity in the seed genebanks (-20°C) is the most cost effective method of *ex situ* conservation following well established techniques which have been developed for several cultivated plant species (Ellis *et al*, 1985). 338 accessions of different medicinal and aromatic plants have been conserved in the National Genebank.

In vitro technique provides a secure, pest free environment for propagation as well as storage of rare and threatened species. It s also applicable to species collected in vegetative state from 'difficult to approach' area or otherwise do not produce seeds. Efficient protocols are available for most of the plat species and are being conserved at NBPGR. Some of them are *Coleus forskohii, Gentiana kurroo, Picrorhiza kurroa, Podophyllum hexandrum, Rauvolfia serpentina, Saussaurea lappa, Allium tuberosum, Mentha Spp., Tylophora indica, Valeriana wallichii* etc.

Cryopreservation involves the storage of viable tissue at ultra low temperature, with liquid nitrogen (LN) being the most commonly used, relatively non hazardous cryogen (at -196°C) or in vapour phase above LN (-150°C). There is virtual suspension of all metabolic activities including biological growth and development (Franks, 1985). It is specifically useful in the conservation of those species which produce recalcitrant seeds.

Apart from these two well established approaches of conservation, there are many other areas of thinking where if care is taken, lot of medicinal diversity can be saved before it is lost forever. These are:

i) Understanding and documenting the roles and functions of genes, species and ecosystems and also building awareness of medicinal diversity amongst the general public.

ii) Systematic rotational collection should be done in the areas of high diversity under different topographical zones.

iii) Germplasm centers for those species which are endangered or threatened should be developed in different regions/ zones.

iv) Heavy grazing and destruction of medicinal herbs should be checked in the areas of natural habitats in general and regions and alpine and subalpine in particular, as most of the species grown in these regions do not produce sufficient seeds/ vegetative material for regeneration. However keeping in view the social needs of the local folk, grazing in the forests and grasslands can not be avoided hence, rotational deferred grazing systems may be introduced.

v) Different organizations engaged in the R & D on various aspects of medicinal plants should develop nurseries and drug farms on their own or in collaboration with forests department.

vi) The herb collectors should be educated and provided with the proper guide lines, so that there is a continuous regeneration of the species, as most of the species do not set seeds and they are reproduced only through their underground parts and the same part is used for medicinal purpose. These plant ones collected lost forever because they can not reproduce further.

vii) While looking at the general cultivation scenario of the medicinal plants in the country it appears to be very discouraging and only few farmers have taken up medicinal plants cultivation that too adopted by big pharmaceuticals. Therefore cultivation of medicinal plants should be encouraged. Farmers should be made well equipped with standardized agro-techniques for easy raising and multiplication of medicinal plants. The cultivation may set a revolutionary landmark in ISM as it shall bring out farm-based production of genuine and highly potent raw materials to the manufacturing sector; this can be achieved by a programme of screening of genetic materials form natural flora, as these taxa may yield suitable genotypes to be valued for introduction into several cropping systems on the one hand and for raising over stress environments, on the other.

viii) Domestication of medicinal plants should be encouraged. In this regard, well planned and coordinated efforts at individual level, voluntary organizations, village, block and district level bodies, NGOs, cooperative societies and various local agencies should be made.

ix) Availability of legal protection and freedom from human interference to maintain the natural habitats sholud be given.

x) Last but not the least using medicinal plant diversity sustainably and equitably i.e. making sure that medicinal plants are used to improve quality of human life of present and future generations.

References

Ellis, R. H., Hong, T. D. and Roberts, E. H. 1985. Handbook of Seed Technology for Gene Banks, IPGRI, Rome.

Frankel, O. H. and Soule, M. E. 1981. Conservation and Evolution. Cambridge Univ. Press, Cambridge.

◆ Franks, F. 1985. Biophysics and Biochemistry at Low Temperature. Cambridge Univ. Press, Cambridge.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants pp. 201-207, 1999

A note on conservation of economically important Zingiberaceae of Sikkim Himalaya

S. KUMAR

Botanical Survey of India, Northern Circle,
192, Kaulagarh Road, Dehra Dun – 248 195.

Abstract

Sikkim Himalaya is one of the richest phytogeographical zones with enormous diversity in almost all the plant families due to variable topography and climatic conditions. Zingiberaceae, an economically important plant family is represented by ca. 54 species falling under 14 genera. The important genera include *Alpinia, Amomum, Kaempferia, Cautleya, Costus, Curcuma, Globba, Hedychium, Roscoea and Zingiber*. The diversity and economic potential of Zingiberaceae and various conservation measures are discussed in this communication.

Introduction

Zingiberaceae, a family of economically important, medicinal and ornamental plants, is represented by ca.1400 species falling under 52 genera in tropical regions of Asia, Africa, Australia and South America. Indo Malayan region is the main centre of its distribution. In India, the family constitutes one of the important groups of monocots being among the ten largest families and there are different estimates of number of genera and species by different workers. Karthikeyan *et al.*, (1989) reported 22 genera and 163 species in his checklist of monocots whereas Bhat (1993) while describing Zingiberaceae of Karnataka mentions 21 genera and 135 species from India. Karthikeyan and Mudgal (1995) in their article on species diversity in Indian Flora in "Bharat ki Vanaspatik Vividhta" listed 22 genera and 167 species of Zingiberaceae. However, Jain & Ved Prakash (1995) in their recent publication on phytogeography and endemism of Zingiberaceae reported 22 genera and 178 species from India. Sikkim Himalayas also have a fair representation of Zingiberaceae with 58 taxa (54 species + 4 varieties) falling under 14 genera being 5th largest family of monocots in the state. The name of species/varieties under different genera is given in Table 1.

Table 1. Total no. of genera and species of Zingiberaceae in Sikkim

Name of the genera	Name of species/varieties
Alpinia Roxb.	*A. bracteata* Roxb., *A. galanga* (L.) Sw., *A. malaccensis* (Burm.f.) Rosc., *A. nigra* (Gaertn.) Burtt.
Amomum Roxb.	*A. aromaticum* Roxb., *A. corynostachyum* Wall; *A. dealbatum* Roxb., A. *dealbatum* Roxb., var. *sericeum* Roxb. Baker., *A. kingii* Baker., A. *subulatum* Roxb.
Caulokaempferia Larsen	*C. secunda* (Wall.) Larsen., *C. sikkimensis* (King ex Baker) Larsen
Cautleya (Benth.) Royle ex Hook.f.	*C. cathcartiii* Baker., *C. gracilis* (Smith) Dandy., *C. robusta* Baker., *C. spicata* (Smith) Baker
Costus L.	*C. lacerus* Gagnep., *C. speciosus* (Koen.) J.E. Smith.
Curcuma Roxb.	*C. angustifolia* Roxb., *C. aromatica* Salisb., *C. caesia* Roxb., *C. longa* L., *C. zedoaria* (Christm.) Rosc.
Curcumorpha Rao & Verma	*C. longiflora* (Wall.) Rao & Verma
Etlingera Gisek	*E. linguiformis* (Roxb.) R.M. Smith
Globba L.	*G. andersonii* Clarke ex Baker., *G. clarkei* Baker., *G. hookeri* Clarke ex Baker., *G. multiflora* Wall. Ex Baker., *G. racemosa* J.E. Smith *G. siamensium* (Koenig) Rao & Verma.
Hedychium koenig	*H. aurantiacum* Wall. Ex Rosc., *H. coccineum* Buch-Ham Ex J.E. Smith.., *H. coccineum* Buch – Ham. Ex J.E. Smith var. *squarrosum* (Buch – Ham ex Wall.) Baker., *H. coronarium* Koening; *H. densiflorum* Wall., *H. ellipticum* Buch-Ham.

Contd...

	Ex J.E. Smith., *H. gardenerianum* Shepp. Ex Ker.-Gawl., *H. gracile* Roxb., *H. greenii* W.W. Smith; *H. spicatum* Buch. Ham.Ex.J.E. Smith; *H. spicatum* Buch-Ham Ex J.E. Smith var. *acuminatum* (Rosc.) Wall., *H. thyrsiforme* Buch.-Ham Ex J.E. Smith
Hemiorchis Kurz.	*H. pantlingii* King
Kaempferia L.	*K. angustifolia* Rosc., *K. involucrata* Eing Ex Baker., *K. rotunda* L.
Roscoea J.E. Smith	*R. alpina* Royle., *R. auriculata* K. Schum., *R. purpurea* J.E. Smith
Zingiber Boehm	*Z. capitatum* Roxb., *Z. capitatum* var. *elatum* (Roxb.) Baker., *Z. chrysanthum* Rosc., *Z. clarkei* King Ex Benth., *Z. officinale* Rosc., *Z. purpureum* Rosc., *Z. rubens* Roxb., *Z. zerumbet* (L.) Rosc.Ex J.E. Smith

Out of these, the economically important genera are *Alpinia, Amomum, Costus, Curcuma, Hedychium, Kaempferi and Zingiber.*

The details on economically important taxa, their distribution in Sikkim and various uses are shown in Table -2.

Table 2. Economically important taxa of Zingiberacea in Sikkim.

Species	Distribution	Economic uses				
		M	S&C	EO	ED	O
Alpinia galanga	Up to 1200 M	+	-	+	-	+
A. malaccensis	Dickchu, Chungthang	+	-	+	-	-
A. nigra	Testa valley	+	-	+	-	-
Amomum aromaticum	Meli, Rishap	-	+	+	-	-
A. dealbatum	Dikchu, Singhik, sittang	+	+	-	-	-
A. dealbatum var *sericeum*	Ragpoo valley	-	+	-	-	-
A. subulatum	Cultivated up to 1000 M	+	+	+	-	-

Contd...

ostus speciosus	Gangtok, Rangpoo, Rangeet valley	+	-	-	+	-
urcuma angustifolia	Upto 1700 M	-	-	-	-	+
. aromatica	Teesta valley, Rongsong	+	-	-	-	-
. caesia	Upto 600 M	+	+	+	-	-
. longa	Cultivated upto 1700 M	+	+	+	-	+
. zedoaria	Ranipul, Teesta valley upto 2000 M	+	+	+	+	+
lobba andersonii	Upto 750M					
. racemosa	Gangtok, Rhenock	+	-	-	-	-
H. coccineum	Ghungthang, Great Rangeet valley	+	-	+	+	+
Hedychium coronarium	Upto 1300 M	+	-	+	+	+
H. spicatum	Upto 3000 M	+	-	+	-	+
Kaempferia angustifolia	Tropical regions	+	-	-	-	+
K. rotunda	Rishap	+	+	+	-	-
Roscoea alpina	Upto 3200 M	+	-	-	-	-
R. purpurea	Bakhim, Lachung, Lachen	+	-	-	-	+
Zingiber capitatum	Terai region	+	+	+	-	+
Z. capitatum var. *elatum*	Sikkim terai	-	-	+	-	-
Z. chrysanthum	Upto 1800 M	-	-	+	-	-
Z. officinale	Upto 1200 M	+	+	+	-	-
Z. purpureum	Upto 1500 M	+	+	+	-	+
Z. zerumbet	Tropical regions	+	-	+	-	+

M = medicinal, S & C = spices & condiment, EO = essential oil, Ed = edible,
O = others, + used, - not used

The economic importance of the family for Sikkim (Table 3) can be understood by the fact that large cardamom and ginger are two major cash crops of the state being grown in larger parts of tropical and sub-tropical regions.

Table 3. Economically important products from Zingiberaceae of Sikkim.

Product	Species
Large cardamom seeds	*Amomum subulatum*
East Indian arrowroot	*Curcuma angustifolia*
Turmeric	*Curcuma longa*
Zedoary	*Curcuma zedoaria*
Oil of ginger	*Zingiber officinale*
Oil of zerumbet	*Zingiber zerumbet*
Abir	*Hedychium spicatum, C. zedoaria*
Galangal	*Alpinia galanga*

The other important feature associated with the conservational aspect of a taxon is its status in the region/state/country. The restricted distribution of a taxon makes it one of the most desired materials for conservation as a taxon may be lost forever if there is any threat to its habitat. In Sikkim, there are 7 endemic taxa out of a total of 58 reported from the state as shown in Table 4.

Table 4. Endemic taxa of Zingiberaceae in Sikkim

Name of species	Status	Region
Amomum kingii	Endemic	EH
Globba andersonii	Endemic	EH
Hedychium aurantiacum	Endemic	India
Cautleya robusta	Endemic	India
Roscoea auriculata	Endemic	EH
Zingiber clarkei	Endemic	EH
Etlingera linguiformis	Endemic	India

EH = Eastern hill

Threats

There are different kinds of threat perceptions to economically important *Zingiberaceous* taxa, which can be broadly classified into two.

1 Natural threats

2 Anthropogenic threats

Natural threats: include habitat loss due to frequent land slides, earthquakes and removal of topsoil due to floods, heavy rains, cloudburst etc and forest fire resulting in destruction of ground vegetation along with forest.

Anthropogenic threats are due to various unthoughtful human activities. These include habitat loss due to roads, bridges and dam construction, tourist activities, army activities in border areas and various developmental projects including hydroelectric projects in fragile hilly terrain; deforestation due to indiscriminate forest cutting and indiscriminate uprooting of desired plants from the field.

Conservation strategies

There is very little control on natural factors except that a few damage control exercises can be undertaken to minimize the loss. For instance, the important and rare taxa can be transferred to some safer places, which are lesser prone to natural calamities. However, anthropogenic threats can be either removed altogether or controlled to a larger extent.

The conservation of Zingiberaceous species of Sikkim requires special attention because of fragile nature of the habitat, availability of about 1/3 of total number of taxa (58/178), high degree of endemism and wider range of variability in *Amomum, Cautleya, Curcuma, Hedychium, Roscoea* and *Zingiber* etc.

In situ conservation and *ex situ* conservation strategies can be followed in this group of plants.

In situ conservation means ensuring the safety of taxa in their native habitat i.e. declaring the area as "Protected". For this, the species richness and diversity of the area is to be assessed before declaring them as "Protected". This can be done by having an action plan for Mapped Geographical Information System (MGIS) indicating habitat threat perception, rarity of taxa and rate of decline of population and also by assessing the degree of protection, identifying most favourable protected areas for a particular taxa or for large number of species concentrated at one point and by forecasting the pressure of human/cattle population and other biotic factors.

For all this, a planned and systemic survey of the area is the foremost prerequisite. Then after assessing the positive and negative aspects, a "Conservation Area Matrix" (CAM) has to be developed to ensure meaningful conservation of taxa. The above scheme can be applied for conservation of narrow endemic species like *Amomum kingii, Cautleya robusta, Roscoea auriculata, Globba andersonii, Zingiber clarkei* etc. There are few additional advantages in ensuring *in situ* conservation of a particular taxa which include protection of associated plant species and wildlife besides other natural resources of the region.

Ex situ conservation : There are various means of *ex situ* conservation which is an effective tool for conservation of species on selective basis by providing them safer environment much away from their original habitat. The following are a few important methods of *ex situ* conservation.

Growing of taxa in botanic gardens, sanctuaries, zoological gardens and safer places at similar altitudes; multiplication by conventional method in safer areas (captive breeding); micropropagation through tissue culture; creating public awareness about the importance of taxa by mass media; interaction between various Govt./non. Govt. agencies and common people by way of organizing meetings seminars/symposia to discuss on various issues related to threat and conservation of taxa and documentation of useful information about all taxa to save our precious natural resources from falling prey to bioimperialism and biopiracy of important taxa by vested interests.

All said and discussed above, however can be achieved only by concerted effort at all levels involving local communities, without whose participation, any talk of conservation, will remain only a tea time gossip of intellectuals.

Acknowledgements

The author wishes to express his thanks to Dr. V. Singh, Additional Director In-Charge, and Botanical Survey of India, Calcutta for facilities and encouragements.

References

Bhat, K. G. 1993. Studies on Zingiberaceae of Karnataka. In: Higher plants of Indian Sub-continent. Vol. IV:BSMPS, Dehra Dun. pp. 39-102.

Jain, S. K. and Prakash, V. 1995. Zingiberaceae in India : Phytogeography and Endemism. Rheedea 5 (2) : 154-169.

Karthikeyan, S., Jain, S. K., Nayar M. P. and Sanjappa, M. 1989 (ed.) Fl. Ind. Enumer. Monocot. Pune.

Karthikeryan, S. and Mudgal, V. 1995. *Jati vividhata* (Hindi) In: Mudgal V. and P.K. Hajra (ed.) Bharat ki Vanaspatic vividhta, 301-318. BSI, Calcutta.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 208 -211, 1999

Endemic, rare, endangered and threatened medicinal plants of Peechi forests in Kerala

N. MINI RAJ* & E. V. NYBE

College of Horticulture
Vellanikkara, Trissur – 680 654, Kerala.

Abstract

Floristic survey was conducted to assess the medicinal plant wealth of Peechi hills in Central Kerala and to assess their threat status. Due to many reasons there has been drastic reduction in the native population of many of the important medicinal plants. Twenty-two plants spread over 18 plant families were found to be endemic to Western Ghats. There were altogether 25 rare, endangered or threatened (R E T) species distributed over 21 plant families out of which 10 were endangered, six rare and nine threatened with respect to Peechi hills. Each of these species has got its own specific reason for the particular threat status. However, the major reasons are over exploitation/extraction, destructive harvesting and other anthropoginic problems leading to habitat destruction. There is an urgent need for exercising some regulation in the collection of medicinal plants from this area.

Introduction

Peechi forests possess a vast treasure of medicinal plants. A major share of the crude drugs reaching Thrissur market in central Kerala come from this area. 'Malayans' who are the tribal inhabitants of the area earn their livelihood mainly by extracting and selling the medicinal herbs and other minor forest produce. Due to many reasons there has been drastic reduction in the native population of many of the important drugs. This paper deals with the

*Cardamom Research Station, Pampadumpara, Idukki – 685 556, Kerala.

results of a floristic survey conducted to assess the status of various medicinal plants in Peechi forests in Kerala.

Peechi hills in the Peechi-Vazhani wild life sanctuary formed the study area. Located in the Thrissur forest division, this area falls between the latitudes 10^0 25^9 and 10^0 35^0 N and longitudes 76^0 15^0 and 76^0 30^0 E. The natural vegetation comprises semi-evergreen (SEG) and moist deciduous forests (MDF).

The survey was conducted for two consecutive calendar years starting from September 1994 to September, '96. Exploration tracts were finalized with the help of tribal herb gatherers and frequent forest trips were conducted along with them to collect the plants. Herbaria were prepared and were later identified at the Kerala Forest Research Institute.

Various publications on endemic plants of Western Ghats were referred to (Nayar, 1997) and the list of endemic medicinal plants in Peechi hills prepared.

A regional assessment of rare, endangered and threatened (RET) species was made and the information is presented.

Enumeration

Twenty-two medicinal plants growing in Peechi hills are found endemic to Western Ghats. Details are given in Table 1.

Table 1. Endemic medicinal plants in Peechi hills

Botanical name	Family
Artocarpus hirsutus Lamk	Moraceae
Atalantia wightii Ten	Rutaceae
Barleria accuminata	Acanthaceae
B. courtallica Nees	Acanthaceae
B. prattensis Sant	Acanthaceae
Bambusa arundinaceae Wild	Poeceae
Bigonia canarana Mig.	Bigoniaceae
Croton malabaricus Bedd	Euphorbiaceae
Cinnamomum malabathrum (Burm.F.) Bercht & Presl.	Lauraceae
Cayratia pedata (Lam.) Juss Ex. Gagnep	Vitaceae
Dysoxylum malabaricum Bedd.Ex.Hier	Meliaceae
Elaeocarpus munronii (Wt.) Mast.	Elaeocarpaceae
Holigrana arnottiana Hook	Anacardiaceae
Ixora malabarica Gam	Rubiaceae
Lagerstroemla microarpa Wight	Lythraceae
Mucuna pruriens (L.) DC	Fabaceae

Contd..

Mussaenda galabrata Hutch.	Rubiaceae
Nilgirlanthus ciliatus (Bees.) Bermek	Acanthaceae
Polyalthis fragrans (Dals.) Bedd	Annonaceae
Phyllanthus kozhikodianus Sivar. Mani	Euphorbiaceae
Syzygium lactum (Ham.) Gandhi	Myrtaceae
Tabernaemontana heyneana Wall	Apocynaceae

These plants are distributed over 18 families. Major families include Acanthaceae (4) Euphorbiaceae (2) and Rubiceae (2). The genus *Barleria* has got three endemic species.

The endemic flora in Kerala is a palaeotropic one, a part of the peninsular Indian endemic flora of the Gondwana land region (Nayar, 1997). Reasons for the high percentage of endemism in Western Ghats have been reported to be due to a multiple of physical, climatoligical and geological changes that have occurred during the evolution of the flora as well as the peninsular Indian region (Sastry and Sharma, 1991). Habitats of endemic species are far more vulnerable than other species. Endemic species once lost is lost forever and hence these species need to be conserved on a priority basis.

There are altogether 25 RET species distributed in 21 families out of which 10 are endangered, six rare and nine threatened with respect to Peechi hills (Table 2). Each species has got its own specific reason for the particular status. However, a strict compartmentalisation of the cause is not possible as one kind may be triggering or leading to the other.

Table 2. Rare, endangered and threatened medicinal plants in Peechi hills

Botanical name	Family	Threat status
Asparagus racemosus Wild	Liliaceae	T
Acacia conicinna DC	Mimosaeae	T
Ademia hondala (Garthn) de Wilde	Passifloraceae	T
Bigonia canarana Miq.	Bigoniaceae	R
Canarium strictum Roxb.	Burseraceae	T
Cycas circinalis L	Cycadaceae	R
Cinnamomum malabatrum (burn L.)	Lauraceae	T
Coscinium fenestratum Colebr.	Menispermaceae	E
Ensete superbum Roxb.	Musaceae	T
Embetia tsjerlam-cottam A. Dc	Myrsinaceae	R

Contd..

Gloriosa superba L.	Liliaceae	E
Holostemma ada-kodien Schult.	Asclepiadceae	R
Ipomoea mauritiana Jacq.	Convolvulaceae	E
Momordica dioica Roxb	Cucurbitaceae	E
Myristica dactyloides Gaerth	Myristicaceae	T
Malaxis rheedii Sw.	Orchidaceae	R
Nervilia aragoana Gound	Orchidaceae	E
Phyllanthus emblica L.	Euphorbiaceae	R
Pseudarthria viscida (L) W&A	Fabaceae	T
Persea macrantha (Nees) Kostern	Launaceae	T
Rauvolfia serpentian (L) Benth. Ex. Kurz.	Apocynaceae	E
Saraca asoca (Rosb). De wilde	Fabaceae	E
Solanum surattense Burm. F	Solanaceae	E
Symplocos cochinchinensis (Lour)	Symplocaceae	E

R - Rare,E - Endangered,T - Threatened

Major reason behind the RET status is over exploitation/extraction in the case of *Rauvolfia, Holostemma, Saraca, Thrichosanthes, Asparagus, Coscinium, Nervilia, Adenia, Pseudarthria* and *Symplocos* and destructive harvesting in the case of *Emblica, Canarium* and *Acacia concinna.*

Among these species, except *Coscinium*, which is found in the semi evergreen forests, all others are found in the moist deciduous forests. Most deciduous forests in this region are subjected to all sorts of perturbations. Apart from the climatic changes, anthropogenic problems like entry of non-tribals for drug extraction, recurrent forests fires, cattle grazing, charcoal making, illicit cutting of wood for props, spread of alien weeds etc. have leed to clearance of the forest, disturbing the natural habitat of many species. This, coupled with the over collection of the survivors contributes to the maity of may these valuable species.

References

Nayar, M. P. 1997. Biodiversity challenges in Kerala and science of conservation biology. In: Biodiversity and Tropical Forests. The Kerala Scenario. Pushpangadan, P & Nair, K. S. S. (eds.) STEC. Kerala, p. 212.

Sastry, A. R. K and Sharma, B. D. 1991. The significance of the Western Ghats in plant conservation. Proc. Symp. Conservation Strategy of Rare, Endangered and Endemic Plants of Western Ghats, Kerala Forest Department, pp.115-119.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 212 - 215, 1999

Ecology of the medicinal flora of Tiger Falls in Tamil Nadu

V. JAYABARATHI

Sri Parasakthi College
Courtallam - 627 802, Tamil Nadu.

Abstract

A study on the distribution pattern of medicinal plants among natural habitats at Tiger falls of Courtallam was carried out. The vegetation was studied by random sampling through quadrat and transect methods. The medicinal plants were enumerated. The population of medicinal plants was found to be gradually reducing due to climatic factors and invasion of exotic weeds.

Introduction

India has rich medicinal plant diversity. These medicinal plants form the source for ever increasing pharmaceutical, cosmetics and biotechnology industry. To strengthen the medicianl plants resource base in India in the context of primary health care, a bilateral aided Indo-Daniesh project was launched in 1993, and the research aspects were entrusted with the Foundation for Revitalization of Local Health Traditions (FRLHT), a non governmental organization, which was in co-ordiantion with the State Forest Departments of Karnataka, Kerala and Tamil Nadu. Twenty sites in different forest/vegetation were selected to demonstrate conservation strategy and also to conserve the maximum floral diversity. These sites are named as Medicinal Plants Conservation Areas (MPCAs). Courtallam Hills occupy the third place in MPCAs.

Environment

Courtallam situated in the Western Ghats lye in the northern half of Tirunelveli District. Towards the west, Courtallam borders with Kerala State, in the North with Virudhunagar District and in the East and South with the Tirunelveli District of Tamil Nadu.

The objective of the medicinal flora survey was to assess the current status of medicinal plants of Courtallam Hills; to understand the interaction among the abiotic world, plants, animals and human beings; to venture into the possibility of conserving *ex situ* of critically endangered/endangered/vulnerable species and to create nurseries in the MPCAs for the species chosen, based on the population census of stock material and considering the climatic and edaphic factors.

Climatology

The average temperature of the area is 91^0 F – 100^0 F during March – May. The lowest temperature is felt during January and September. The high winds during hot season with their dessicating effect of the vegetation that grows on the hill tops gives no chance at all for plant growth and are responsible to certain extent for the appearance of barren hilltops. Rainfalls of Courtallam range from 70" to 80". The rainfall is not evenly distributed throughout the year. During June to September and October to December the hills get the maximum rainfall from the South-West monsoon and North-East monsoon, respectively. The hill chiefly consists of granitoid or gnesic stones studded with numerous small pink garnets of inferior type. Patches of coarse conglomerate containing a high percentage of lime stone are seen. In the plains an admixture of quartizite are seen where the soil is reddish.

Of the 147 plant species in the Tiger falls area, 77 species representing 52.38% are medicinal plants showing richness in medicinal plant wealth. They are listed below on the basis of morphological classification.

Polypetalae	Family
Azadirachta indica	Meliaceae
Aegle marmelos Corr.	Rutaceae
Alangium salvifolium Wang	Alangiaceae
Corchorus aestuans L.	Sterculiaceae
Cassia tora L.	Fabaceae
C. auriculata L.	"
C. occidentalis L.	"
C. angustifolia Vahl.	"
C. fistula L.	"
Cleome viscosa L.	Capparidaceae
Crataeva religiosa Forst	"
Calophyllum inophyllum	Guttiferae
Cissus quadrangularis L.	Vitaceae
Cardiospermum halicacabum, L.	Sapindaceae
Coccinia indica L.	Cucurbitaceae

Contd...

Centella asiatica L.	Umbelliferae
Cissampelosparica L.	Menispermaceae
Dodonea viscosa L.	Sapindaceae
Elaeodendron glaucum Pers.	Celastraceae
Eugenia caryophyllata L.	Myrtaceae
Garcinia mangostana L.	Guttiferae
Grewia optiva Drumm. Ex. Burret	Tiliaceae
Lawsonia inermis L.	Lythraceae
Mucuna prurita Hork	Fabaceae
M. hisuta W & A	"
Mucurna pudica L.	Minosae
Mollugo cerviana Scr.	Aizoaceas
Mollugo pentaphylla L.	"
Pongamia glabra Vent.	Fabaceae
Polygala chinensis, L.	Polygalaceae
Sida cordata (Burn.f) Borssum	Malvaceae
S. rhombifolia L.	"
Syzygium jambolanum DC	Myrtaceae
Tiliacora acuminata (Lam) Hook.f.& Thoms.	Menispermaceae
Tinospora cordifolia Miers	"
Tephrosia purpurea Pers.	Fabaceae
Terminalia paniculata Roth	Combretaceae
T. arjuna W & A	"
Trianthema portulacastrum, L.	Aizoaceas
Waltheria indica	Sterculiaceae
Gamopetalae	**Family**
Alstonia scholaris R.Br.	Apocynaceae
Andrographis paniculata Nees	Acanthaceae
Anisomeles malabarica R.Br.	Verbenaceae
Bassia latifolia, Roxb.	Sapotaceae
Calotropis procera R.Br.	Asclepiadaceae
Elephantopus scaber L.	Asteraceae
Eclipta alba Hassk	"
Evolvulus alsinoides L.	Convolvulaceae
Gymnema sylvestre R. Br.	Asclepiadaceae

Contd...

Gmelina asiatica L.	Verbenaceae
Hydrophilla spinosa R. Br.	Acanthaceae
Lippia nodiflora Mich.	Verbenaceae
Leucas aspera Spreng	Verbenaceae
Morinda. tinctoria Roxb	Rubiaceae
Notonia grandiflora DC	Asteraceae
Oldenlandia umbellata L.	Rubiaceae
Plumbago zeylanica L.	Asteraceae
Pedalium murex L.	Pedaliaceae
Strychnos nux-vomica L.	Loganiaceae
S. potatorum L.	"
Solanum nigrum L.	Solanaceae
Scoparia dulcis L.	Scrophulariaceae
Tridax procumbens L.	Asteraceae
Tylophora indica W & A	Asclepidaceae
Vitex nigundo L.	Verbenaceae
Monochlamydeae	**Family**
Achyranthes aspera L.	Amaranthaceae
Aristolochia indica, L.	Aristolochiaceae
Acalypha indica L.	Euphorbiaceae
Boerhaavia diffusa L.	Nyctaginaceae
Cymbopogon citratus Stapf	Poaceae
Cyndon dactylo Pers	"
Euphorbia hirta L.	Euphorbiaceae
Emblica officinalis Gaertn.	"
Jatropha gossypifolia L.	"
Mallotus philippinensis Muell	"
Phyllanthus amarus L.	"

The outskirts around Tiger falls harbours the South Indian dry deciduous forest. The manifold differences manifested in the habitats of the area have given rise to a correspondingly diverse vegetation. There are good numbers of medicinal plants, which are seen distributed amidst other vegetation. But the number of each species is reducing year after year due to reduced rainfall, felling of trees and the disturbance caused by human being. Vegetation is removed and the land around Tiger falls area are getting converted into building sites at present.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 216 -218, 1999

Flora of Deviar beat of Rajapalayam town of Tamil Nadu with special emphasis on medicinal plants

A. THANGARAJ, M. RAPHAEL AROKIARAJ, & V. GANESAN

Ayya Nadar Janaki Ammal College
Sivakasi – 626 125, Tamil Nadu.

Abstract

Deviar beats in the eastern slopes of Western Ghats (Virudhunagar District of Tamil Nadu), chosen for the present study covers an area of 1564.84 ha. Intensive botanical exploration trips were undertaken from October '95 to February '96, for collection of data, relating to the habit, habitat and association of plants with other plants. An endangered species *Eugenia discifera*, an endemic taxon *Vernonia travancoria* and root parasitic achlorophyllous herb *Aeginetina indica* were recorded during the survey.

Introduction

The present paper on the flora of Deviar beat in Seithur reserved forest is the outcome of an intensive study of this region during 1995-1996. The Deviar beat lies on the eastern slope of Western Ghats, in Virudhunagar District. It is situated 25 kms, away from south west of Rajapalayam township. This area falls between 9^0 16^0 - 19^0 19^1 N and 77^0 21^0 E. This area with steep mountains and valleys has an altitude varying from 200 – 1450 M MSL. In the vast areas of foothills on the northern side, teak plantation was raised by the Forest Department of Tamil Nadu. During the year 1995 and 1996, the authors made different seasonal visits to these forest areas and collected species of flowering plants. The specimens were deposited in the Plant Herbarium, Ayya Nadar Janaki Ammal College, Sivakasi. The plants were identified with the help of Flora of the Presidency of Madras (Gamble 1940 and Gamble and Fischer 1940), Flora of Tamil Nadu Carnatic (Mathew 1991). The identified plants were confirmed with the herbarium of Botanical Survey of India (Southern circle), Coimbatore.

In general this mountain tract has the same features of geology as that of adjoining Western Ghats. It is composed of crystalline and metamorphic rock of Archaeon age mainly gneissic variation. In places where there is a dense forest canopy, the soil is the result of disintegration of gneiss. The humus content of the soil is very high in the evergreen regions when compared to the deciduous area. Along the streams and river bank, loamy alluvial deposition also occurs.

In this hilly region temperature varies according to the elevation and it ranges from 12 to 32^{0}C. The warmest months are from March to May. As this area is situated near Kerala, during June to September, it receives copious rainfall from the south west monsoon. The north west monsoon also brings rain during October – November. The average rainfall of 35 cm (during the period under review) was recorded in Deviar estate, an area which falls under this Deviar beat.

Vegetation

The vegetation of Deviar beat varies in many characters from place to place throughout the extensive region which consists of steep mountain ranges, fertile valleys, rivers and streams. The differences in altitude, climate, rainfall, the prevalence of wind of varying nature and other geological variation results in the diversity of the vegetation pattern in this region. The vegetation of this region consists of scrubs, deciduous forest interspersed by open grasslands, as well as semi evergreen and evergreen forest types. The scrub jungle which extends to a height upto 200 M is composed mainly of the thorny shrubs and climbers. The characteristic features of this vegetation is dominated by the population of the following species, *Barleriá acuminata, Lantana camera, Crossandra infundibuliforms, Glycosmis mauritiana, Cardiospermum halicacabum, Cansjera rheedi, Clitoria terneta, Helicteres isora, Cissamppelos pareira, Zizyphus maurtiana, Abrus precatorius, Waltheria indica, Spermacoce hispida* etc.

The deciduous and grassland region lies between 200-800 M MSL. The vegetation is characterized by the following species. *Anogeissus latifolia, Cassia fistula, Murraya paniculata, Emblica officinals, Macaranga indica, Mallotus philippenis, Cipadessa baccifera, Mimusops elangi, Albizia lebbeck, Jasminum auriculatum, Lawsonia inermis, Polygala arillata, Plumbago zeylanica, Chromolaena odorata, Scutellaria violacea* etc. The open glasslands however show dominant population of *Setaria verticillata, Eragrostis bifaria, Apluda mutica, Cyperus iria, C. compressus, Panicum notatum, Bulbostylis barata* etc.

The semi evergreen forest appears at the height of 800 to 1400 M. The trees here are larger in size with thick undergrowth of shrubs, herbs and climber. The evergreen forests are mainly covered by the private estates and cultivated cardamom. The flora of this region mainly consists of the following species. *Pavetta indica, Artocarpus heterophyllus, Aganosma cymosum, Elytraria acaulis, Triumfetta* *rhomboidea, Biophytum sensitirum, Asclepias currasavica, Begonia malabarica* etc.

The ever green type above 1,300 M. includes huge trees like *Artocarpus heterophyllus, Gordonia optusa, Syzyium cumini, Pavetta indica, Mappia foetida, Terminalia arjuna* and an undergrowth consists of *Centella asiatica, Haracleum rigents, Knoxia sumatrensis, Strobilanthus wightianus, Barleria gibsoni* etc.

Lower level vegetation is composed of the following plants. *Euphorbia hirta, Abutilon indicum, Achyranthes aspera, Boerhaavia diffusa, Cleome aspera, Eleusine indica, Indigofera linnae, Leucas aspera, Mollugo pentaphylla, Ocimum cannum, Oldenlandia umbellata, sida acuta, Orthosiphon glabratus* etc.

The orchid flora of this forest range consists of terrestrial orchids like *Habenaria plantaginea, Anoectochilus elatus* and epiphytic like *Eria pauciflora, Vanda tessellata.* During exploration an endangered species *Eugenia dscifera*, (Nair and Srinivasan 1980). *Vernonia travancoria* and root parasitic achlorophyllous herb *Aegintina indica* were found.

Important medicinal plants of Deviar beat are *Abrus precatorious* L. (Faboideae), *Achyranthes bidentata* Blume (Amaranthaceae), *Ammannia baccifera* L. (Lythraceae), *Aristolochia tagalacham* (Aristolochiaceae), *Asclepias curassavica* L. (Asclepiadaceae), *Begonia malabarica* L. (Begoniaceae), *Begonia picta* Sm. (Begoniaceae), *Centella asiatica* Urban (Apiaceae), *Clitoria ternata* L. (Faboideae), *Curculigo orchiodes* Gaertn (Amarillydaceae), *Diddymocarpus tomentosa* Wt. (Gesneriaceae), *Drynariacordata* Sp. Roemer *ex Schulter* (Caryophyllaceae), *Gloriosa superba* L. (Liliaceae), *Gordonia obtusa* Wall. (Theaceae), *Elytraria acaulis* Lindau. (Acanthaceae), *Macaranga indica* Wt. (Euphorbiaceae), *Ocimum basilicum* L. (Lamiaceae), *Operculia turpethum* Silva Mans (Convolvulaceae), *Oxalis corniculata* L. (Oxalidaceae), *Rauvolfia serpentina* Benth ex kurz (Apocynaceae), *Sida acuta* Burm f. (Malavaceae) and *Toddalia asiatica* L. (Rutaceae)

Acknowledgment

We kindly acknowledge Dr. Vivekananthan and Dr. Uma Maheswari of BSI (SC), Coimbatore for helping us in the identification of specimens.

References

Gamble, S. G. 1941. The Flora of Presidency of Madras. vol I, I & 2 Adlard and Son Ltd, London.

Gamble, G. S. and Fischer, C. 1948. The Flora of Presidency of Madras Vol III. Adlard and Son Ltd., London.

Mathew, K. M. 1991. The Flora of Tamil Nadu Carnatic Vol. I, II & III. Rabiner Herbarium, St. Joseph's College, Trichy.

Nair, N. C. and Srinivasan, S. R. 1980. Rediscovery of *Eugenia discifera* Gamble (Myrtaceae) and its lactolypification. Bull. Bot. Surv. Ind. 22 : 232-233.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 219 -228, 1999

Diversity and collection of germplasm of spices, medicinal, aromatic and dye yielding plants from Andhra Pradesh, South India

S. R. PANDRAVADA & N. SIVARAJ

National Bureau of Plant Genetic Resources, Regional Station, Hyderabad - 500 030, Andhra Pradesh.

Abstract

Significant endemic diversity in native land races of many cultivated plants and traditional cultivars occur in Andhra Pradesh especially in the tribal hill tracts of Eastern Ghats in the coastal areas and in the Telangana region. The crops of importance in spices include chillies, turmeric, ginger, coriander, onion and garlic. Still, there are pockets under the influence of local cultivars because of their adaptability, stability of yield and for tolerance/ resistance to several biotic/abiotic stresses. In medicinal, aromatic and dye yielding plants also, rich variability exists and some species are endemic/ occur in greater population in this part of the country. Since the establishment of the NBPGR Regional Station, efforts were made to survey and collect the germplasm and a total of 1,310 accessions of germplasm of spices, medicinal, aromatic and dye yielding plants were collected during seven crop specific and other surveys undertaken in this part of the country. A total of 720 accessions of germplasm were shared with the collaborating institutes.

Introduciton

Significant endemic diversity exists in spices and medicinal plants in all the important states/regions of the country. Considerable native variability occurs in Andhra Pradesh in the Coastal, Telangana and Rayalseema regions especially in chillies, turmeric, ginger, coriander, onion and garlic. Due to several biotic/abiotic interferences there is a threat to the native land race diversity and related wild species. In medicinal plants and allied species, also rich variability occurs and some species are endemic/occur in greater population in this part of the country. About 700 species of medicinal importance are recorded in this region.

Since the establishment of National Bureau of Plant Genetic Resources, (NBPGR) Regional Station at Hyderabad, seven crop specific surveys were undertaken for the collection of spices, medicinal, aromatic and dye yielding plant germplasm. The areas, districts surveyed, the collaborating institutes involved, the number of collections made are given in Table 1. A total of 1,310 accessions of germplasm (ginger-31, turmeric-37, chillies-636, garlic-13, onion-49, coriander - 113, fennel-2, *Piper* Spp.-8, *Curcuma* Spp-10, *Capsicum frutescens*-11 and 400 medicinal, aromatic and dye yielding plants had been collected during the surveys undertaken in Andhra Pradesh. This paper describes the surveys undertaken, the diversity collected and the potential of the material for utilization. The crop wise variability encountered and promising accessions collected during the surveys are given below:

Table 1. Surveys undertaken for the collection of spices and medicinal plants germplasm from Andhra Pradesh.

Year	Crop	Coll. Instt.	Districts surveyed	No. of accs.
1993	Coriander	ANGRAU	Prakasam, Kurnool, Cuddapah, Anantapur	110
1993	Chillies	IIHR	Warangal, Khammam	95
1994	Spices	IISR	Visakhapatnam	93
1995	Chillies	IIHR	Srikakulam, Vizianagaram, Visakhapatnam, East Godavari, AP & West Godavari Bastar of MP & Koraput of Orissa.	177
1997	Chillies	IIHR	Prakasam, Nellore, Chittoor	98
1997	Medicinal plants	CRIDA	Visakhapatnam	182
1998	Chillies	IIHR	Nalgonda, Kurnool, Anantapur, Cuddapah, Mahaboobnagar	72

Ginger

Ginger is an important and oldest spice crop of India. About 40% of the dry ginger of the world is produced in India. The important districts in which ginger is grown are Visakhapatnam, Medak and East Godavari and significant variability exists in this crop. Cultivars grown are as follows.

Coastal areas

Visakhapatnam : Araku, Bhyri, Narsapatnam, Pandimallelu, Rellakommalu

East Godavari : Tuni

Telangana

Medak : Siddipeta

Four species of *Zingiber* are reported from Andhra Pradesh (Pullaiah, 1997) *Zingiber capitatum* (Mahaboobnagar, Visakhapatnam and Warangal), *Z. purpureum* (*Syn. Z. cassumunar*) (East Godavari), *Z. roseum* (East Godavari and Visakhapatnam) and *Z. wightianum* (East Godavari and Visakhapatnam).

A total of 32 accessions of germplasm had been collected mainly from Visakhapatnam district during a collaborative survey with Indian Institute of Spices Research (IISR) in December, 1994. Variability was mainly observed for days to maturity, rhizome shape, rhizome size (small/medium/big), no. of fingers/ branches (primary/secondary/tertiary), surface colour (brownish-orange/ shining brownish yellow/ brownish-saffron/ light brownish - red/ dull brown), inside colour (light greenish-yellow, dark greenish-yellow, different shades of saffron-red, dark orange-red), aroma, yield and resistance/ tolerance to different biotic/abiotic stresses.

Promising accessions based on phenotype and yield attributing characters collected are given in Table 2.

Table 2. Promising accessions of ginger germplasm collected from Andhra Pradesh

Character	Accession no.
Big/long rhizomes	SJ-4053, SJ-4062, SJ-4083
Tertiary branching	SJ-4035, SJ-4104
Fibrous	SJ-4035, SJ-4060, SJ-4095 SJ-4098, SJ-4104
Less pungent	SJ-4035
More pungent	SJ-4060, SJ- 4095, SJ-4104
Yield	SJ- 4021, SJ-4035, SJ-4060, SJ-4062, SJ-4080, SJ-4081, SJ-4083, SJ- 4084, SJ-4098, SJ-4098, SJ-4100, SJ-4120
Highy dry recovery	SJ –4081
Resistant to rhizome rot & diseases	SJ- 4083.

Turmeric

India leads in turmeric production in the world (Abdul Khader *et al.*, 1994). In India the important states which grow turmeric and important for genetic resources are Andhra Pradesh, Orissa, Tamil Nadu, Assam, Maharashtra etc. In acreage and production Andhra Pradesh stands first in the country.

Andhra Pradesh is endowed with a vast range of genetic wealth in having land races/traditional cultivars which are region specific (Anonymous, 1990). The districts where different forms are grown and important for germplasm diversity are Karimnagar, Nizamabad, Guntur, Cuddapah, Visakhapatnam, Vizianagaram and East Godavari. (Rao and Rao, 1994).

A total of 37 germplasm accessions of turmeric, four accessions of *C. angustifolia* and six accessions of other *Curcuma* Spp. were collected during a collaborative survey undertaken in December, 1994 with IISR and during other surveys.

Variability was observed in traits such as days to maturity, rhizome shape (slender/thick/long/short), rhizome surface (smooth/scaly), surface colour (brownish-orange/shining brownish-yellow/ brownish - saffron/ light brownish-red), inner core colour (different shades of yellow, cadmium/ light yellow/ bright yellow/ orange-red), aroma, yield and resistance/tolerance to different biotic/abiotic stresses. Promising accessions based on phenotype and yield attributing characters collected by NBPGR are given in Table 3.

Table 3. Promising accessions of turmeric germplasm collected from Andhra Pradesh

Character	Accession no.
Good aroma	SJ-4006, SJ-4019, SJ-4033, SJ-4061, SJ-4074, SJ 4082, SJ-4091, SJ-4094, SJ-4099, SJ-4103
Big/long rhizomes	SJ—4012, SJ- 4026, SJ-4058, SJ-4068, SJ-4085
Secondary fingers	SJ-4015, SJ-4025, SJ-4026, SJ-4051, SJ-4061, SJ 4076, SJ-4078, SJ-4116
Good yield	SJ-4006, SJ-4026, SJ-4033, SJ-4040, SJ-4051, SJ 4058, SJ-4061, SJ-4068, SJ-4074, SJ-4082, SJ 4085, SJ-4099
Inside colour: Dark organge	SJ-4040, SJ-4061, SJ-4074, SJ-4082, SJ- 4085, SJ 4091, SJ- 4094
Dark yellow	SJ- 4103

Coriander

Though coriander is an introduced crop from Mediterranean region, because of its long history of continuous domestication and selection, considerable indigenous variability got accumulated. NBPGR Regional Station in collaboration with All India Coordinated Research Improvement Programme on Spices (AICRPS) centre, located at Lam, Guntur had undertaken a survey in 1993 and collected about 110 Accs. from Prakasam, Kurnool, Cuddapah and Anantapur districts.

In coriander, variability was observed mainly in vegetative characters like plant height, shape of primary and secondary branches (2-8), days to maturity (150-180 days), aroma, fruit size and yield (2-5q/ha.) Land races with more bushy and branching habit, good aroma and promising for their yield potential occurred in Kurnool and Anantapur districts.

The promising accessions in coriander germplasm collected from Andhra Pradesh are listed in Table 4.

Table 4. Promising accessions of coriander germplasm collected from Andhra Pradesh

Character	Accession No.
Good branching	NIC-18184, NIC-18235, NIC-18255, NIC-18257, NIC-18258, NIC-18262, NIC-18287
Highly aromatic	NIC-18232, NIC-18242
Big/bold seed	NIC-18185, NIC-18242, NIC-18246
Very attractive seed type	NIC-18286
Yield attributing characters	NIC-18184, NIC-18229, NIC-18232, NIC-18233, NIC-18260, NIC-18288
Ideal plant type	NIC-18288
Tolerant/resistant to wilt	NIC-18202
Tolerant/resistant to moisture stress/drought	NIC-18217, NIC-18208

Chillies

Andhra Pradesh is one of the important states of chilli cultivation with regards to acreage, production and the diversity of the cultivars grown. Chillies were introduced into the sub-continent from the tropical South America in the 17th century by the Portuguese. Long history of cultivation and adaptability to different environments led to diversity of forms with respect to growth habit, size, colour, shape, flavour and pungency.

In order to collect and conserve the available endemic genetic diversity in chillies, efforts were made to undertake four crop specific collaborative surveys with Indian

Institute of Horticultural Research (IIHR), in Andhra Pradesh and adjoining areas which have some tribal pockets and where some land races are still under cultivation, for the collection of the germplasm. The land races collected in chilli germplasm from different districts of Andhra Pradesh are given below.

Srikakulam: Pachcha Mirapa, Kurakulakaya, Rytuvari Mirapa, Pondari Mirapa, Podaga kaya, Pedda mirapa, Kurakulakaya

Vizianagaram: Karavakala mirchi, Deshavali, Podugu mirapa, Potti mirapa, Chinnakaya, Kurakula mirapa

Visakhapatnam: Peddamirapa, Sannakaya, Kurakulakaya, Pachcha mirapa, Pandukaya, Bondu mirapa.

Guntur: Bajjikaya, Byadige, Devannur Dabba, Saripudi, Sirigiripadu

Prakasam: Saripudi, Byadige, Byadige kaddi, Devanuru Dabba, Mannepudi, Maddalakatta

Nellore: Natu Rakam, Guntur Sannam, Pottikaya, Seemamirapa

Warangal: Patti mirapa, Warangalkaya, Bharachalam mirapa, Doddukaya, Nallakaya, Gutti mirapa, Vejedu mirapa, Sannakaya, Guttikaya, Chandura , Buddakaya.

Khammam: Boora mirapa, Tigamalle, Doddukaya

Nalgonda: Warangalkaya, Pachchamirapa

Mahaboobnagar: Devanur Dabba, Byadige, Pachcha mirapa

Chittoor: Natu, Mundu, Doddukaha, Buddakaya

Kurnool: Devanur Dabba, Byadige, Ballapuramkaya

Anantapur: Byadige, Ballapuramkaya

Cuddapah: Buddakaya, Laavukaya, Bajjikaya

Significant diversity was observed in plant height (short, mediuml, tall), degree of plant spread, fruit colour (shades of red, orange and yellow), bearing (single / clusters erect/pendent), shape and size (small round cherry type, small oblong stout, small conical stout, small slender, medium long slender, medium long thick/stout, medium long cylindrical, long slender, extra long thick/stout broad at base and tapering with blund tip paprika types). The promising accessions collected for different characters are given in Table 5.

Medicinal plants

In medicinal, aromatic and dye yielding plants, some species are endemic and occur in greater population in this part of the country. The occurrence of about 450 medicinal plants in and around the Chittoor district, Andhra Pradesh had been documented by Vedavathy *et al.*, 1997 and many other medicinal plant species from different parts of the state are described by various workers, Hemadri *et al.*, 1987a; 1987b; Sudhakar and Rao 1985; Venkaiah, 1980. Since the establishment of the NBPGR Regional Station, efforts were made to survey and collect the germplasm of medicinal plants.

A total of 400 accessions of medicinal, aromatic and dye yielding plants are collected by this station so far. About 104 spe-

Table 5. Promising accessions of chilli germplasm collected from Andhra Pradesh

Character	Accession no.
Early flowering	IC- 208586, Indian Council of Agricultural Research-208595, IC-208592, Indian Council of Agricultural Research-208587, IC-208588, IC- 208595, Indian Council of Agricultural Research-208598, IC-208600, Indian Council of Agricultural Research-20860
Erect bearing	NIC-19957, NIC-23760, NIC-23769
Cluster bearing	NIC-19958, NIC-19959, NIC-19972, NIC-19984, NIC-19987, NIC-19991
Purple mutants	NIC-19977, NIC-23870, NIC-23905, NIC-23927, IC-208552
Yellow anther mutants	IC- 208555, IC-208556
Destalking fruit types	IC-20006, IC-208535, IC-208567, IC-208571, IC-208572, IC-208575, IC-208577
Highly pungent	NIC-23782, NIC-23882
Paprikas (Warangal type)	NIC-19936, NIC-19943, NIC-19951, NIC-19952, NIC-19953, NIC-19962, NIC-19963, NIC-19966, NIC-19967, NIC-19968, NIC-19969, NIC-19971, NIC-19976, NIC-19978, NIC-19979, NIC-19980, NIC-19981, NIC-19997, NIC-19998, NIC-19999, NIC-20000, NIC-23771, NIC-23778, NIC-23913, IC-208559, IC-208573, IC-214942, IC-214943, IC-214944, IC-214949, IC-214957, IC-214959, IC-214976.
Paprikas (Byadagi type)	IC-208534, IC-214965, IC-214966, IC-214967, IC-214968, IC-214976, IC-214977, Indian Council of Agricultural Research- 214985, IC- 214987, IC-214988, IC-215011, IC-215012, Indian Council of Agricultural Research-215013.
Yellow chillies	NIC-20004, NIC-23829, NIC-23840, NIC-23847, NIC-23885, NIC-23906, NIC-23911, NIC-23914, NIC-23923, IC-208518, IC-214947, IC-214948, IC-214979.
Green chillies	NIC-23889, IC-208558, IC-208566, IC-208570, IC-214962, IC-215008, IC-215009
Good yield	NIC-19996, NIC-23920, NIC-23925, NIC-23926, NIC-23919, NIC-23924, IC-208524, IC-208534, IC-208535, IC - 208558

cies belonging to 86 genera of 49 families were collected during the 39 surveys conducted in this region. Some of the species collected were *Abrus precatorius, Acorus calamus, Adhatoda vasica, Aegle marmelos, Alpinia galanga, Andrographis paniculata, Argyreia nervosa, Aristalochia indica, Asparagus racemosus, Calycopteris floribunda, Cannabis* Spp., *Catharanthus roseus, Centella asiatica, Cissampelos pareira, Clitoria ternatea, Cardiospermum halicacabum, Curculigo orchioides, Datura stramonium, Dioscorea Spp., Entada rheedii, Gloriosa superba, Gymnema sylvestre, Hemidesmus indicus, Holorrhina antidysenterica, Ionidium sufruticosum, Mimosa pudica, Mucuna pruriens, Passiflora sp., Pedalium murex, Phyllanthus amours, Piper longum, Plumbago zeylanica, Litsea glutinosa, Pterocarpus sp., Rauvolfia serpentina, Rauvolfia tetraphylla, Solanum incanum, Solanum indicum, Solanum nigrum, Solanum torvum, Sphaeranthes indicus, Stachytarpheta* spp., *Sterculia urens, Strychnos nux-vomica, Strychnos potatorum, Terminalia bellerica, Terminalia chebula, Tinospora cordifolia, Tylophora asmatica, Vandellia erecta, Withania somnifera, Woodfordia fruiticosa, Wrightia tinctoria, etc.*

Aromatic plants

Artemisia sp., Cymbopogon citratus, Eupatorium sp., Hyptis sp., Limonia acidisma, Murraya sp., Ocimum americanum, Ocimum sanctum, Santalum album, Vetiveria zizoinoides, Zanthoxylum alatum.

Dye yielding plants

Bixa orellana, Lawsonia inermis Mallotus philippensis,

Some of the genera collected under this category and their medicinal uses are given in Table 6.

Potential medicinal/ethno-botanical uses

The plants collected are useful in traditional/ethno-botanical remedies for a number of health problems.

The main ethnic groups encountered and from whom some ethno-botanical information is gathered are Bagata, Kondadora, Koraputia, Mugadora Nukadora etc. The vernacular names and uses vary from one tribal group to the other and from place to place. For some medicinal plants varied uses are reported, other than the traditional uses that a particular plant is well known for.

Some of the plants used in different health problems/diseases/situations are as follows. For cooling of the body system (*Asparagus racemosus*-orally; *Ricinus communis* perennial topical application); body swelling/boils/dropsy (*Costus specious, Dioscorea Spp.*); fevers (*Hemidesmus indicus, Rauvolfia serpentina*); fracture (*Litsea glutinosa*); hallucinations/ psycho-somatic problems (*Acorus calamus, Calycopteris floribunda, Sanseviera, Litsia glutinosa*); injuries/cuts/ wounds (*Eupatorium* sp., *Stachtarpheta* sp.); intestinal worms (*Curculigo orchioides, Costus speciosus*); joint pains (*Terminalia chebula*); stomachache (*Rauvolfia serpentina*); strength (*Terminalia chebula*); toothache/related

Table 6. Important/rare species of medicinal plants collected during surveys and their medicinal uses.

Name	Family	Plant parts used	Uses
Aristalochia indica	Aristalochiaceae	Root	Skin disease, fever, as aphrodisiac, snake bite
Acorus calamus	Araceae	Rhizome	Dysentery, diarrhoea, emetic, carminative, antibacterial
Clitoria ternatea	Fabaceae	Seed, root juice	Diuretic, nasal congestion, constipation.
Dioscorea Spp.	Dioscoreaceae	Tuber	Steroidal drugs, starch
Gloriosa superba	Liliaceae	Rhizome, seed	Gout, arthritis, carminative, skin diseases
Hemidesmus indicus	Asclepiadaceae	Root	Rheumatism, blood purifica-tion, coughs, diarrhoea, for cooling the system
Rauvolfia Spp.	Apocynaceae	Root	Fever, sedative, blood pressure, diseases of bowels
Tinospora cordifolia	Menispermaceae	Aerial part	Hyperacidity, jaundice
Gymnema sylvestre	Asclepiadaceae	Root, aerial parts	Malarial fever, jaundice, diabetes

dental problems (*Tephrosia sp.*, *Zanthoxylum alatum*); venomous bites/ stings (*Adhatoda vasica*); acidity/epilepsy/ nausea (*Passiflora* sp.) etc.

Many plants for which there is no specific use known to the tribal doctors are tried for curing hallucinations. The health problems/diseases which they did not come across generally are attributed to hallucinations/psychosomatic origins and treated accordingly. It was also observed that the tribal doctors use more than one plant for a particular health problem. The tribal doctors belonging to Kondadora tribal group in Maalivalasa Village of Anantagiri mandal in the Visakapatnam district gives a cocktail of powdered root/ bark of different plants in which *Rauvolfia serpentina* and *Piper longum* are invariably present.

Some of the potential uses of the medicinal plants collected from Andhra Pradesh were described by Hemadri *et al.*, (1987a; 1987b) and Vedavathy *et al.* (1997).

Germplasm exchanged

A total of 720 accessions of germplasm of spices, medicinal, aromatic and dye yielding plants were shared with the collaborating institutes. About 93 accs. of germplasm of ginger, turmeric, other spices and wild species were exchanged with IISR, Calicut. A total of 140 Accs. of coriander germplasm collected during a collaborative survey with Acharya N.G. Ranga Agricultural University (ANGRAU) were shared with them. A total 433 accs. of chilli germplasm collected during four collaborative surveys. were shared with IIHR. With regards to medicinal, aromatic and dye yielding plants about 84 Accs. of germplsm were shared with Central Research Institute for Dryland Agriculture (CRIDA).

Future course of action

Even though efforts were made to collect the germplasm in spices and medicinal plants, lot of areas remain to be surveyed in the tribal and other areas in the Coastal, Telangana and Rayalseema regions of Andhra Pradesh and needs to be collected in the near future for conservation of the diversity.

Acknowledgments

The authors are thankful to Dr. P.L Gautam, Director, Dr. D. M. Majumdar, Head, Div. of Plant Quarantine, NBPGR, New Delhi and Dr. K. S. Varaprasad, Officer - In- Charge, NBPGR, Regional Station, Hyderabad for constant encouragement and for providing the necessary facilities.

References

Abdul Khader. M. D., Peter, G. B., Vedamuthu and Balashanmugham 1994. Improvement of Turmeric. In: Advances in Horticulture Vol. 9 (1) : Plantation and Spice Crops (eds.) K. L. Chadha and P. Rethinam. Malhothra Publishing House, New Delhi, pp. 315-332.

Anonymous, 1960. Turmeric Description Record. Turmeric Research Station, Pedapalam, Agricultural University, Hyderabad.

Hemadri, K., Sarma, C. R. R. and Rao S. S. 1987a. Medicinal plant wealth of Andhra Pradesh, Part-I, Ancient Science of Life, 6 : 67-186.

Hemadri, K., Sarma. C. R. R. and Rao. S. S. 1987b. Medicinal plant wealth of Andhra Pradesh, Part II, Ancient Science of Life, 7 : 55-64.

Pullaiah, T. 1997. Flora of Andhra Pradesh. Vol. 3. Scientific Publishers, Jodhpur.

Rao Rama, M. and Rao, D. V. R. 1994. Genetic Resources of Turmeric. In: Advances in Horticulture Vol. 9 (1) Plantation and Spice Crops. K. L. Chadha and P. Rethinam (eds.) Malhotra Publishing House, New Delhi, pp. 131-149.

Sharma, R. K. 1994. Genetic Resources of Seed Spices. In: Advances in Horticulture Vol. 9 (1) Plantation and Spice Crops. K. L. Chadha and P. Rethinam (eds.) Malhotra Publishing House, New Delhi - 110 069, pp. 193-207.

Sudhakar, S and Rao, R. S 1985. Medicinal plants of upper East Godavari District (AP) and need for establishment of medicinal farm. J. Econ. Tax. Bot, 7 : 399-406.

Vedavathy, S., Mrudula, V. and Sudhakar, A. 1997. Tribal medicine of Chittoor District, A.P (India). Herbal Folklore Research Centre, Tirupati, India.

Venkaiah, M 1980. Studies on the vegetation and flora of Vizianagaram district. Ph. D. Thesis, Andhra University, Visakhapatnam.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants 229 -233, 1999

Anatomical variations in four species of *Ocimum*

LISYMOL J. VADUKKOOT & K. T. PRASANNAKUMARI

College of Horticulture
Vellanikkara
Trichur – 680 654, Kerala.

Abstract

A comparative study of the anatomical features of the four different species of *Ocimum* viz., *O. tenuiflorum, O. gratissimum, O. basilicum* and *O. canum* was carried out. Though there was uniformity in the fundamental structure of the stem, variations were observed in the density of trichomes, nature of cortical cells, nature of xylem vessels and size of pith. *O. canum* could be identified by the absence of pericycle and by the presence of xylem vessels which are circular in transverse section. *O. basillicum* could be identified by the presence of discontinuous patches of pericycle, xylem vessels which are circular in transverse section and presence of prominent pith. *O. canum and O. basilicum* are also characterized by the presence of prominent pith and pitted vessel elements. *O. gratissimum* could be identified by the presence of 5-6 layers of collenchyma in the corners of cortical region, presence of xylem vessels which are angular in transverse section and early extra stellar secondary thickening. *O. tenuiflorum* could be identified by the presence of 3-4 layers of collenchyma in the corners of stem. Study of leaf anatomy revealed that the leaves of *O. gratissimum* were hypostomatic and with fewer number of trichomes when compared to other species.

Introduction

Ocimum is an important genus, which includes several species yielding essential oil that is valued in medicine and perfumery. Oil of some like sweet basil has insecticidal properties also. The nomenclature of *Ocimum* is complicated and confused and hence eventhough different species yield essential oil, it is difficult to classify oil according to botanical nomenclature. Further the plants are collected by people who base their identification on a few characters only. In many cases samples are adulterated with plant organs of similar morphology. There is, at present, no scientific control at any stage of collection and it passes through so many hands that indiscriminate adulteration/substitution is possible.

The anatomical markers like trichomes, crystal, xylem vessels etc. along with morphological features will serve as ready reckoner for the correct identification of the species. These have also great relevance to our understanding of the phylogenetic trends and systematic relationship of different species of *Ocimum*.

Four different species of *Ocimum, viz., O. tenuiflorum, O. gratissimum, O. basilicum* and *O. canum* were selected for comparison of anatomical characters. Plants were raised in medium sized pots, filled with potting mixture in the Department of Plant Breeding and Genetics, College of Horticulture, Vellanikkara during 1994-95.

Stem anatomy

Free hand sections of the third internode of the first vegetative primary branch from each species were taken and made permanent following the procedure described by Prasad and Krishnaprasad (1970). The internodal segments were macerated in Jeffrey's fluid (Prasad and Krishnaprasad, 1970), slides were prepared and the features of xylem vessels were observed. For each species, observations were taken from ten different fields.

Leaf anatomy

The leaf anatomy was studied by taking transverse sections of the leaves in third node of first primary vegetative branch. Stomatal size and stomatal index (SI) were calculated by taking observations from epidermal peelings of the upper and lower surfaces of mature leaves with the help of 'Quickfix' (adhesive). Vein angle was measured with the help of camera lucida from ten mature cleared leaves. For clearing leaves, a quick method described by Payne (1979) was followed.

Stem anatomical features

Comparative study of the stem anatomy of the four species revealed that though there was uniformity in the fundamental structure, variations could be observed in the size of epidermal cells, density of trichomes, nature of cortical cells, nature of xylem vessels (Table 1), and size of pith. The anatomical evidences in the stem for identification of the four species can be summarized as follows:

O. canum

: absence of pericycle

: presence of xylem vessels which are circular in T.S.

: presence of pitted vessel elements

: presence of plenty of epidermal appendages

: presence of short hairs (2-3 celled)

O. basilicum

: presence of discontinuous patches of pericycle

: presence of xylem vessels which are circular inT.S

: presence of pitted vessel elements

: presence of prominent pith

: epidermal hairs are rarely seen

O. gratissimum

: presence of 5-6 layers of collenchyma in the corners of cortical region

: presence of xylem vessels which are angular in T.S

: early extra selar secondary thickening

: presence of a few number of short epidermal hairs

O. tenuiflorum

: presence of 3-4 layers of collenchyma in the corners of stem

: presence of xylem vessels which are angular in T.S.

: presence of plenty of epidermal appendages

: presence of long hairs (7 to many celled)

Anatomy of leaf

Irrespective of the species, three types of tissue systems *viz.*, epidermis, mesophyll and vascular tissue were present in leaves. In all the four species of *Ocimum*, epidermis was composed of a single layer of cells both on adaxial and abaxial surfaces. Trichomes were present on both surfaces, but more abundant along the leaf margins and in the region of veins on abaxial surface (Table 2). Mesophyll tissue was found to be bifacial or dorsiventral. Protoxylem was directed towards surface of leaf. Bundle sheath was absent in all the four species.

Among the four species, trichomes were fewer in the leaves of *O. gratissimum*. It had hypostomatic leaves (Table 3) and a prominent collenchymatous layer near the veins. In all other species leaves were amphistomatic with higher stomatal index on lower leaf surface. Stomatal index was the highest in *O. gratissimum*

Vein angle

Vein angle did not have much significance in the identification of various species in the genus *Ocimum* (Table 4).

Table 1. Percentage of different types of xylem vessel elements in four species of *Ocimum*

Species	Proportion of xylem vessel elements					
	Annular	Helical	Spiral	Scalarifor	Reticulate	Pitted
O. tenuiflorum	8.4	36.8	52.7	1.5	0.6	0
O. gratissimum	7.6	31.3	58.5	1.1	0.9	0.6
O. basilicum	5.9	36.0	52.1	1.7	3.1	1.2
O. canum	6.6	37.5	51.4	1.1	2.4	1.2

Table 2. Type and distribution of trichomes in different species of *Ocimum*

Species	Trichomes
O. tenuiflorum	2-3 celled medium sized trichomes all over the surface, slightly less on upper surface, more abundant on the veins and along the margins of the leaf
O. gratissimum	Trichomes are less in number, but large in size, distributed all over the surfaces, plenty along the margins
O. basilicum	Minute trichomes, mainly on veins, on both surfaces
O. canum	A large number of long trichomes on both surfaces of the leaf

Table 3. Stomatal size and stomatal index in different species of *Ocimum*

Species	Stomatal size (μm) L x B	Stomatal Index	
		Upper surface	Lower surface
O. tenuiflorum	22.5±2.2 x 18.3±2.2	132	199
O. gratissimum	29.2±1.9 x 20.8±1.9	2	251
O. basilicum	33.3±2.8 x 21.7±5.5	128	132
O. canum	30.4±3.4 x 20.0±1.8	101	132

Table 4. Range of vein angle in different species of *Ocimum*

Species	Range of vein angle
O. teniflorum	55^0 - 72^0
O. gratissimum	30^0 - 82^0
O. basilicum	40^0 - 43^0
O. canum	30^0 - 42^0

Acknowledgement

This paper forms part of the M Sc (Ag) thesis of the senior author submitted to the Kerala Agricultural University, 1996. The facilities provided by KAU for the smooth conduct of the research work and Junior Research Fellowship awarded to the senior author by ICAR are gratefully acknowledged.

References

Payne, W. W. 1969. A quick method for clearing leaves, Ward's Bull. 8 (61) : 4-5.

Prasad, M. K. and Krishnaprasad, M. 1970. *Outlines of Microtechnique.* Emkay Publications, New Delhi.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 234 -236, 1999

Genetic variability in palmarosa (*Cymbopogon martini* var. *motia*)

O. P. SINGH, T. P. SINGH, A. L. YADAV, C. M. OJHA, J. PRASAD & P. N. YADAV

Department of Horticulture
Narendra Dev University of Agriculture & Technology
Faizabad - 224 229, Uttar Pradesh.

Abstract

Six genotypes of palmarosa (*Cymbopogon martini* var. *motia*) were studied for their genetic variability. High heritability (broad sense) coupled with high genetic advance were recorded for number of tillers/hill, oil yield and fresh weight. The values of phenotypic coefficient of variation were higher than corresponding genotypic coefficient of variation.

Introduction

Palmarosa (*Cymbopogon martini* var. *motia*) (Gramineae) is an essential oil bearing plant growing wild in the forests of Madhya Pradesh, Maharashtra and Assam. It is also cultivated in some parts of Uttar Pradesh, Madhya Pradesh, Orissa and Kerala. The oil of palmarosa is base for fine perfumery. The geraniol is the major constituent of its oil.

Since it is widely available in the forest, it is expected that enough variability must be present in natural population. For initiating any selection program, the knowledge of variability is essential. Keeping this in view, the present study was undertaken.

Six genotypes of palmarosa (*Cymbopogon martini* var. *motia*), *viz*, IW-4501, CI-80-68, CI-80-41, IW-4478, IW-31245 and HR-92 were grown during July 1994, at Horticultural Research Station, Kumarganj, Faizabad. The experiment was conducted in randomised block design replicated thrice in a plot size of 4 x 2.35 m^2 with spacing 45 cm. between rows and 25 cm between plants. Normal cultural practices were followed. Two cuttings were performed in one year. The observations were recorded on plant height (cm) number of tillers/hill, panicle length (cm), fresh weight of herb (q/ha), oil per cent on fresh weight basis (FWB) and oil yield in (kg/ha). Oil content was estimated with the help of Clavenger apparatus.

Pooled data of two cuttings for fresh weight of herb and oil yield were used for statistical analysis and for remaining characters the average of two cuttings were utilized as per standard procedure.

Heritabiliy in broadsense and expected genetic advance at 5% selection intensity were estimated following the method of Johnson *et al.*, 1995. The genotypic coefficient of variations (GCV) and phenotypic coefficient of variation (PCV) were calculated as per Burton (1953).

Variability

Significant differences among genotypes were noticed for all the characters except plant height (Table 1.) Plant height varied from 253.6 cm to 313.3 cm, number of tillers/hill from 62.5 to 131.2, panicle length from 23.5 cm to 33.2 cm., fresh weight of herb from 279.73 q/ha to 370.26 q/ha, oil content from 0.33% to 0.48% and oil yield from 91.2 kg/ha to 144.83 kg/ha.

Table 1. Phenotypic variability for different characters among genotypes of palmarosa (*Cymbopogon martini* var. *motia*)

Character	Mean	Range	CD (p=0.01)	CV %
Plant height (cm)	271.60	253.60 – 313.40	-	10.77
No. of tillers/hill	101.05	62.50 – 131.20	28.17	15.32
Panicle length (cm)	26.73	23.50 – 33.20	6.68	13.73
Oil content (%)	8.93	00.33 – 0.48	-	-
Fresh weight, q/ha	320.35	279.73 – 370.20	41.99	7.20
Oil yield, kg/ha	117.9	91.20 – 144.83	17.75	8.27

Estimate of genetic parameters for the different traits are presented in Table 2. It was observed that the characters which showed a wide range of variations had high genotypic coefficient of variation (GCV) indicating the good scope for selection.

Table 2. Genetic parameters for different characters among genotypes of palmarosa (*Cymbopogon martini* var. *motia*)

Characters	GCV (%)	PCV (%)	Heritability in broad sense (%)	Genetic advance	GA % of mean
Plant height (cm)	4.8	11.8	16.5	10.8	3.97
No. of tillers/hill	28.5	**32.2**	**77.5**	52.1	51.5
Panicle length (cm)	11.3	**17.7**	40.2	3.9	**14.7**
Fresh weight (q/ha)	9.2	11.6	61.8	47.6	14.9
Oil yield (kg/ha)	16.3	18.2	79.4	35.2	29.8

The estimates of PCV were higher than those of GCV for all the characters, indicating that all the characters are influenced by environment to some extent.

High heritability (in broadsense) was observed for oil yield, number of tillers/hill and fresh weight and medium to low for panicle length and plant height. High levels of heritability coupled with moderate to high genetic advance indicate the involvement of additive gene action for these traits. This implies that selection will be effective in improving these traits.

References

Burton, G. W. and De Vane, E. M. 1953. Estimating heritability in tall fescue (*Festuca arundiacea*) from replicated clonal material. Agron. J. 45 : 478-481.

Johnson, H. W., Robinson, H. F. and Comstock, R. E. 1955. Estimates of genetic and environmental variability in soyabeans. Agron. J. 47 : 314-318.

Biodiversity, Conservation & Utilizatizon of
Spices, Medicinal & Aromatic Plants 237 -240, 1999

Conservation of *Terminalia chebula* germplasm

THAKUR SANJEEV, S. D. BADIYALA & N. K. SHARMA

Regional Horticultural Research Station
University of Horticulture & Forestry
Nurpur – 176 201, Himachal Pradesh.

Abstract

A survey was conducted in the 'Harar' growing areas of Himachal Pradesh. Significant variation in fruit shape, size and weight, seed/pulp ratio and fruit quality was found. The character of importance viz., seed weight (green and dry) has shown highly significant correlation between each other. Sowing of extracted kernel by breaking the strong endocorp has given 90% germination. Patch budding has been the most successful method of grafting. A budwood bank of six clones has been established.

Introduction

Terminalia chebula commonly known as 'Harar' is a moderately to large sized decidous tree with rounded crown, spreading branches and short trunk. The species is found throughout the greater part of India in mixed deciduous forests. In Himachal Pradesh, it is confined to subtropical zone (400-900 M above m.s.l). The tree is found in natural forests land mostly owned by the farmers. 'Harar' tree is important mainly on account of its fruits which are valued for medicine and tanning. The shape and size of the fruit determine its price. The farmers sell green as well as processed fruit which brings hard cash to them. A lot of variation exists in natural population with respect to shape and size of the fruit.

Natural seed germination in the species is very poor, though Bharadwaj and Chakraborty (1994) have reported 70%

germination with cow dung treatment. No major work has been done on clonal propagation of the species. Sharma *et al.*, (1995) have reported successful patch budding.

A survey was conducted in four districts of Himachal Pradesh to study the amount of variation present in the species. The experimental material consisted of 20 individual provenances collected from natural stands. Ripe fruits were harvested from each tree and observation on quantitative characters viz., fruit length and diameter, seed length and diameter, fruit weight (green and dry) were recorded. The fruits were also graded on the basis of quality. The data was statistically analyzed as per the procedure given by Panse and Sukhatme (1985).

Using patch budding, six different strains were grafted to examine the varietal effect on grafting.

Results

The survey conducted in the four districts of Himachal Pradesh revealed wide variation in fruit characters of 'Harar'. More then 90% 'Harar' was of low quality (*Kachra* type). Natural 'Harar' forests are concentrated in three areas *viz.*, Pragpur & Bachwain (Kangra Dist.) and Gini block (Sirmour District)

The analysis of variance showed significant variations. Perusal of data (Table 1.) reveals that longest fruits in term of length (7.80cm) were obtained in provenance T_{18}. However, on the basis of diameter, the provenance T_{19}, excelled all other provenance's. Fruit weight (dry) was maximum in case of T_{13} (15.45 g) closely followed by T_{19} (15.00 g). Seed/pulp ratio on the basis of dry wt was maximum (0.57) in T_9 provenance. There was not much difference in colour of fruits, whereas large variation was observed in the shape of the fruits. Overall, quality of T_{18} provenance was found to be the best in terms of price/kg, however, for *murrabba* and pickle making T_{19} provenance was most suitable.

In case of one year old stock, highest sprouting and grafting percent (100 and 92.30) was observed in 'Kothi Harar' strain whereas minimum sprouting and grafting percent (80 & 46.66) was observed in Tamber strain. Overall sprouting percent was 89.85 and successful grafting was 69.52 percent.

Maximum sprouting and grafting percent was found in P_1 (100 % 83.33) strain where as, minimum (84.61 & 86.15) was in P_3 strain in three year old stock. Overall sprouting and successful grafting per cent was 94.02 and 68.65.

Acknowledgement

The authors are grateful to ICFRE, Dehradun for providing financial assistance.

Table 1. Variation for fruit and seed characters in 'Harar'

District	Prov-nance no.	Length (cm) (cm)	Fruit diam.	Length (cm)	Seed diam. (cm)	Fruit wt green (g)	Fruit wt. dry (g)	Seed/ pulp ratio (green)	Seed/ pulp ratio (dry)	Colour	Shape	Quality
Kangra	T_1	4.78	2.73	2.24	0.96	16.60	5.95	0.07	0.19	Pale green	Elliptical	Kachra, LQ*
	T_2	4.62	2.48	2.44	1.05	15.60	7.05	0.20	0.30	Pale yellow	Oblong (slightly necked)	Kachra, MQ*
	T_3	4.64	2.67	2.42	1.24	16.30	5.90	0.26	0.22	Green slides	Oval, pointed both	Kachra, LQ
	T_4	4.30	2.64	2.23	1.15	16.60	9.70	0.15	0.15	Light yellow	Oblong	Kachra, LQ
	T_5	6.53	3.23	2.92	1.20	33.35	13.15	0.08	0.15	Pale yellow	Long necked	Koonj HQ*
	T_6	6.11	3.22	2.71	1.25	32.30	10.35	0.11	0.08	Light green	Medium necked	Murabi HQ
	T_7	4.60	2.56	2.48	1.12	16.60	8.70	0.15	0.17	Pale yellow	Unsymmetrical	Kachra, LQ
	T_8	6.36	3.33	3.12	1.45	32.95	12.05	0.12	0.29	Light yellow	Medium necked	Murrabi MQ
	T_9	4.91	2.78	2.47	1.31	19.60	3.70	0.16	0.57	Light yellow	Obvate	Kachra, HQ
Bilaspur	T_{10}	4.64	2.50	2.42	1.16	15.90	6.85	0.18	0.24	Light green	Oblong	Murrabi MQ
	T_{11}	5.06	3.19	2.47	1.30	28.60	13.20	0.10	0.15	Pale green	Oval	Murrabi, MQ
	T_{12}	4.53	2.78	2.19	1.05	21.60	7.10	0.08	0.18	Light yellow	Oval	Murrabi, LQ
	T_{13}	5.48	3.15	3.17	1.42	30.60	15.45	0.17	0.24	Light yellow	Oval	Murrabi, HQ
	T_{14}	4.99	2.45	2.20	1.10	13.60	5.35	0.20	0.30	Light green reddish tinge	Oblong	Kachra, LQ
	T_{15}	4.58	2.54	2.14	1.17	15.00	6.35	0.20	0.25	Pale green	Nacked	Murrabi, MQ
Hamirpur	T_{16}	4.65	2.65	2.91	1.19	19.60	8.50	0.21	0.24	Light green	Oblong	Kachra, HQ
Sirmours	T_{17}	5.78	2.20	2.72	0.93	13.85	7.40	0.10	0.16	Pale green	Oblong	Kachra, HQ
	T_{18}	7.80	2.91	3.36	1.08	27.00	11.35	0.12	0.19	Pale green	Long necked	Koonj, HQ
	T_{19}	6.24	3.57	2.35	1.25	38.45	15.00	0.07	0.13	Light yellow	Oval	Murrabi, HQ
	T_{20}	5.64	3.15	2.44	1.21	26.70	11.85	0.09	0.18	Light yellow	Oval	Kachra, LQ
CD (p=0.05)		0.48	0.22	0.24	0.26	2.04	0.76	0.03	0.01			

LQ=low quality, MQ = medium quality, HQ = high quality

References

Bharadwaj, S. D. and Chakraborty, A. K. 1994. Studies on time for seed collection, sowing and presowing seed treatments of *Terminalia ballerica* and *Terminalia chebula*. Ind. Forester, 17 : 430-439.

Panse, V. G. and Sukhatme, P. V. 1985. Statistical methods for agricultural workers, New Delhi, ICAR, p. 359

Sharma Kamal, Thakur Sanjeev, Badiayal, S. D. and Sharma, N. K. 1995. First report on propagation of *Terminalia chebula* through patch budding. Ind. Forester, 121: 760-761.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants 241 -246 , 1999

Conservation strategies for indigenous *Vitis* and related genera of importance in traditional medicine

S. GANESHAN

Indian Institute of Horticultural Research
Hassaraghatta Lake P. O,
Bangalore – 560 089, Karnataka.

Abstract

Grape, one of the most popular and delicious fruits attracting a global research priority, belongs to the genus *Vitis*. This genus has several other related genera, which occur, in the sub-tropical and temperate regions. A total number of 8 genera with 102 species are reported to have a natural distribution and occurrence in India. The present paper attempts to highlight the efforts that are underway to conserve the Vitaceae genepool particularly in the Indian sub-continent and the need for a national conservation program, defining the advantages and limitations while conserving the entire species diversity.

Introduction

Vitis species and related genera in the Vitaceae family, particularly the edible grape is reported to have been introduced in the Indian sub-continent about 2600 years ago, perhaps in the year 620 BC (Olmo, 1976). Ancient books such as the medicinal treatise 'Charak Samhita' and 'Arthashastra' written in the first century (AD) and fourth century (BC), have recorded the presence of cultivated grape in India. Although several authors have reported the presence of grape species in India, there are no direct evidences to confirm its origin or the exact date of its introduction to the Indian subcontinent. Occurrence of the species in the Himalayan, north eastern and the peninsular regions have been reported. (Anon. 1962) but none of the species in peninsular India related to *Vitis* produce edible fruits. Plant parts of these related species belonging to Vitaceae family are collected from wild and used in the preparation of indigenous medicines, used locally even today by Ayurvedic and Unani doctors.

It is in this context, the importance of Vitaceae genepool is highlighted, describing the present status on collection, characterisation, evaluation and conservation of the species diversity.

The objectives of the present study were collection and conservation of indigenous Vitaceae genepool; evaluation of species wide genetic variation for identification, maintenance and characterisation of value added heritable traits; domestication of wild species for location specific needs, such as use in traditional medicine and introgression of such heritable traits in the ongoing cultivated grape breeding strategies or in future programs aimed at evolving specific genotypes for traditional medicine.

Occurrence and *in situ* distribution of Vitaceae species in the Indian subcontinent can be mapped to 10 states/union territories. Andamans, Arunachal Pradesh, Assam, Himachal Pradesh, Kerala, Meghalaya, Nagaland, Sikkim, Sahyadri hills of Maharashtra and Tamil Nadu. In these areas, there are 8 genera and 102 species reported (Table 1). A complete inventory of the number of species, their distribution in India along with their taxonomy and chromosome numbers is reported elsewhere (Patil, 1993).

Table 1. Distribution of Vitaceae in India

Genus	No. of species	Genus	No. of species
Ampelocissus	10	*Leea*	33
Ampelopsis	2	*Parthenocissus*	3
Cayratia	12	*Tetrastigma*	15
Cissus	21	*Vitis*	6

Medicinal properties of Vitaceae

Fresh fruit juice, pulp, dried fruits, roots, tender twigs and leaves of several indigenous Vitaceae members form an integral part in the preparation of different Ayurvedic and Unani medicines. Table 2 3, and 4 shows details of plant parts used and the therapeutic use of 15 species, belonging to four genera of Vitaceae. The potential value of these species is yet to be exploited, especially when there is a great demand for the active ingredients present in these species in the local drug industry.

Conservation strategies

There is a world wide effort for conservation of *Vitis* germplasm (Alleweldt *et al.*, 1990). However, aspects such as what germplasm needs to be given priority for maintenance and conservation and how this is going to be accomplished at a global level is not clearly defined, either for cultivated edible grape, or for the indigenous and endemic or location specific wild species which contain valuable genes for introgression into the modern grapes. Domestication of wild, non-edible Vitaceae members can be an alternative for their use both in traditional medicine as well as bridge species for improvement of modern grape. While this is easier said than done, prospects are quite encouraging with the refinement of breeding methodology and use of biotechnology. Conservation *in situ* and domestication at near *in situ* areas of the species could reduce genetic erosion risks and help maintain the species wide range of genetic diversity.

Among the several options available for heterozygous vitaceae species, to be adopted as a conservation strategy, a holistic approach would be to intensify and

Table 2. Medicinal properties of Vitaceae (Genus: *Ampelocissus)*

Species	Part used	Therapeutic use
Ampelocissus arneosa	root	astringent and cooling
A. barbata	root	ayurvedic
A. arnottiana	root	depurative, aperiment diuretic, blood purifier, eye diseases & ulcers
A. rugosa	root, fruit	ayurvedic
A. latifolia	tender leaf	odontalgia, detergent for indolent ulcers
A. tomentosa	root, bark	allevation of swellings, treatment of piles

Table 3. Medicinal properties of Vitaceae (Genus : *Cayratia, Cissus)*

Species	Part used	Therapeutic use
Cayratia carnosa	leaf, seed, root	treatment of yolk sores on bullocks, embrocation, boils
Cissus adnata	tuber, root	blood purifier, diuretic, renders secretion, applied to cuts and fractures
C. quadrangularis	young shoot, leaf, stem	appetizer, stomachic, bowel disorders, otorrhoea, epistaxis scurey, irregular menstruation
C. sedosa	leaf	indolent tumor, deworming

Table 4. Medicinal properties of Vitaceae (Genus : *Leea*)

Species	Part used	Therapeutic use
Leea aspera	fruit	ayurvedic, edible
L. crispa	leaf and tuber	heals cuts & wounds, deworming
L. macrophylla	tuber, root	deworming (ring worm), astringent, clotting of blood
L. robusta	root	diarrhoea, dysentry, anodyne
Leea sambucina	root	thirst reliever, cooling properties

accelerate *in situ* conservation methods in endemic areas such as forest ecosystems, biosphere reserves, *ex situ* maintenance in the form of live collections in field genebanks, *in vitro* conservation approaches using tissue culture methods, seed conservation, pollen cryopreservation to conserve the intra-clonal genetic diversity and DNA conservation using biotechnological tools.

In India, efforts to conserve seeds of *Vitis* species and using in breeding strategies are lacking (Jindal and Singh, 1993). The most common method presently practiced is in the form of *ex situ* field maintained cultivar and species germplasm, which are found at Indian Agricultural Research Institute (IARI), Indian Institute of Horticultural Research (IIHR), National Bureau of Plant Genetic Resources (NBPGR), some State Agricultural Universities and Maharashtra Association for Cultivation of Science (MACS), Agharkhar Research Institute (ARI), Pune.

In vitro conservation techniques for *V. vinifera, V. candicans* and *V. champini* have been optimized, which could result in the development of conservation protocols under low temperature storage (10^{0}C) in the dark with reduced ammonium nitrate in the culture medium for 12 months (*V. candicans*) (Ganeshan *et al.*, 1992) reducing the subculture frequency to just once in six months. Further, storage under these conditions could be extended to 18 months. Under standard culture conditions (25^{0}C ± 2^{0}C; 16 hour light = 23 ± 2μEm^{-2} S^{-1} per culture tube and 8 hours dark) the schedule of subculture frequency was once every 10-12 weeks. Conservation protocols for *V. vinifera* and *V. champini* could be optimized for 12 and 9 months, respectively. Vitroplants of these species were deposited at the National Facility for Plant Tissue Culture Repository (NFPTCR), NBPGR, New Delhi, for further maintenance and conservation *in vitro* (Anon. 1994). Experiments continued on medium term storage of these vitroplants at NFPTCR resulted in maintenance of the species at 25^{0}C for 11-12 months, with over 75% survival (Anon. 1995).

At IIHR, under a ICAR cess fund project, 40 *Vitis* accessions which include 6 species and 6 exotic interspecific hybrids have been cultured and maintained *in vitro*. Efforts are underway to assess indigenous species available at the centre. Pollen cryopreservation protocols for long term storage of nuclear genetic diversity of clonal (cultivar) germplasm are also available (Alexander and Ganeshan, 1993).

Meristem cryopreservation attempts has offered success, limited to specific genotypes (Plessis *et al.*, 1993). So far, no efforts are attempted to establish DNA banks for Vitaceae. Considering the advances made in biotechnology, the possibility of maintaining only chromosomes, single gene sequences or DNA (gene) libraries instead of entire genotypes can offer a greater prospect for germplasm conservation in future.

At MACS Pune, a field bank has been established for *Vitis* species and 70 wild relatives along with hybrids, mutants and cultivated grape varieties (Anon., 1995a). Genes for salt tolerance (present in *V. champini*) and drought tolerance (present in *C. quadrangularis*, *C. pallida* and *C. woodrowii*) are used in the ongoing breeding program at the centre.

Conclusion

Considering the importance of Indian Vitaceae genepool, prioritization is needed for :

1. assessing the economic value of species at regional and national levels and reported rarity of a given species (if any).
2. distribution range in the Indian sub-continent.
3. identification of *in situ* locations (Hot spots).
4. intensification of *ex situ* conservation strategies.
5. documentation of local or community knowledge about the various uses of these species.
6. regulate collection of wild species from *in situ* areas in a sustainable manner, allowing evolutionary processes to continue and without conflict with social requirements.
7. encourage cultivation of these species in a favourable economic environment, fostering partnership between growers,local communities, R & D establishments and industry.

References

Anonymous, 1992. Grapes. In: Wealth of India, CSIR, New Delhi.

Anonymous, 1994. Annual report, 1993-94. Department of Biotechnology, Ministry of Science and Technology, Government of India. p. 92.

Anonymous, 1995. Annual report, 1994-95. NBPGR, (ICAR), New Delhi, p. 56.

Anonymous, 1995a. Annual report, Agharkar Research Institute (MACS) Pune. 1994-95. p. 36

Alexander, M. P. and Ganeshan, S. 1993. Pollen Storage. In : Advances in Horticulture Vol. I, Part-1. Fruit

Crops. (eds.) K.L. Chadha and O.P. Pareek. Malhotra Publishing House, New Delhi, India, pp. 481-496.

Alleweldt, G. Spiegel Roy, P and Reisch, B. 1990. Grapes (*Vitis*) In: Genetic resources of temperature fruits and nuts. Acta. Hortic. 290 : 291-327.

Ganeshan, S., Doreswamy. R and Krishnappa, D. G. 1992. Prolonged storage of grape germplasm *in vitro*. Influence of low temperature and reduced ammonium nitrate concentration. *In vitro* 28 : Part II 1054, p. 1057.

Jindal, P. C. and Singh, R. 1993. Genetic resources of grape. In: Advances in Horticultre, Vol. 1 Part-1 Fruit Crops. (eds.) K.L. Chadha and O.P. Pareek. Malhotra Publishing house, New Delhi, India, pp. 149-169.

Olmo, H. P. 1976. Grapes In: Evolution of crop plants, Simonds N. W. (ed.) Wah. Cheong, Hong Kong, pp. 294-98.

Patil, V. P. 1993. Indigenous germplasm of *Vitaceae*. In: Advances in Horticulture, Vol. 1. Part-1 Fruit Crops. (eds.) K.L. Chadha and O.P. Pareek. Malhotra Publishing house, New Delhi, India, pp. 149-169.

Plessis, P., Leddet. C., Colas, A & Dereuddre, J. 1993. Cryopreservation of *V. vinifera* L. Cv. 'Chardonnay' shoot tips by encapsulation dehydration. Effect of pre-treatment. cooling and post culture conditions. Cryoletters 14 : 309-320.

.iversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants 247 -251 , 1999

Ethnomedicines practiced by the 'Malayans' of Peechi forests in Kerala

N. MINI RAJ & E. V. NYBE*

Cardamom Research Station
Pambadumpara
Idukki – 685 556, Kerala.

Abstract

An attempt was made to document the ethnomedicines practiced by the 'Malayans', the native tribes of Peechi hills in the Thrissur forest division. The scientific name, family, local name, habit and habitat of the plant, its therapeutic application, dosage and the manner of use are presented. Majority of the plants were used in skin disorders and rheumatism. Inspite of their fairly good knowledge on the native medicinal plants, the dependence of the folk on these plants was only partial due to many reasons. The over powering intrusion of extraneous cultures have practically wiped out their irreplaceable life style diversity. Only the older generation had some knowledge on the traditional curing practices and that too for minor ailments only. Among the list of plants used by this tribe, a few have been accepted widely by the Ayurveda physicians and the properties of some have been clinically proved also.

Introduction

'Malayans' are the jungle tribe who inhabit the Peechi hills in the Trissur forest division. The primary occupation of this hill tribe is collection of minor forest produce, chiefly medicinal plants. Living close to nature, these tribes have developed their own unique medical systems, have learned to utilise the local herbs for different ailments, after centuries of trial and error. An attempt has been made to document the ethno-medicine in practice among this tribe.

* Dept. of Plantation Crops & Spices, Kerala Agricultural University, Vellanikkara, Trissur.

The study was conducted among the tribes of Thamaravellachal settlement in the Peechi-Vazhani wild life sanctuary. The vegetation include both moist deciduous (MDF) and semi ever-green (SEG) forests.

Frequent visits were made to the settlement and the herb gatherers were identified. Elder men and women were contacted and details about herbal medicine practiced by them collected. Visits were made to the forests along with them to identify the plants used in these medicines. Voucher specimens were collected and herbaria prepared. Herbaria were later identified at the Kerala Forest Research Institute.

Enumeration

Among this tribe, people who still depend solely on ethnomedicines for their health care are nil though they have very good knowledge on the native medicinal plants. Developmental activities have brought them to the main stream of life and as a result, most of the younger generation depends on modern systems of medicine for their health problems.

Even though all the tribal families were contacted and discussed, only a few people in the older generation could share their knowledge on the details of ethnomedicines. Compared to men, it is the women folk who still hold this tradition passed on from their ancestors, alive. The scientific name, local name in Malayalam, family and habit of the plant, its therapeutic application and the manner of use are presented in Table 1.

Information presented in Table 1, reveal that some species have restricted use. While others have wide use in medicine. Majority of the plants were used in skin disorders and rheumatism. Use of single plant could be observed in certain cases like psoriasis, jaundice etc. Among the list of plants used by this tribe a few have been accepted widely by the Ayurveda physicians (*Wrightia* for psoriasis, *Entada* seeds for rheumatism etc.) and the properties of some have been clinically proved also. (*Holarrhena* seeds for amoebiasis). However, pharmacological studies are needed to establish the utility and efficacy of these plants in therapeutics.

Conclusion

Majority of 'Malayan' population residing in Peechi hills go for gathering medicinal plants. About 77 different plants/ produce are collected regularly from the forests. But this tribal community seem to have only limited knowledge in ethnomedicine and the present situation gives serious causes for concern. The over powering intrusion of extraneous cultures have practically wiped out their irreplaceable life style diversity. The vast treasure of indigenous knowledge was something precious they had to compromise in the name of development.

On the other hand the increasing demand on medicinal plants has led to destructive collection of many of the drugs. This has made many valuable plants in the threatened category.

But the tribal people here by and large do not appear to be aware of the seriousness of the threat, inspite of the fact that there is a custom among them of exercising utmost care in avoiding damage to plants while collecting them. Eventhough some of the elder women expressed their anxieties about the shortage of plants, there is lack of concern about securing long term availability of the plants on which the sustainability of tradition so critically rests.

Table 1. Ethnomedicines practiced by the 'Malayan' tribe in Peechi hills

Scientific name	Family	Local name	Habit	Usage
Aristolochia indica L.	Aristolochiaceae	Karalakom	Herbaceous climber	Juice of the leaf consumed against snake and scorpion poisioning.
Butea monosperma Lank	Fabaceae	Plass	Tree	Root bark applied as a paste against craking of skin inthe foot. Also used as an antithelmintic.
Baliospermum solanifolium (C.J. Burn) Suresh	Euphorbiaceae	Naganti	Herb	Salted rice gruel prepared in the root decoction is used as a purgative
Caesalpinia mimosoides Lank	Fabaceae	Goomullu	Herbaceous climber	Tender leaves applied as a paste on the forehead of small babies against common cold
Coscinium fenestratum	Menispermaceae	Maramanjal	Woody climber	Stem applied as paste on the forehead in severe headache.
Caesalpinia bonduc (L) Roxb	Fabaceae	Kazhanji	Woody climber	Decoction of the endosperm effective against vomiting and bleeding
Cissamapelos pariera (L)	Menispermaceae	Malathangi	Herbaceous climber	Coconut oil boiled with the extract of the whole plant when applied externally cures skin diseases.
Cyathuala prostrata (L.)	Amaranthaceae	Cherukadaladi	Herb	Whole plant applied as a paste against swellings.
Curcuma zedoaria (Christn) Rosc.	Zingiberaceae	Manjakoova	Herb	Extract/essence of the dried rhizome after purification *(koovanooru)* taken by women in genital diseases. Paste of the fresh rhizomes applied over face for lustrous and shining skin.
Centranthera anthelmintica	Asteraceae	Kattujeerakom	Herb	Hot infusion of seeds given to children as antihelmintic.

Canarium strichum Roxb	Burseraceae	Telli	Tree	Fumes of the dried resin extracted from this tree repel mosqutoes and purifies air. Fine powder of the dried resin is applied as a past in coconut oil against cracking of skin in the foot.
Dracaena terniflora Roxb	Liliaceae	Manjakantham	Herb	Used as a panaceae for jaundice
Desmodium motorium (Hoult) Merr	Fabaceae	Thozhukanni	Herb	Woman use it as an aphrodisiac
***Entada** scandens* (L) Benth	Fabacae	Kalkunvally	Woody climber	Rice gruel prepared in the decoction of the endospem of the seed, along with coconut grating is good for rheumatic pain
Embelia isjariam Cotton A.D.C.	**Myrsinaceae**	Ammimuriyan	Shrub	Rice guel prepared in the decoction of root of this plant along with the endosperm of Bntada scandons and a few cumin seeds taken consectively for 7 days wards off severe back pain.
*Harpullia **aborea*** (Balanco) Radlk	**Sapindaceae**	**Puzhukoli**	**Tree**	Skin shavings applied as a paste over body to repel leaches
*Hollarrhenna **pubescens*** (Buch- Han)	Apocynaceae	Kutakappala	Tree	Decoction of seeds in water is useful against amoebiasis
Ixora coccinia L.	Rubiaceae	Chethi	Shrub	Coconut oil boiled with the flowers of this plant along with goat droppings on external application wards of skin disease.
Ipomoea pestigridis L.	Convolvulaceae	Puliyadi	Herbaceous climber	Leaves ground with cows milk is consumed against spider poisoning

Laportea crenulata (Roxb) Gaud	Urticaceae	Anaveratti	Shrub	Used to cause enlargement of glands and high fever to enemies. Usually used to ward of elephant attack inside the forest.
Nervilia aragoana Gaud	Urticaceae	Arilathamara	Shrub	Turber of the plant used against gonorrboea
Naravelia zeylanica (L) DC	Ranunculaceae	Vathakodi	Herbaceous climber	Fresh roots after crushing if inhaled directly removes common cold, bathing in water boiled with leaves of this paint removes rheumatic pain, roots useful against snake poison
Thottea siliquosa (Lamk)	Aristolochiaceae	Alpam	Shrub	Roots useful against snake poison
Xylia xylocarpa (Roxb) Taub	Fabaceae	Irul	Tree	Decoction of stem bark given to neutralise the problems of over consumption of honey.
Mangifera indica L	Anacardiaceae	Mavu	Tree	Green fruits given to mullify the problems of over consumption of honey
Terminalia bellarica	Combretaceae	Thanni	Tree	Believed as antidote for allergy caused by certain species of Holigrana and Semicarpus
Wrightia tinctoria	Apocynaceae	Dantapala	Tree	Leaves very effective against actue psoriasis. Spines or pickles stuck on the body naturally gets ejected out when the milk of the tree is applied on the spot.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 252 -257, 1999

Some folk remedies for common ailments in Tamil Nadu

A. SARASWATHY

Drug Standardization Research Unit (Siddha)
Captain Srinivasa Murti Drug Research Institute for Ayurveda
Arumbakkam, Chennai – 600 106, Tamil Nadu.

Abstract

Twenty medicinal plants used by the tribal folk of Tamil Nadu are described. Scientific names, vernacular names, active principles, uses and dose are given.

Introduction

Our country is endowed with one of the richest flora on earth due to its varied eco-climatic conditions and wonderful ranges of mountains and forests. Plants are commonly available in abundance, especially in the tropics. The uses of these flora as medicinal are countless. They offer to the local population and others, an immediate access to safe and effective remedies for use in the treatment of illness through self-medication.

The rural folks in Tamil Nadu have immense faith in traditional herbal medicine. The folk practitioners give treatment for almost all types of diseases. Some of them are well known and have been worked out to a great detail for the chemical, pharmacological and clinical aspects. Certain species have not been scientifically evaluated. It is estimated that only 5000 species have been scientificaly evaluated out of the estimated total of 2,50,000 to 3,00,000 species. This contribution confines to the information on the following twenty interesting, commonly available plants used in treating certain diseases.

Enumeration

Acalypha indica (Euphorbiaceae)

Vernacular names: *Kuppaimeni* (Taml.), *Marjaragandha* (Sanks.)

Uses and doses: The drug '*Kuppaimeni'*/ '*Marjaragandha'* is anthelmintic, anodyne, expectorant, emetic, hypnotic, and laxative and used in scabies and snakebites. The cat is supposed to be very fond of this plant, hence the meaning of the name 'Punai vananki'.

Plant contains kaempferol, acalyphine, acalyphamide, triacontamine, other amides, quinone, quebrachitol and sterols. Plant proved to be useful for severe cough associated with bleeding from lungs, heamoptysis and incipient phthisis. Leaf extract is antifungal, useful in wheezing cough, desponoea, in bone fractures. Leaf decoction (for 10-180 days) on oral administration showed good clinical response for bronchopasms.

***Achyranthus aspera* L. (Amaranthaceae)**

Vernacular names: Nayuruvi (Taml.), *Apamargi, Kadaladi* (Mal.)

Uses and doses: 'Nayuruvi'/'Kadaladi', a small herb found all over India, useful for stomach ache, piles, bowel complaints, skin eruptions and boils. Leaf paste is applied on cuts, wounds and sores; arrest dysentery and diarrhoea, useful in swellings and water retention. The ash yields large quantity of potassium and is used in oedema, asthma, cough. 'Nayuruvi tailam prepared from the entire plant is used for asthmatic conditions. Decoction of the whole plant is useful in the treatment of lapromatous leprosy along with DDS.

It contains achyranthine, achyranthes saponins A and B (oleanolic acid, glucose, galactose, rhamnose, xylose), basic substances like betaine. Plant juice 30-60 ml, decoction 10-20 ml, powder 10-20 mg.

***Adhatoda vasica* (Acanthaceae)**

Vernacular names: Adhatodai (Taml.), *Vasa* (Sansk.)

Uses and doses: The drug '*Adhatodai'*/ '*Vasa'* is a reputed remedy for cough, and chronic bronchial asthma, exceedingly bitter, bleeding from the lungs in tuberculoses, and rheumatism, relieves cough and breathlessness. Therapeutic actions of the plant are attributed to several alkaloids such as vasicine, vasicinone etc. and essential oil.

The drug can be used as 'Adhthoda syrup' or 'Adhathoda kutinir' or 'ney'. Vasicine is proved to possess abortifacient activity. Mixture of vasicine and vasicinone on administration (24 mg twice a day) asthmatic patients showed good bronchodilating activity. 'Vasavalehya' 6-12g b.i.d., Vasarishta 15 ml b.i.d., Vasadgutika, 6-12g b.i.d.

***Aloe barbadensis* (Liliaceae)**

Vernacular names: Katralai (Taml.), *Kumari* (Sansk.)

Uses and doses: 'Kumari'/'Katralai' is a stemless, large, thick, fleshy leaves plant. The jelly obtained from the leaves is cooling and brings down fever and also alleviates inflammations in the stomach. As opposed to this, 'musambaram', a black brittle solid obtained from this jelly, is an irritant, causes vomiting and loose motions when taken in and in large doses causes uterine bleeding and abortion hence it is used in delayed periods. Also is used in herbal cosmetics like hair oils, shampoo, herbal creams etc. useful in jaundice due to viral hepatitis, constipation and general debility. Anthraquinone derivatives like aloin, emodin, barbaloin, β-barbaloin, isobarbaloin and polysaccharids and glycoprotein have been reported. They have antibacterial and antifungal activities.

Five ml of 20% *Aloe* extract was administered twice a day for 24 weeks to 33 cases of bronchial asthma. The drug was effective in 5 cases (62.5%). Leaf juice 10-20 ml b.i.d.; mucilage 1-4g. b.i.d; 'Kumari asava' 5-10 ml b.i.d.

***Andrographis paniculata* Nees (Acanthaceae)**

Vernacular names : Nilavembu (Taml.), *Bhunimba* (Sansk.), *Kiniyath* (Mal.)

Uses and doses: 'Nilavembu'/' Kalmegh' is an annual herb, bitter leaves and valuable antifever agent, vermifuge, liver tonic, commonly useful in skin disease viral hepatitis

It contains andrographolides and 5-hydroxy 7,8, 2', 3' - tetramethoxy flavone, diterpenes and diterpene /glucoside. Decoction 20-40 ml b.i.d.

***Boerhaavia diffusa* L. (Nyctaginaceae)**

Vernacular names: *Mokkirattai* (Taml.), *Punarnava* (Mal./Sansk.)

Uses and doses: The roots of *'Mookkirattai'/' Punarnava'* are powerful diuretic, useful in oedematous swellings, cut, wounds, stomach enlargement, ascites and internal inflammations; It has been administered for diverse disease for many centuries in India. Fresh leaf juice in a dose of 20 ml 2 to 3 times a day is given for renal failure.

Alkaloid bunarnavine is the major active constituent.

***Cissus quadrangularis* L. (Vitaceae)**

Vernacular names: *Pirandai* (Taml.),*Hastisandhana*(Sansk.), *Changalamparand* (Mal.)

Uses and doses: 'Pirandai' a plant with the four angled stem and the tuberous roots are widely used in folkore medicine to heal bone fractures. As the Sanskrit name 'Hastisandhana' indicates, the drug is an efficient fracture healer. A potent anabolic oxysteroid has been isolated from the plant, which enhances the rate of fracture healing by influencing early regeneration of all eonnective tissue cells involved in the healing. Also useful in scurvey and irregular menstruation. Rich in vitamin C and calcium oxalate. Healing of bone fracture is proved in human. Decoction of stalk : 10-30 ml., juice 10-20 ml; powder 2-5 g.

***Coccinia indica* (Cucurbitaceae)**

Vernacular names: Kovai (Taml.), *Bimbi* (Sansk.)

Uses and doses: 'Kovai' is a climber, leaf, flower, root and fruit are medicinally useful; cooling, and an effective antidiabetic drug. Leaf juice is applied for ulcers, psoriasis. Cephalandrine A & B, cephalandrol, cucurbitacin, glycoside are the active constituents. Clinical evaluation of green leaves extract at a dose of 10g/ day showed significant inhibition of infeetive hepatitis. Antidiabetic activity for the leaf alkaloid, aqueous and extracts were evaluated and positively reported.

***Eclipta alba* Hassk (Compositac)**

Vernacular names: Karisalnkanni (Taml.), *Bhringaraj* (Sansk.)

Uses and doses: 'Karisalnkanni'/ 'Bhringaraj' is useful as whole plant in the treatment of viral hepatitis and skin diseases. It is cholagogue, tonic, alternative, emetic, purgative, deobstruent. It is a plant with the property of increasing longevity of a person, useful for dental diseases, memory disorders, hair hygiene.

Wedelolactone is the main active principle. Crude extract is anticancerous against ehrlich ascites carcinoma, 50% ethyl extract is antiviral and haemostatic and hypotensive. Powder cured 100% patients suffering from infective hepatitis.

Powder heated with any edible oil is useful in elephantiasis. Oil is a wound healer. The plant is used in hair oils, as it contains a black dye (leaf juice: 6-12ml, seed powder 0.5, - 1.5 Bhringaraj taila : Hair oil).

***Enicostemma littorale* Raynal (Gentianace)**

Vernacular names: Vallaruku (Taml.), *Chota-chirata* (Sansk.)

Uses and doses: 'Vellaruku'/'Chotta' - chirata is a tiny herb grows throughout India, whole plant is stomachic, bitter, tonic, laxative and carminative. Dried powder is given with honey as a blood purifier and in dropsy, rheumatism, malaria abdominal ulcer, fever, diabetes, hernia, swellings, itches and insect poisoning, used for the treatment of leucorrhoea by grinding the plant with *Piper nigrum* and *Allium sativum* and administered with milk by several traditional practitioners and 'Irular' tribals of North Arcot district (Tamil Nadu). One of the antidiabetic drugs considered as a sovereign, remedy in all 'vata' diseases.

It contains saponanin, apigenin, genukwanin, isovitexin, swertisin, 5-0-glucosides of sylswertisin and isoswertisin, swertiamarin, enicoflavine, gentianine, gentiocrucine. Powder 2-5g : decotion 30-60 ml.

***Lippia nodiflora* Mich. (Verbenaceae)**

Vernacular names : Poduthalai (Taml.), *Vashira vashira* (Sansk.).

Uses and doses: 'Poduthalai'/' Vashira' is used in fevers and retention of urine, wounds, ulcers and boils. Juice is incorporated in hair tonics to remove dandruff as the Tamil name 'Ponduthalai' implies.

Flavonoids, the phytochemicals isolated from this plant are reported to be antibacterial and antifungal.

***Oldenlandia umbellata* L. (Rubiaceae)**

Vernacular names: Imbural (Taml.) *Chayaver* (Sansk.)

Uses and doses: This drug *'Imbural'/ 'Chaya* ver' finds extensive use in the treatment of tuberculosis, haemptysis, bronchitis and asthma in the Siddha system of medicine. In olden days, the roots were used as dye for cotton. Seven anthraquinone derivatives have been isolated. They have been found to have bacteriostatic activity against gram positive bacteria. The ruberthyric acid has been tested against H37 RV strain of

Mycobacterium tuberculae and found to have antibacterial activity., 2 x 500 mg crude drug is given thrice a day.

Phyllanthus amarus (Euphorbiaceae)

Vernacular names: Kilkaynelli (Tam.) *Bhumiamla* (Sansk.) *Keezhanelli* (Mal.).

Uses and doses: 'Kilanelli' or *'Kikkaynelli'/'Bhumiamla'* is the popular antihepatitic drug, bitter, antidiabetic, diuretic, carminative. Phyllanthin (a bitter constituent) and hypophyllanthin (a non bitter constituent upto 0.7% and 0.3% (w/w) are the major active constituents, besides several lignans, tannins and flavonoids.

Whole plant extracts and isolates were scientifically evaluated for their therapeutic actions and proved to produce hypoglycemic, antihepatotoxic action. Powder 3-6 g, juice 10-20 ml.

Physalis minima L. (Solanaceae)

Vernacular names: Chadakkuthakkali (Taml.) *Lakshmipriya* (Sansk.)

Uses and doses: The drug *'Chadakkuthakkali'* and *'Lakshmipriya'* is considered as tonic, diuretic, purgative and an ingredient of a medicinal oil which is given for spleen.

Highly oxygenated, biogenetically related ergostane type of steroids knows as physalin A-D and 5/3, 6/3 - epoxy physalin were characterised from the plant.

Ricinus communis L. (Euphorbiaceae)

Vernacular names: Aamanakku (Taml.) *Eranda* (Sansk.) *Avanakku* (Mal.)

Uses and doses: Aamanakku/Eranda is laxative, cooling, lactogogue and an antivata. It is a popular liver tonic, an antiinflammatory drug.

Seed contains 50% fixed oil; leaf, root, seed oil are used in Siddha system of medicine. If given internally the leaf decoction and external application of paste of leaves on the chest, increases the secretion of milk for feeding mother. The oil is emollient on external application. Alkaloid (ricinine) is the major active principle. Leaf juice 10 ml (jaundice); seed oil (constipation); root bark (rheumatic disorders) is given.

Solanum trilobatum L. (Solanaceae)

Vernacular names: Thuthuvalai (Taml.) *Alarka* (Sansk.)

Uses and doses: 'Thuthuvali'/'Alarka' is a thorny hedge plant with lilac flowers, used in cough, fever and consumptive and respiratory diseases. The active chemical from this plant was β-solamarine which has antibiotic and antifungal activity. The isolate was also tested positively against sarcoma 180 and KB cell. Clinically it is used as an adjuvant in chemotherapy of cancer.

The crude drug can be administered either in the form of vegetable or as 'Thuthuvali ney', 'Thuthuvali vatakam' or 'Thuthuvalai kutinir', in combination with other raw drugs. It is one of the 'Kaya kalpa' drugs of Siddha system of medicine.

Tribulus terrestris L. (Zygophyllaceae)

Vernacular names: Nerunjil (Taml.) *Gokshura* (Sansk.) *Nerinjil* (Mal).

Uses and doses: 'Nerunjil'/'Gokshura'

is a common creeper, with yellow flowers, fruits resemble the hoof of a cow. The whole herb is diuretic, aphrodisiac, and dissolves stone in urine. The fruits are often used. Useful in jaundice, infusion useful in gout, kidney diseases and gravel. Fruits contain 0.001% of an alkaloid, a fixed oil, a small amount of essential oil resins, nitrates.

Vitex negundo L. (Verbenaceae)

Vernacular names: Nochi (Taml. & Mal.) *Nirgundi* (Sansk.)

Uses and doses: 'Nochi'/'Nirgundi' is a small tree grown for hedges. Leaves aromatic, with purple flowers. They are insect repellent, smoked to ward off mosquitoes, used as cigarette to relieve head ache and running nose; paste relieves joint pains, back ache put into boiling water and vapours inhaled to relive fever with cold very good for rheumatism.

Vitexin, isovitexin, alkaloids, flavanoids, sterols are the active constituents. Leaf juice 10-20 ml, root powder 1g : seed/bark powder :1/2 -1g oil topical use, decoction 30-60 ml.

Wedelia calenduleceae (Compositae)

Vernacular names: Manjal karisalai (Taml.) *Pithabhringaraj* (Sansk.)

Uses and doses: 'Manjal karisalai'/'Pithabhringaraj' is used in Siddha system. It has got therapeutic actions as that of *Eclipta alba* and can even be considered as superior drug to *Eclipta alba*. Whole plant juice 15-30 ml.

Withania somnifera (Solanaceae)

Vernacular names: Amukkara (Taml.), *Ashwagandha* (Sansk.), *Ammukkaram* (Mal.)

Uses and doses: 'Ammukkara'/'Ashwagandha' is a rejuvenative drug. The drug is diuretic, alternative tonic, aphrodisiac, hypnotic, antirheumatic and antiarthritic. It promotes disease resistance and therapeutic actions are almost similar to the Chinese drug *Panax ginseng*. Bruised leaves are applied in painful swellings, carbuncles and ulcers.

Several steroidal lactiones namely withanolides and alkaloids are responsible for its healing property. It gives good sleep in doses of 2 to 4g root powder. Withaferin has been found to possess hypotensive action and withanolides are immunomodulators.

Acknowledgements

Acknowledgements are due to the Director, Central Council for Research in Ayurveda and Siddha, New Delhi for financial support.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 258 -261 , 1999

Herbal folk remedies for skin diseases in Tamil Nadu

SASIKALA ETHIRAJULU & S. USMAN ALI

Drug Standardisation Research Unit (Siddha)
Captain Srinivasa Murti Drug Research Institute for Ayurveda
Arumbakkam, Chennai - 600 106, Tamil Nadu.

Abstract

Folk medicine plants used by tribals of Tamil Nadu are given. Botanical names, vernacular names and uses are mentioned.

Introduction

Herbal folklore medicine, has recently been receiving an increased interest all over the world. Folk medicine is a veritable gold mine of health care knowledge inherited by the rural folk and tribes inhabiting forests. Tribal populations of our country have still retained their folk medicines and curative methods which are mainly based on biological resources in the immediate vicinity of their habitat. Tribal medicine offers vast scope for medical research in modern terms and all the available information on it should be collected and recorded for proper scientific evaluation and wider application.

The present paper is the result of such a study made on the tribal communities found in Tamil Nadu. Wherever recent work is done on the phytochemical and pharmacological aspects, relevant reference is made to show the scientific basis behind the folk knowledge.

Enumeration

***Acalypha indica* L. (Euphorbiaceae)**

Vernacular names: Harita Manjari (Hind.), Kuppaimeni (Taml.), Kuppaimani (Mal.)

Uses: Leaves of *A. indica* either alone or with some turmeric and salt are ground into paste and applied on skin for scabies. Extract shown to possess antifungal activity.

***Andrographis echioides* Nees (Acanthaceae)**

Vernacular names: Birkubat (Hin.), Gopuramthangi (Taml. & Mal.)

Uses: Equal quantity of leaf juice is

mixed with sesame oil, boiled and filtered. Oil is used for oil bath to cure psoriasis.

***Argemone mexicana* L. (Papaveraceae)**

Vernacular names: Brahmadandi (Sansk.), Bhramadandu (Taml.),Bharamadanti. (Mal.)

Uses: Latex is applied to cure psoriasis. Paste of leaf is applied against scabies, boil & leprosy. Latex contains the alkaloids berberine and protopine.

***Aristolochia bracteolata* Retz. (Aristolochiaceae)**

Vernacular names: Dhumra patra (Sansk.), Atutinappalai (Taml. & Mal.)

Uses: Juice of whole plant is mixed with equal quantity of sesame oil, boiled upto dehydration and applied on skin to cure psoriasis and other skin diseases. Aristolochic acid exhibits anticancer activity as well as antitubercular activity.

***Aristolochia indica* L. (Aristolochiaceae)**

Vernacular names: Ishvari (Sansk.), Isvaramuli (Taml.), Isvaramuli (Mal.)

Uses: Ash of whole plant and coconut oil are mixed and applied externally for skin diseases. Root ground with honey and applied on white spots. Leaf paste is used against leucoderma. Biological activity - Same as *A. bracteolata*

***Azadirachta indica A. Juss.* (Meliaceae)**

Vernacular names: Nimba (Sansk.), Vepa (Taml.), Vepu (Mal.)

Uses: Required quantity of leaves and turmeric are made into a paste with hot water, applied for scabies and vitiligo. The seed oil (margosa oil) is used in skin diseases such as scrofula, indolent ulcers, sores and ringworm. Oil possess anthelmintic and insecticidal properties. Neem contains nimbidin.

***Cassia auriculata* L. (Fabaceae)**

Vernacular names: Talapotaka (San.), Avaram (Taml.), Avara (Mal.)

Uses: Seeds ground with water and applied on skin. Root is used in skin diseases. Ethyl acetate extract showed antiviral properties. The anthraquinone compounds are antibacterial, antifungal and irritant.

***Cassia fistula* L. ((Fabaceae)**

Vernacular names: Araghwada (Sansk.), Konnai (Taml.), Kanikonna (Mal.)

Uses: Flowers are ground with lime juice and applied on skin to cure itching and fungal infections.

***Centella asiatica* L. Urban (Apiaceae)**

Vernacular names: Mandukaparni (Sansk.), Vallarai (Taml.), Kodangal (Mal.)

Uses: Leaves are used both internally and externally in syphilitic skin diseases. Said to promote complexion. Asiatic acid and asiaticoside improve skin texture and useful in pruritis and healing ulcers and wounds. Asiaticoside and derivatives effective in leprosy tuberculosis.

***Corallocarpus epigaeus* Benth ex. Hook. f. (Cucurbitaceae)**

Vernacular names: Patalagaruda (Sansk.), Akasagarudan (Taml.), Kollanhova kizhangu (Mal.)

Uses: The tubers are grated, dried and powdered. The powder is mixed with coconut oil and exposed to sunlight and then applied on skin in a wide variety of skin diseases. Contains essential oil and resin which are antibacterial.

Cynodon dactylon **(L.) Pers. (Graminae)**

Vernacular names: Dhurva (Sansk.), Arugampullu (Taml.), Karuka (Mal.)

Uses: Required quantity of grass either alone or with some turmeric ground into paste. It is applied on to skin to cure all kinds of skin diseases. Antiviral and antifungal activity of extracts established.

Dalbergia latifolia **Roxb ((Fabaceae)**

Vernacular names: Shishapa (Sansk.), Ithi (Taml.), Ithi (Mal.)

Uses: Stem bark rubbed with water or oil to cure leucoderma. Extract found to possess anthelmintic activity.

Elytraria acaulis **Lindau (Acanthaceae)**

Vernacular names: Ezhuthanippundu (Taml.)

Uses: Leaf juice is mixed with equal quantity of sesame oil and applied externally for skin diseases.

Enicostemma litorale **Blume (Gentianaceae)**

Vernacular names: Nagajivha (Sansk.), Vellarugu (Taml.), Vallari (Mal.)

Uses: Paste of whole plant is mixed with hot water and smeared on the skin. Extract shown to be antibacterial and fungistatic.

Erythroxylum monogynum **Roxb. (Erythroxylaceae)**

Vernacular names: Jeevadali maram (Taml.) Devadaru (Mal.)

Uses: Oil extracted from the wood and stem bark is used to cure all types of acute skin diseases. Wood contains an essential oil.

Euphorbia hirta **L. (Euphorbiaceae)**

Vernacular names: Dugdhika (Sansk.), Amman pacharisi (Taml.) Nelapala (Mal.)

Uses: Powder of whole plant is given internally and paste is applied externally particularly for allergic skin diseases. 50% extract found to posses antiviral and anticancer properties.

Ficus religiosa **(L.) Moraceae**

Vernacular names: Aswatta (Sansk.) Arasu (Taml.), Arayal (Mal).

Uses: Bark rubbed with water, applied on dermatitis particularly in 'kumkum' dermatitis. 30 g of root bark is boiled with 300 ml of water and reduced to 100 ml. and given with sugar and milk for scabies. Water extract shown to be antibacterial.

Hemidesmus indicus **R. Br. (Asclepiadaceae)**

Vernacular names: Ananta (Sansk.), Nannari (Taml.), Narunecendi (Mal.)

Uses: 20g of root is boiled with 500ml of water reduced to 200 ml. 100ml of decoction is taken regularly twice a day. Root powder with edible oil made into ointment consistency and applied on pimples. Pome salicyclic aldehyde is the active principle against leprosy bacteria.

Ocimum amerianum **L. (Labiatae)**

Vernacular names: Ajaka (Sansk.) Ganjankorai (Taml.), Katturamathulasi (Mal.)

Uses: Leaves made into paste, used in parasitical skin diseases. The essential oil and components shown to be antibacterial and antifungal.

Plumbago zeylanica **L. (Plumbaginaceae)**

Vernacular names: Chitraka (Sansk.), Kodiveli (Taml.), Tumpukote velli (Mal.)

Uses:Root paste is applied against chronic skin diseases. Plumbagin is a strong irritant and a powerful germicide.

It possesses anticancer activity.

***Tinospora cordifolia* (Wild) Miers (Menispermaceae)**

Vernacular names: Guduchi (Sansk.), Seenthil (Taml.), Sittamrytu (Mal.)

Uses: For chronic skin ulcers, apply leaves smeared with castor oil and warmed till flaccid. Contains berberin alkaloids.

***Pongamia pinnata* (L) Merr (Fabaceae)**

Vernacular names: Karanja (Sansk.) Pungu (Taml.), Punnu, Ungu (Mal.)

Uses: Seeds are made into paste and used as external application for leprous sores & skin diseases. Karanjin is the active principle responsible for the curative effect of the oil in skin diseases.

***Sesbania sesban* Merr. ((Fabaceae)**

Vernacular names: Jayanti (Sansk.) Karunchemabai (Taml.) Sempa (Mal.)

Uses: Oil prepared with flowers are used as antidandruff. Equal quantity of leaves paste of *S. sesban* and *Acalypha indica* are mixed with salt and smeared on skin.

***Terminalia arjuna* W & A (Combretaceae)**

Vernacular names: Arjuna (Sansk.), Marudu (Taml.) Vellamaruthu (Mal.)

Uses: Bark powder is mixed with coconut oil and applied to cure leprosy. Fresh fruits are boiled until soft and converted into paste and applied. Terminalia tannins are shown to be antibacterial.

***Thespesia populnea* Soland ex. Correa (Malvaceae)**

Vernacular names: Parisha (Sansk.) Puvarasu (Taml.), Cheelandi (Mal.)

Uses: Equal quantity of flower, fruit and bark are mixed, powdered. About one teaspoon of powder is given daily. Ash of leaf powder is mixed with coconut oil and smeared on all kinds of skin diseases. Yellow liquid from the fruit is applied externally to scabies, psoriasis and other skin diseases. Antipsoriatic activity confirmed in clinical trials.

***Vernoria cinerea* Less (Compositae)**

Vernacular names: Sahadevi (Sansk.), Neychitti (Taml.), Puvan karuntal (Mal.).

Uses: Mature flower heads are made into a paste with oil and applied to cure leucoderma.

Acknowledgement

We are immensely thankful to the Director, Central Council of Research in Ayurveda & Siddha, New Delhi, for financial support & facilities in our studies.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 262 -264, 1999

A study on the plants in folk medicine of Srivilliputhur taluk of Tamil Nadu

V. JAYABARATHI & C. JANAKA KUMARI

Sri Parasakthi College
Courtallam - 627 802, Tamil Nadu.

Abstract

The present paper deals with forty six species of plants belonging to 40 genera used by the common folks of Srivilliputhur Taluk of Virudhunagar District in Tamil Nadu for curing various ailments. The paper includes some of the commonly used cultivated as well as wild plants by the folk, in medicine. For each species, botanical name, vernacular name, family name and uses are given.

Introduction

Srivilliputhur Taluk is very close to Chathuragiri Hills of Western Ghats of Virudhunagar District in Tamil Nadu. It is a taluk of mostly villages and agriculture is the main occupation of the people. The climate is hot and dry. The average rain fall is from 8 cm to 35 cm. Heavy rainfall occurs during October and November. Villages at the foot of Chathuragiri hills like Watrap, Maharajapuram, Sundarapandiam, Pudupatti, Koomapatti, Meenakshipuram, Krishnankovil, Thambipatti, Ramachandrapuram, Malli and Coonoor were surveyed for folk medicinal plants.

The following is an enumeration of some plants used by the folk in day-to-day life. The information was collected from the village folk and local medicine men. The plants are arranged alphabetically according to botanical names, followed by local names in Tamil and their uses.

Enumeration

Aegle marmelos Corr. ('Vilvam') Rutaceae. Leaves and root used for fever and stomach ache. Fruit is a medicine for chronic diarrhoea.

Agave americana L. ('Katralai'). Liliaceae. Used as antiinflamatary medicine. Also used along with onion and lemon juice for stomach ache.

Allium cepa, L. ('Ulli') Liliaceae. Juice mixed with ghee, jaggery and lime and use for stomach disorders. Juice is used for insect bites.

Allium sativum L. ('Vellai poondu') Liliaceaece. Roasted scale leaves are made into a paste with honey and used for gastrities. Boiled with cow milk and taken to reduce high blood pressure. Juice is used as an external medicine for headache.

Alstonia scholaris R. Br. ('Ezhilaipalai') Apocynaceae. Bark used to cure diarrhoea, and malaria. It is also used for skin diseases.

Adhatoda zeylanica, Nees ('Adhathodai') Acanthaceae. Juice of leaves is used for cough, cold and decoction is given to cure fever.

Acalypha indica L. ('Kuppai mani') Euphorbiaceae. Leaves are used to cure cough, bornchitis, ulcers, wounds, scabies. Root is used as a laxative.

Abutilon indicum L. ('Thuthi') Malvaceae. Useful to cure head ache, fever and uterine disorders

Acorus calamus L. ('Vasambu') Araceae. Used for cuts, cough, diarrhoea, epilepsy, fever hysteria and piles.

Azadirachta indica, A Juss. ('Vembu') Meliaceae. Leaves pound into a paste and mixed with turmeric powder and used to cure mumps, small pox and boils. Leaf juice is used for malaria and undulant fever. It also used for skin diseases. Bark is used against eczema.

Andrographis paniculata, Nees ('Sirianangai') Acanthaceae. Leaves are used as an antidote for snake bite and scorpion bite.

Borrieria hispida L. ('Nathai churi') Rubiaceae. Leaves used to cure jaundice.

Boerhaavia diffusa L. ('Charanathi') Nyctaginaceae. Root decoction is used to cure urinary disorder.

Centella asiatica L. ('Vallarai'). Umbelliferae. Leaves are used to strengthen nerves. Decoction of leaves are used to cure leprosy.

Cassia auriculata L. ('Aavarai') Fabaceae. Leaves are used to cure nervous disorder, to strengthen the nerves and also as a head scalp cleaner. Bark is used to cure stomach disorders.

Cassia occidentalis L. ('Ponnavarai') Fabaceae. Leaves are used as a paste to cure inflammation.

Cassia fistula L. ('Charakonrai') Fabaceae. Pulp of the fruit is used as purgative

Cleome viscosa L. ('Naikadugu') Capparidaceae. Leaves are used for teech ache.

Cyperus rotundus L. ('Koraikizhangu') Cyperaceae. The rhizome is used to reduce body heat, irritation in the eye, cough and cold. It is also used to cure ulcer in the stomach.

Cynodon dactylon Pens. ('Arugampul') Poaceae. The juice is used as an anti dote. It also cures skin ailments.

Cardiospermum halicacabum L. ('Mudakkaruthan') Sapindaceae. Juice of the leaves is used as an antidote, refreshing drink, and also to cure skin diseases. Leaves are mixed with rice and mung flour and cooked and used to cure joint pain and back pain.

Dodonaea viscosa L. ('Virali') Sapindaceae. Leaves are boiled and used as an anti-inflammatary agent.

Eclipta alba. L. ('Kaiyanthakarai') Asteraceae. Used as hair tonic and against jaundice.

Evolvulus alsinoides L. ('Vishnukiranthi') Convolvulaceae. The whole plant is used to prepare a decoction which cures stomach disorder and fever.

Emblica officinalis Gaertn, ('Nelli') Euphorbiaceae. Fruit is used in 'triphala' to cure Kapha, Pitha diseases. Juice is given to cure jaundice and anaemia.

Euphorbia hirta L. ('Amman pacharasi') Euphorbiaceae. The plant is used to cure asthama, bronchitis, gonorrhoea and intestinal worms.

Heliotropium indicum L. ('Thelkoddukkupatchilai') Boraginaceae. Leaves are used for tuberculosis, gonorrhola and leucorrhoea.

Jatropha glandulifera Roxb. ('Athalai') Euphorbiaceae. Juice of the stem is used for peptic ulcer.

Lippia nudiflora Mich. ('Poduthilai') - Verbenaceae. Leaves are used to cure cough, cold and fever especially in children. Used also for stomach disorder.

Leucas aspera Spr. ('Thumbai') Lamiaceae. Whole plant is boiled and the vapour is used to cure cold, cough and headache.

Momordica charantia, R.Br. ('Pakal') Cucurbitaceae. Leaves used for stomach disorder and fruit for diabetes.

Mollugo cereviana, Scr. ('Parpadakam'). Aizoaceae. Plant is used to cure fever and ulcer.

Murinda tinctoria, Roxb ('Manjanathi') Rubiaceae. Leaves are used for sprain, blood clot and also for inflammation. Juice of the leaf is mixed with onion juice and used for amoebiosis.

Ocimum sanctum L. ('Thulasi') Lamiaceae. Leaves are used to cure cold, cough, fever and intermittent fever.

Pedalium murex L. ('Aanai nerungi'), Pedaliaceae. Fruit is pounded, decoction is prepared and used against gonorrhoea.

Punica granatum ('Mathulai') Punicaceae. Rind of the fruit is used to cure diarrhoea and dysentry.

Solanum surattense Burm. ('Kandankathiri') Solanaceae. Root used for tuberculosis, fever and cough. Removes kidney stones.

Solanum trilobatum L. ('Thoothuvalai') Solanaceae. Decoction of leaves to cure cough and fever. It is also used against cancer.

Tridax procumbens L. ('Kintaradi poondu') Asteraceae. Leaves are used as a paste to cure wounds and ulcers.

Thespesia populnea Car. ('Poovarasu') Malvaceae. Leaf and bark are used against scabies and eczema.

Tinospora cordifolia Miers ('Seenthilkodi') Menispermaceae. Root is used to cure fever. Stem is used to cure diarrhoea and fever.

Trianthema portulacastrum L ('Charanai') Ficoideae. Leaves are used against jaundice, diabetes and fever.

Tribulus terrestris L. ('Nerungi') Zygophyllaceae. Fruit is a medicine for urinary disorder and gout.

Tylophora asthmatica R.Br. ('Nanjarruppan') Asclepiadaceae. Root is used for diarrhoea and leaves for asthma.

Zingiber officinale Rosc. ('Inji') Zingiberaceae. Rhizome used for cold, fever, cough and stomach disorder.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants 265-268, 1999

Ethnomedical information on some pteridophytes of the Western Ghats

P. J. MATHEW, MATHEW DAN, C. M. UNNITHAN & P. PUSHPANGADAN

Tropical Botanic Garden & Research Institute,
Palode, Thiruvananthapuram - 695 562, Kerala.

Abstract

This paper gives ethno-medico-botanical information on 10 species of pteridophytes gathered from traditional healers of 9 tribal communities of Kerala state. Details on ethnomedicinal aspects of the species such as medicinal part, method of preparation of crude drug, mode of external application/ administration, dosage and duration of treatment are given besides botanical aspects such as scientific name, family, habit, habitat, distribution and voucher specimen numbers of the species. These preliminary basic information recorded here may be useful for traditional health care practise and phytotherapy research based on these species.

Introduction

Since time immemorial some pteridophytes are being used as curative plants in India . Pteridophytes were also used in the ancient treatment systems of China, Europe, N.America, Brazil, Argentina and Africa (Banerjee and Sen 1980). There are reports from India on ethnic / folk medicinal uses of pteridophytes(Puri and Arora 1957, Dixit Bhatt 1974, Dixit *et al* 1978 and Jain *et al* 1991) . Hartwell (1968, 1970 and 1971) and Banerjee and Sen (1980) have suggested that pteridophytes are a potential group of plants for pharmacological investigations. Schultes (1996) has pointed out that angiosperms are highly explored and exploited for their medicinal potentialities, while pteridophytes are considerably neglected.

The southern part of the Western Ghats that enjoys luxuriant rains and high humidity is a haven for pteridophytes. About 250 species of pteridophytes are reported from

Kerala sector of the Western Ghats (Nayar 1997). Therefore this area is an ideal geographic region to be searched for medicinally potential pteridophytes. The Ghat region of Kerala harbours a rich ethnic cultural diversity too. About 30 distinct ethnic tribes are dwelling in this region. Each of them have their own cultural and health care traditions. But as a result of aculturation,their traditional health care knowledge is getting lost. Therefore, the studies leading to the conservation of ethno-medical knowledge is an urgent need of the time. The present study is an attempt to record such ethno medico botanical knowledge of nine tribal communities of Kerala, with reference to pteridophytes.

Methodology

The authors repeatedly visited selected settlements of the tribes, *Adiyan, Irular, Kani, Kattunaikan, Malappandaram, Malayan, Muthuvan, Pathinaikan* and *Ulladar* and established good rapport with elderly knowledgeable persons of these settlements who practise tribal medicine. They shared their experiences on herbals in informal discussions with the authors. On request, they accompanied the authors to nearby forest areas of their settlements and located the plants used by them. Specimens for the herbarium were collected, identified and voucher specimens were deposited in the herbarium of TBGRI, Palode.

Observations and results

First hand ethno-medico-botanical information on 10 species of pteridophytes were recorded below. Ethnomedicinal aspects of the species such as medicinal part, method of preparation of crude drug, mode of application / administration, dosage and duration of treatment are given. Botanical aspects such as scientific name, family, habit, habitat, distribution and voucher specimen numbers are also supplemented.

Actiniopteris radiata **(Sw.) Link.**
Actiniopteridaceae

A pretty small herb, terrestrial or lithophytic,forming colonies in fully exposed dry places. Its laminae are semicircular, dichotomously divided upto 6 times. *Irular* tribals (Palakkad district) use leaf juice of the plant to cure dysentery in children. The juice mixed with breast milk, given internally for 3 days. The plant possesses anthelmintic property. In West Indies its leaves are chewed for sore throat and decoction of its rhizome is used to cure dandruff.

Voucher specimen - TBGRI 1880

Angiopteris erecta (Forst.) Hoffm.
Angiopteridaceae

A stout, elegant herb which grows upto 1.7 metres. The plant prefers moist evergreen condition and distributed at an elevation of 50-1830 m. Its fronds has thick branched stipes with a basal fleshy stipule. Circinate leaves of the plant are used by *Adiyan* tribals (Wyanad District) against tumours. They apply paste made out of the leaves on tumour, once in a day up to three days.

Voucher specimen - TBGRI 2245

Drymoglossum heterophyllum **(L.) Trimen**
Polypodiaceae

An epiphytic fern growing on tree trunks along stream banks and shaded moist areas up to an altitude of 1000 m. The rhizome is creeping, wiry and blackish brown. Sterile leaves are orbicular-ovate and fleshy. Fertile leaves are oblong, narrow and thin. The plant is used by *Kani* tribals (Thiruvananthapuram District) against jaundice. The whole plant grind to paste and mix with coconut milk . This mixture is given internally, thrice a day.

Voucher specimen - TBGRI 7705

***Equisetum ramosissimum* Desf. Equisetacea**

A rizhomatous herb growing in marshy lands. The stem is cylindrical, hollow, rough and having ring like nodes. The leaves are very small and scaly. The plant is used by *Muthuvan* tribals (Idukki District) for pain in joints. The whole plant grind to paste and apply on joints, once in a day for about 7 days. In South Africa, Suto women used to drink the decoction of the rhizome against sterility.

Voucher specimen - TBGRI 5881

***Helminthostachys zeylanica* (L.) Hook. Ophioglossaceae**

A single leaved rhizomatous herb growing upto 30cms.; seen in open swampy areas. The stipes are produced annually from the creeping rhizome. The lamina is ternately divided into lobes. *Kattunaikan* tribals (Malappuram District) use the plant against snake bite .Paste made out of the rhizomes of this species and that of *Calanthe masuca* is applied on wound of the bite and also on crown of the head of the wounded. In Malaysia the tender stalks of the plant is eaten. The rhizome is used against dysentery, malaria, and also used as tonic and mild aperient. The leaf juice relieves blisters on tongue.

Voucher specimen - TBGRI 3946

***Hemionitis arifolia* (Burm.) T. Moore Hemionitidaceae**

A small herb with dark green leaves and blackish stipe. The leaves are cordiform and leathery. It is a common fern found on partially shaded cuttings, upto an altitude of 1400m. *Ulladan* tribals (Pathanamthitta District) used to administer decoction of the whole plant to cure fever. *Irular* tribals (Palakkad District) use juice of the entire plant mixed with leaf juice of the plants-*Ocimum sanctum, Amaranthus viridis* and *Leucas aspera* against vomiting in children.The fronds are reported to be used in treating aches. In Philippines, juice of the plant is used to cure burns. The plant possesses anti-bacterial property. (Banerjee and Sen 1980).

Voucher specimen - TBGRI 7107, 1881

***Lygodium flexuosum* (L.) Sw. Lygodiaceae**

A climbing fern having wiry stem of about 3mm thickness. Fronds are tripinnately lobed, while in juvenile stage they appear as palmately lobed. This plant is seen in partially exposed areas up to 800m. *Malappandaram* tribals (Kollam District). use the plant to cure burns.A few pieces of the entire plant fried in coconut oil and grind to paste with a little coconut oil. This paste is applied over burns repeatedly for 4-5 days whenever it gets dried up. *Pathinaikan* tribals (Malappuram District) use the plant for treating epilepsy. The root of the plant grind to paste and given internally,4 times a day. The plant has significant antibacterial property (Banerjee and Sen, 1980).

Voucher specimen - TBGRI 2290, 3932

***Pityrogramma calomelanos* (L.) Link Hemionitidaceae**

A beautiful herbaceous fern growing upto 50cm height. Its stipes are dark brown and the fronds are having about 12 pairs of pinnae. The fronds are coated below with silver coloured waxy powder. This species is common in partially exposed places upto 1800m. *Malayan* tribals (Ernakulam District) administer juice of the whole plant for smooth expulsion of placenta after delivery. Decoction of the plant is used against kidney disorders in Philippines; tea prepared out of its fronds is used to cure flu, hypertension, fever and cough in Trinidad. Rhizome is considered as anthelmentic in South Africa. The leaves possess antibacterial property (Banerjee and Sen, 1980).

Voucher specimen - TBGRI 8781.

Selaginella delicatula **(Desv.) Alston Selaginellaceae**

A delicate herb growing on partially shaded moist cuttings and slopes. It is seen throughout the southern part of the Western Ghats. The *Malayan* tribals (Ernakulam District) use this plant for healing external ulcers. They apply juice of the whole herb on ulcers.

Voucher specimen - TBGRI 8768.

Selaginella wightii **Hieron. Selaginellaceae**

A pretty prostrate herb having creeping branched stem with small leaves arranged densely and spirally. It is seen in open, dry rocky areas .This is a rare species reported only from two localities in Kerala. It has a wonderful adaptation to resurrect after drought. It is used by *Muthuvan* tribals (Idukki District) against urinary infections. They administer decoction prepared out of the entire plant (using a few chopped pieces) and some cumin seeds,twice a day for 2-3 days.

Voucher specimen - TBGRI 5895.

Acknowledgements

The authors are thankful to the traditional healers of the various settlements of the 9 tribal communities for imparting their valuable traditional health care knowledge.

References

Banerjee, R. D. and Sen, S. P. 1980. Antibiotic activity of Pteridophytes. Econ. Bot. 34: 284-98.

Dixit, R. D. and Bhatt, G. K. 1974. Ferns: a much neglected group of medicinal plants II. J. Res. Ind. Med. 9 : 59-68.

Dixit, R. D, Anjali Das and Kar, B. D. 1978. Studies on ethnobotany III. On some less known edible, economic and medicinal ferns of Darjleeing Dt., West Bengal. Nagarjun, 21 : 1-4.

Hartwell, I. N. 1968. Plants used against cancer: - A survey. Lloydia, 31 : 71-170.

Hartwell, J. N. 1970. Plants used against cancer: A survey. Lloydia, 33:97-194, 288-392.

Hartwell, J. N. 1971. Plants used against cancer: A survey. Lloydia, 34: 386-425.

Jain, S. K., Sinha, B. K. and Gupta, R. C. 1991. Notable plants in ethnomedicine of India. Deepa Publications, New Delhi.

Nayar, M. P. 1997. Biodiversity challenges in Kerala and science of conservation Biology. In: Biodiversity and Tropical forests - The Kerala Scenario. (ed.) P.Pushpangadan & K.S.S. Nair, STEC, Thiruvananthapuram.

Puri, G.S and Arora, R.K. 1957. Some medicinal ferns from Western India. Ind. Forest. 87 : 179-183.

Schultes, R. E. 1996. The Plant Kingdom - A Thesaures of Biodynamic Constituents. Ethnobotany, 8 : 2-13.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants 269-273, 1999

Immunomodulating medicinal plants in folk medicine of Goa, India

M. V. G. ACHARYA & K. KUPPURAJAN

A. L. Research Centre for Ayurveda
Central Council for Research in Ayurveda and Siddha
Chennai – 600 113, Tamil Nadu.

Abstract

Ethnomedicine information collected from the rural folk of Goa is presented. Botanical names of plants along with Sanskrit names, common names and uses are given.

Introduction

The present paper is an output of ethno-medico-botanical survey of Goa during the year 1991-95 in different seasons. These claims were recorded from cattle tenders known as 'Dhanagars', rural public and traditional medicinal practitioners.

Many interesting and worthwhile claims for different diseases are reported. Out of them, certain important claims for bettering health conditions, methods to enhance immunity and regulate certain metabolic processes are discussed in this paper. These immuno modulators deserve due attention as they have stood the test of time.

Immunomodulating agents can be better understood and correlated with the concept of *rasayana*, *vayastapana*, *vrushya*, *vajeekarana*, *balya* and *ojaskara*. For each species, the dose and diet pattern restrictions are explained. (Table 1)

Table 1. Immunomodulating plants of Goa

Sl.	Botanical name	Family	Administration	Uses and dose
1	*Actinopteris radiata* (SW) Link *Mayura shikha **Locality name	Polypodiaceae	10 g. of total plant powder mixed in 2 g. of dried ginger boiled with 250 ml. of milk and sweetened. According to taste twice a day for 21 days to be given internally for immunity.	Antibiotic, Antidibetic,febrifuge, antidiarrheal, haemostatic, aphrodisiac, diuretic strengthens body tissues also in urinary tract infections. 1 – 2 g
2	*Adiantum lunulatus* Burm. *Hamsapada **Hamsaraj	Polypodiaceae	10 g of total plant powder mixed with *Evclvulus alsinoides* and *Actinopteria radiata* 10 g. each and mixed in 30 g. of sugar candy to be given internally twice a day for 40 days to get body strength.	Detoxicant, antibiotic, blood purifier, expectorant. 1-3 g.
3	*Cissus quadrangularis* L. *Asthi Srunkhala/Asti Samhari ** Kandevel	Vitaceae	25 gms of tender stem chopped and fried in castor oil is given for reducing all allergic symptoms. Tender stem made into a 'chatnee' with some spices and condiments used regularly with food for disease resistance.	Antibiotic,demulcent, appetiser, aphrodisiac. Juice 10-20 ml.
4	*Cuccina grandis* W&A *Bimbi **Tondli	Cucurbitaceae	a) Total twiner is made into a paste and mixed with *Argemone mexicana* (Swarna kasheeri) latex and applied externally in severe infected wounds to speed up healing.	Anti diabetic, nervine tonic, hepatic stimulant, demulcent, haemostatic.

			b) 10 g of leaf paste is given along with 250 g of curd for 40 days to treat viral hepatitis	
5	*Curculigo orchioides* Gaertn *Talamuli **Nelapana – Kelanga	Hypoxidaceae	10 to 20 g of root paste along with honey. Once a day to be given for 40 days improve health and emaciation.	Aphrodisiac, useful in urinary tract infections, diuretic, nervine Tonic, geriatric. 3-6 g
6	*Cycas ciricinalis* L. **Jangli sindoli	Cycadeceae	10 g of dried stem powder, 20 g of sugar candy to be given internally followed by 100 ml. of decoction made with 10 g of coriander seeds mixed with 100 ml. of milk once a day for 21 days in wasting disease.	
7	*Evolvulus alsinoides* L. *Vishnukranta **Vishnukranta	Convolulaceae	10 g. of dried powder of the total plant mixed in 10 g. of sugar candy, 5 g. of dried g., 5 grams of *Piper longum* mixed in 250 g. of curd given internally once a day for 21 days to strengthen the nervous system.	Nervine tonic, appetiser, demulcent, digestive, haemostatic, diuretic, aphrodisiac, antibiotic, expectorant. 3 - 6 g. 20-40 ml. of juice.
8	*Hemidesmus indicus* R. Br. Sariba	Periplocaceae	2 g of root powder, 20 g of sugar candy with 250 ml. of milk to be given internally twice a day.	Demulcent, appetiser, digestive, blood purifier, uterine tonic, aphrodisiac, detoxicant. 3-6 g.
9	*Hygrophila auriculata* (Schum.) Hetne	Acanthaceae	10 g of root paste or 20 ml juice mixed in cow's urine and given	Nervine tonic, hepatic stimulant,

	*Kokilaksha, Ikshura **Talimkhane		internally twice a day for 40 **days** to treat viral hepatitis and promote healthy condition.	demulcent, heamostatic, aphrodisiac, **diuretic. 1-3 g**
10	*Hybanthus suffruticosus* L. *Ratna purusha **Ratna purusha	Violaceae	10 g of total plant is ground along with 5 *Piper longum*, 2.5 g of dried ginger, 2 cloves of *Allium sativum* and mixed in 250 g of curd and given internally once a day for 40 days to improve body strength.	
11	*Pedalium murex* L. *Gaja Gokshura **Kante Gokshur/ Hatti saratte	**Pedaliaceae**	10 gms of leaf paste is mixed with a cup of water and allowed to stand. The mucilage is taken with sugar or honey for promotion of immunity or disease resistance	Aphrodisiac, diuretic, analgestic, demulcent, nervine tonic. 3-6g
12	*Pergularia daemia* R. Br. *Uttamarini **Uttamaree	Asclepia-daceae	10 g of lead, 5 cloves of *Allium sativum* ground well and mixed in 250 g of curd given internally once a day for 21 days to improve disease resistance.	
13	*Purerla tuberosa* (Roxb-Ex Willd) Dc. * Bedariya. **Vidari kanda	**Papilionaceae**	10 g of root powder, 20 g of sugar candy, 5 g of dried ginger mixed in 250 g. of curd given internally once a day for 40 days in emaciation and sexual debility in male.	Haemostatic, analeptic, aphrodisiac, diuretic, geriatric, hepatic-stimulant, antibiotic. 3 to 10g.
14	*Soymida febrifuga* A. Juss	Meliaceae	a) 10 g of dry root powder, 20 g	Improves the repair

	*Mamsarohini **Rohanchi Jhad		of sugar candy, 200 ml. of milk to be given internally once in a day for 21 days to promote immunity b) 50 g of stem bark ground and made a decoction in which 1 g of Jeeraka and 25 g of blackgram may be added and again boiled and given internally once a day for 40 days to strengthen nervous system.	mechanism of the skin, haemostatic, antispasmodic. 1-3 g.
15	*Sphaeranthus indicus* L. *Mundi, Hapusha *Gorakh mumdi	Composit-aecae	25 g. of total plant put into 100 ml. of water boil it as decoction, made 50 ml. add one spoon of ghee (5 g.) and 10 ml. of milk will be given on empty stomach once in a day for 21 days to get strength for nervous.	Nervine tonic, appetiser, digestive, aphrodisiac, antibiotic, cardiac tonic, febrifuge and blood purifier
16	***Terminalia chebula*** **Retz.** *Hareetaka **Harade	**Combretaceae**	5 g of fruit pulp powder + 2.5 g of *Hamedesmus indicus* root powder. 2.5 g of dried ginger, 2.5 g of *Piper longum* and 2.5 g of *Piper nigrum* to be ground well and given internally once a day along with 250 g of curd for better absorption and to improve metabolitic processes.	Nervine tonic, demulcent, laxative, antibiotic, haemostatic, aphrodisia, geriadric, analeptic. 3 - 6 g of laxative, 2 – 4 g for all other purposes
17	*Vinca rosea* L. *Nityakalyani **Nitya kalyani/ Sadaphuli	Apocynaceae		Appetiser, hepatic stimulant, blood purifier

*sanskrit ** common name

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 274 -281 , 1999

Medicinal use of spices for skin care in Unani medicine

A. LATIF & S. Z. RAHMAN

Dept. of Ilmul Advia, A. K. Tibbiya College
Aligarh Muslim University
Aligarh – 202 002, Uttar Pradesh.

Abstract

Different spices and their uses in skin care in Unani system of medicine are described.

Introduction

As we know that skin diseases are very common in India and a vast majority of villagers depend on home remedies for common ailments based on medicinal plants which belongs to spices group. The practice of spices (medicinal plants) date back to the very early period of the human history. There is evidence of medicinal plants and spices having been used in the treatment of various diseases in all old civilisations e.g. the Indian, Chinese, Egyptian, Romans & Greek. Many spices are valued as medicines in Ayurveda and Unani systems. This paper reviews the various spices used in Unani system of medicine.

Allium cepa (Liliaceae)

Chemical constituents: Onion contains essential oil and compound similar to glucosinolates found in mustard. It also contains protein, calcium, iron and riboflavin.

Pharmacological properties: Stimulant, mild counter irritant, diuretic, antiphelgmatic, antimicrobial, antifungal.

Uses: It's juice is mild, irritating to skin and increase blood circulation in the mucous membrane. It's juice is applied on scalp for dandruff. Sometimes cut onion is applied to remove small warts.

Allium sativum (Liliaceae)

Description: The 'Seer' or

'Lahsun' (garlic) is bulb of *Allium sativum* L. Garlic is a sub-globular compound bulb surrounded by dry white membranous scales. Garlic has a disagreeable smell and burning taste.

Chemical constituents: Essential oil contains allyl propyl disulphide, and diallyl disulphide beside sulphur containing compounds allicin and allistatin. Allicin is pungent tasting somewhat acrid and irritating. Allicin also have antitumor and hypoglyacemic property.

Pharmacological properties: Stimulant, antihelmintic, diaphoretic, diuretic, oil is a strong stimulant and antiseptic, soothing agent, hypoglyacemic and anticholesterol. It is a good blood purifier.

Uses: It is used as blood purifier against ringworm by rubbing it over affected part; oil is germicidal and beneficial in scabies. Also useful in maggot infested ulcers and wounds.

***Anethum graveolens* L. (Umbelliferae)**

Description: The 'Shibth' (Arabic name) or 'Soya' (dill) is an annual or biennial herb. Dill is widely cultivated in India. Dill herb is also called as dill weed, has a smooth surface, grows to a height of 75 cm, with a spread of 30 cm. The green stem is hollow and smooth, many branches at the top and carries large flat umbells of bright yellow small flowers, the leaves are ultra-fine, feathery, and dark green. The flat oral seeds are parchment coloured and have a rather bitter flavour.

Chemical constituents: Essential oil, anetheole, apiol, carvone, anethine.

Pharmacological properties: Aromatic, stimulant, febrifuge, resolvent, diuretic.

Uses: Seeds bruised and boiled in water to be applied on inflammations externally. A fresh dill poultice is used for abscess. It is also used for flavouring soups.

***Amomum subulatum* Roxb. (Zingiberaceae)**

Description: The 'Heel kalan' ('Qaqlah kibr') cardamom major is the dried ripe fruits and seeds of *Amomum subulatum* Roxb. Abundant in eastern Himalayas, Sri Lanka and Nepal. Cardamom major sometimes is used as a substitute of a cardamom (minor).

Capsules of *Amomum subulatum* is much larger than *Elettaria cardamomum*. It is dark brown in colour and three-valved. Each valve is furnished with three ragged, membranous wings, extend towards upper part of fruit and disappearing at apex. The seeds are arranged as in cardamom. Its taste is aromatic and camphoraceous.

Chemical constituents: Borneol, cineole, limonene, terpineol, essential oil.

Pharmacological properties: Anthelmintic, tonic for skin, antipyretic and astringent.

Uses: It is cheaper than cardamom so it is also used in place of cardamom (minor). It is also used in tooth powder preparations as flavouring agent. It is useful in gonorrhoea and skin ailments such as dermatophytes, scabies.

***Carum copticum* Benth (Umbelliferae)**

Description: The 'Nankhah' (ajwan desi) is the dried ripe fruit or seeds of *Carum copticum* Benth. The fruits are of the size and shape of parsley. It is greyish brown in colour. Each mericarp has five ridges. The odour is similar to thyme.

Chemical constituents: Aromatic, volatile oil, thymol (sat-e-ajwan) and minerals.

Pharmacological properties: Antimicrobial, antifungal (thymol), aphrodisiac, antioxidant, flavouring agent.

Uses : It is used in infections of skin and also beneficial in case, of fungal infection of skin. 'Ajwas kathol' or 'Sat-e-ajwas' is used as an antifungal agent.

Carum carvi **(Umbellifereae)**

Description: The 'Zerasiyah', 'Kamun' is dried ripe fruits of *Carum carvi* L. Carway is also called 'sushva', 'krishna – jiraka' or black cumin. The carway plant is biennial herb, 30-90 cm. In India it is cultivated in the hills of Kashmir, Kumaon and Garhwal.

Fruits are curved, slightly, elongated, 7 mm long & 2 mm wide. Ovoid, slightly arched, laterally compressed. Odour is aromatic, like cumin.

Chemical constituents: Essential oils present are corvone and carvacrol.

Pharmacological properties: Astringent, antiseptic, aromatic, anti-inflammatory, diuretic, anthelmintic and sedative.

Cinnamomum zeylanicum **Blum. (Lauraceae)**

Description: The 'dalchini' (cinnamon) is the dried inner bark of stem of *Cinnamomum zeylanicum* Blume. Occurs in Kerala and Tamil Nadu also as wild in Western Ghats. It is an evergreen tree of medium size. Leaves and dried inner bank ('dalchini') are used as a spice and condiment. Inner surface of bark is dark in colour, fragrant in odour, taste is sweet and aromatic with sensation of warmth. Bark is about 0.5 mm thick, brittle, single or double, closely packed compound quills. Outer surface dull, yellowish brown, marked with pale wavy longitudinal lines *with occasional small scars or holes.*

Chemical constituents: Carbohydrates, protein, fat, fibre, calcium, phosphorous, iron, sodium, potassium, vitamin, thiamin, vitamin C and A. Cinnamon has very important essential oil as cinnamon oil which contains eugenol.

Pharmacological properties: Demulscent, antiphelgmatic, astringent, stimulant, diuretic.

Uses: Bark of cinnamon is used in acne, useful in fungal infection of skin. Its oil is antiseptic and used as flavour in food and medicine.

Citrus medica **(Rutaceae)**

Description: The 'Turunj limu' is ripened fruit of citrus lemon. It is an evergreen shrub, 1.5 m to 3.6 m height with stem upto 10 cm. diameter. Fruit 5-7 cm long, obovoid, green but turn yellow when ripe.

Chemical constituents:

Essential oil, vitamin C and citric acid.

Pharmacological properties & uses: Rubefacient, lemon is anti-leprotic, antiseptic, juice inhibits synthesis of melanin pigment. It is used for fair complexion. It is mixed with camphor and rosewater and is used against itching and other skin disease, lemon is mixed with glycerin and applied for acne, lemon juice is bactericidal, antiscorbutic, and refrigerant. Lemon juice is effective against scabies. It promotes the function of skin. Due to rich source of vit. C it is used for revitalising skin.

***Coriandrum sativum* L. (Umbelliferae)**

Description: The 'Kishneez' ('Dhania') is a dried ripe fruit of *Coriandrum sativum* L., an annual perennial herb. The plant is erect, slender, glabrous, branched and sweet smelling. The plant is also known as 'Kothmir'. The fruits are spherical with longitudinal ridges, globular, green and tender turn brownish yellow when ripe. Odour aromatic, taste spicy.

Chemical constituents: Essential oil, volatile oil-1% and fixed oil-13%. It also contains minerals and vitamin such as calcium, phosphorous, iron, thiamin, riboflavin. Temperament cold and dry.

Pharmacological properties: Sedative, antiinflammatory, astringent, cooling & soothings.

Uses: A decoction of coriander seed powder mixed with turmeric powder is used for acne and black heads. It is used externally for ulcers and carbuncles. It is as used an ingredient of pharmaceutical preparations used as blood purifier (Araq musaffi-e-khoon) in unani medicine.

***Crocus sativus* L. (Iridaceae)**

Description: The 'Zafaran' or Saffron or 'Kesar' is the dried stigma and styles of the flowers of *Crocus sativus* L. Saffron is an annual herb. Quality saffron is obtained from Kashmir.

Chemical constituents: Natural colouring matter, glucoside crocin, picrocrocin, colchicine, starch, sugars, proteins and essential oil.

Pharmacological properties: It is stimulant for endocrine system and increases blood circulation. Aromatic, aphrodisiac, antipasmodic and flavouring agent.

Uses: In olden days it was used in colouring the cloths and colouring hairs and skin. Saffron is beneficial in various skin diseases eg. vitiligo and acne etc. It is also used as sun screen and in beauty creams.

***Cuminum cyminum* L. (Umbelliferae)**

Description: The 'Kamun' (Zera safed'/cumin) is the dried ripe fruits of *Cumin* The cumin is used as a condiment in India. Cumin plant is an annual herb, and grows upto 50 cm. high., much branched. Seeds oval in shape, 6 mm long, light yellowish in colour odour strong, aromatic.

Chemical constituents: Essential oil, thymol fixed oil, resin, gum, protein and also contain minerals and vitamins.

Pharmacological properties: Digestive, anthelmintic, antifungal, antiseptic, stimulant, diurectic, sedative, antispasmodic.

Uses: The cumin seed powder + turmeric powder mixed together is used as skin dye. The oil is used for eczema and also other skin diseases and against boils, burn and scald . Washing face with seed powder water infusion is beneficial in improving face complexion.

Curcuma longa **L. (Zingiberaceae)**

Description: The 'Uruk-es-sufr' (arabic name) 'haldi' or turmeric is a dried rhizome of *Curcuma longa* L. an annual herb rhizome are branched and yellow, deep orange coloured.

Chemical constituents: Essential oil, curcumin, minerals, protein, carbohydrates.

Pharmacological properties: Antiinflammatory, hepatoprotective, immuno stimulant, antimicrobial and antiviral.

Uses: It is used in boil, skin wounds and trauma and injuries. Effective against psoriasis, skin cancer and viral infections of skin. It is used externally and internally as a remedy for various skin diseases. It is widely used in beautification of face and body.

Elettaria cardamomum **Maton (Zingiberaceae)**

Description: The 'Heel khurd' (lesser cardamom) is a dried, ripe capsules of *Elettaria cardamomum* Maton, a perennial herb used as spice. The fruits are three sided, oblong or roundish capsule of yellowish brown or dirty white colour. Capsules with partition and each partition filled with closely packed angular tiny seeds, each surrounded by a thin transparent membrane (aril). The seeds, are dark blackish brown colour with shining, depressed helium. The capsule is tasteless. The seeds have agreeable flavour with slightly pungent and camphoraceous taste. Gives a cooling sensation to tongue.

Chemical constituents: Essential oil, coineol, terpinene, limonene, borneol, sabinine and terpineol.

Pharmacological properties: Aromatic, flavouring, stimulant, astringent

Uses: Due to aromatic flavour cardamom is used against bad breath. The essential oil is used in pharmaceutical industry, perfumery, tinctures and as a stimulant. It is also used in some chronic skin diseases eg. vitiligo, psoriasis, with cases of nervous depression.

Ferula foetida **Regd. (Umbelliferaea)**

Description: The 'Hilteet' (asafaetida) or 'Heeng' is collected oleogum – resin from rhizomes and roots of *Ferula foetida.* Plant is perennial herb, occurring in Persia & Western Afganistan. The resin gradually hardens and becomes brittle and is of a rich red brown colour. The odour is of garlic and carway oil. The taste is bitter and acrid.

Chemical constituents: It contains resin, gums and essential oil.

Pharmacological properties: Antispasmodic, stimulant, sedative and nervine, digestive, antiseptic, diuretic. Antidote for opium.

Uses: 'Hilteet' (asafoetida) is mixed with honey and applied for acne. It is also useful for toning up the skin on external application after mixing it with mustard oil it's used as skin cleanser. It is used in preparation of pharmaceuticals, "zimad-e-khanazeer", a lotion for lymphadenitis.

Foeniculum vulgare **Mill (Umbelliferae)**

Description: The 'Badiyan' ('saunf' or 'fennel') is dried ripe fruits of *Foeniculum vulgare* Mill. It is biennial or perennial aromatic herb of 1-2 m height and cultivated through out India. The fruits are oblong, pedicel attached, five sided with a wider surface usually tapering towards apex and base, greenish or yellowish green in colour. Taste is sweet and favourable. Indian sweet fennel is smaller and straighter than European fennel.

Chemical constituents: Essential oil and fixed oil, minerals (calcium, phosphorus iron, potassium, sodium) riboflavin and vitamin C in traces.

Pharmacological properties: Tonic for eye and skin, laxative, anticatrrahal.

Uses: Constipation, phelgmatic, disease of skin, weakened eye sight. A distilled, water from fennel called "Arqe Badiyan" is used in bathing of weakened eye or inflamed eye. *Arqe-Badiyan* + honey is used as remedy for inflamed pimples.

***Myristica fragrans* Houtt. (Myristicaceae)**

Description: 'Jauzbuwa' (jaiphal) or nutmeg is dried seed (kernels) of *Myristica fragrans*. In India it is mostly found in Kerala, Karnataka, Andhra Pradesh and Assam. Its tree is of about 20m high. The fruit of *Myristica fragrans* is pendulous, globose, its seed ellipsoid, 20-30 mm long, greenish brown, sometime marked with irregular dark brown patches which is furrowed. It has greyish brown endosperm, odour-strong, aromatic, taste pungent aromatic.

Chemical constituents: Nutmeg contains 2 - 8% volatile oil, 25 to 30% fat and starch, protein, fixed oil, myristicene.

Pharmacological properties: Narcotic, astringent, tonic for endocrine system and exhilarant.

Uses: The oil is used for various pharmaceutical preparations. The oil is used in perfumery, hair lotions, treating skin diseases, ringworm and also used as antiwrinkle.

***Nigella sativa* L. (Ranunculaceae)**

Description: 'Kalounji' (black cunmin) is the seed of *Nigella sativa*. It is cultivated in Punjab, Bihar and other parts of India. Occurs wild. It is small herb of 30-60 cm high. Seeds trignonous, flattened oblong, angular, small, funnel shaped – 0.2 cm long and 0.1 cm wide, black in colour, odour slightly aromatic and bitter in taste.

Chemical constituents: Glucosides – melanthin and melanthigenin, bitter substances and a crystalline active principle nigellone, essential oil, fixed oil, resin and tannin.

Pharmacological properties: Detergent, sedative, antiinflammatory, expectorant. Nigellende and non-carboxyl fractions are reported to protect guinea pigs against histamine – induced broncho spasm and phenolic fractions obtained from seeds has been reported antibacterial.

Uses: In vitiligo its powder is used with vinegar and applied on spots followed by exposure to sun light. A decoction of seeds mixed with sesame oil is used externally in various skin eruptions. The oil is also said to act as anaesthetic locally. Externally used in pityriasis, ringworm, eczema, alopecia, freckles, pimples.

***Pimpinella anisum* L. (Umbelliferae)**

Description: The 'Razianah' (Persian)

is the seed of *Pimpinella anisum* L. (aniseed) a plant of 75 cm. The aniseed is also called as 'Velati Saunf'. Aniseed is grown in north India. The fruit varies in size. Each fruit has 10 ridges and is covered with short hairs. The taste is sweet and aromatic. The seed is ground –grey to greyish-green or greyish in colour, oval and 3.0 to 4.5 mm in length.

Chemical constituents: The seed yields an oil which is a colourless liquid. It also contains starch, protein, fatty acid, crude fibres. Anethol is the main constituent of aniseed oil.

Pharmacological properties: Perspirant, diuretic, anticatarrhal. Externally acts as insecticidal against small insects eg. lice, mites. Have antifungal properties. It is also useful in ulcer.

***Piper longum* (Piperaceae)**

Description: The 'Filfil karaz' is dried fruit of *Piper longum*, 'Pipli' a creeper. Flowers are unisexual, with spikes of 3.8 cm long and 0.75 cm thick. The spikes are ovoid, about 2.5 mm in diameter, greyish green or blackish in colour.

Chemical constituents: The chemical constituents are mostly same as those of *Piper nigrum.*

Pharmacological properties: Diuretic, stimulant, digestive.

Uses: Rheumatism, asthma, leprosy, gonorrhoea. 'Tawarish bisbasa' is an important formulations.

***Piper nigrum* (Piperaceae)**

Description: The 'Filfil siyah' ('Kalimirch') is the dried berries of *Piper nigrum* a perennial climber cultivated in south India, Assam & Tripura.

Chemical constituents: Carbohydrates, protein, minerals, calcium, iron, phosphorous and vitamins eg. riboflavin thiamine and niacin and resin. Alkaloids pipernine, piperidin, chavicine, balsmic volatile oil, fats etc.

Pharmacological properties: Rubefacient externally and stimulant of skin. Pungent, aromatic, nervoine, antidot to poison, deobstruent, resolvent. Externally it dialates superficial blood vessels and acts as counter irritant, antiwrinkle and astringent.

Uses: It is in used as nervine tonic for skin besides for skin toning.

***Syzygium aromaticum* (Myrtaceae)**

Description: The 'Qaramfal' ('Laung') is the dried flower bud of *Syzygium aromaticum*. It is as evergreen tree of 10-12 m height cultivated in many countries. In India, it is cultivated in south India. Dried flower bud is the clove of trade. It is dark brown in colour and strongly aromatic. Taste is pungent and aromatic with sensation of tingling of the tongue.

Chemical constituents: Essential oil, eugenolaceate and caryophyllene.

Pharmacological properties: Resolvant, antiseptic, sedative, antifungal.

Uses: Oil antifungal, antiseptic, chewing of clove remove bad odour of mouth, used in toothache antiwrinkle properties.

***Trigonella foenum-graecum* (Fabaceae)**

Description: The 'Hulba' (fenugreek) is the seeds of *Trigonella foenum-graecum*, a seasonal herb of 60 cm height.

In India it is widely cultivated. The pod is sickle shaped slightly flattened and ending in a long point. It contains 10-20 rhomboidal seeds which is compact and pale brown in colour. The taste is bitter oily and aromatic.

Chemical constituents: Seed contains alkaloid, essential oil and saponin, fixed oil, mucilage, protein and minerals.

Pharmacological properties: Anti inflammatory, hypoglyacemic, antiseptic, soothing agent, diuretic, aphrodisiac and skin cleanser.

Uses: Fenugreek and henna fine powder paste in water is beneficial in cracking of feet, heal and lips. It is also useful against falling of hairs used as poultice in external and internal swelling. Fenugreek powder is beneficial against diabetes. It is also used in case of dandruff and it is one of the ingredients of herbal shampoo.

***Tamarindus indica* L. (Fabaceae)**

Description: The 'Tamar' ('Imli') is ripened pulp mesocarp of *Tamarindus indica* L. Tamarind tree is cultivated in South India. The fruit is oblong or linear oblong, slightly compressed, curved or straight. It has thin but hard and brittle outer epicarp. The seeds 4 to 12 are enclosed in endocarp surrounded by pulp (mesocarp). The seeds have hard cotyledons.

Chemical constituents: Sugar with tartaric, acetic, citric acids. Proteins, mineral oil.

Pharmacological properties: Refrigerant, astringent, cardical, aperient.

Uses: Poultice is used as an anti-inflammatory. It is useful in bilibious conditions of body and skin, scurvy and fever. Its oil with sesame oil is useful in burns.

***Zingiber officinale* Rosc. (Zingiberaceae)**

Description: The 'Zajbajil' (ginger) is the dried rhizome of *Zingiber officinale,* a perennial herb. Ginger has been cultivated since time immemorial. Usually the fresh ginger is known as 'adrak' and dryginger is called 'sunth' or 'zanjabil' in unani system of medicine.

Ginger have underground much branched rhizome which have swollen nodes. It has a characteristic fragrance and bitter in taste.

Chemical constituents: Volatile oil, fat, wax, resin, mucilage, alkaloid, essential oil.

Pharmacological properties: Stimulant, rubefacient, counter irritant, aphrodisiac.

Uses: Its essential oil is used as flavouring agent and medicinal purposes. Fresh ginger's decoction in useful in swollen feet due to cold, used externally. Ginger is beneficial in skin disease with asthama.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants 282 -285 , 1999

Medicinal value of everyday spices

SANTOSH MEHTANI

National Institute of Science Communication
Dr. K. S. Krishnan Marg, New Delhi - 110 012.

Abstract

Indian cuisine in particular is renowned for its spicy and tasty qualities and perhaps that is why, in general Asians are more tolerant or even resistance to infectious diseases than their new world counterparts. The medicinal properties of the spices that go into every day cooking in India, as also the contribution of the spices to the overall flavour of the meal, form the theme of this paper.

Introduction

Indian cuisine to a large extent depends on certain spices being regularly added to the cooking in specific form and method over centuries. Man must have been aware of the value of spices in sustaining his well-being against the vagaries of nature. His exposure to the rich biological diversity of fauna in sub-tropical countries must have taught him the use of medicinal and aromatic plants to combat their deadly attacks. Besides topical application, healing through ingestion must slowly have dawned on him. Through hit and trial methods he must have included many plants/ plant products in his food and found that some of them even enhanced the taste of his food. India being the birth place of many spices, quite naturally took the lead in this regard and over the years with suitable finishing touches mastered the art of using spices in food so as to heal while you eat.

Spices in Indian cuisine

The flavour characteristic as well as the medicinal properties of spices included in day to day cooking in India by and large, are enumerated in the order of their importance. Of course, these may vary to a small extent from region to region depending on their availability and the method of cooking.

Black pepper (*Piper nigrum* L.)

Vernacular names: *Kalimirch, Menasu milagu, Kurumulagu*

Flavour characteristics: Black pepper has a characteristic, delicate, penetrating aroma and pungent, biting taste. It is used whole or ground as a seasoning or a condiment to flavour green salads, soups or yoghurt preparation. A number of compounds including salimene, myceine, pinenes, caryphyllene, etc. make up the complex flavour.

Medicinal properties: Pepper is a carminative and prevents dyspepsia and flatulence. It is an aromatic stimulant in weakness following cholera, fevers, vertigo, coma, etc. It is an ideal additive to diets given to malarial patients. It is bacteriostatic and antiblood coagulant. It should be regularly consumed by patients with arthritis or paraplegia.

Chilli (*Capsicum annuum* L.)

Vernacular names: *Bell pepper, Lal mirch, Menasinakaye, Mulagaye*

Flavour characteristic: The green form is used for garnishing savory dishes while the powder of the dry red form is an important spice imparting a bright red colour and pungent flavor to the curries and other cooking. Capsaicin and isobutylmethoxy pyrazine are the important flavor constituents.

Medicinal properties: Green chilli is an effective antiscorbutic due to its high vitamin C content (340 mg/100). Dry chilly powder is carminative, stimulant; it stimulates the secretion of saliva and gastric juice and increases peristaltic movement and motility of the stomach. It is an excellent remedy in flatulent dyspepsia and dipsomania. Regular ingestion is beneficial in anorexia and varicose veins, liver congestion and vascular conditions. It reduces the liver cholesterol levels. In limited quantities it is bacteriostatic and hypoglycaemic, but if taken in large amounts it is a gastric irritant.

Cinnamon (*Cinnamomum verum* Presl.)

Vernacular names: *Dal-chini, Lavanga patti, Canna lavangapattai, Karuvapatta, Elavarngam.*

Flavour characteristic: Cinnamon which constituents pieces of bark, is used like cloves to season whole pulses, 'pulão', certain snacks, etc. It is an ingredient of the north Indian garam masala added to a variety of curries and fried vegetables to give the preparations the spicy aroma. Cinnamaldehyde, cinnamyl alcohol and eugenol mainly make up the sweet, pungent aroma.

Medicinal properties: Cinnamon is astringent, carminative and stimulant. As a stimulant it is beneficial in cramps of the stomach, gastric irritation, diarrhoea and dysentry. It is even reported useful in cancer of stomach, rectum, uterus, etc. cinnamon is curative in paralysis of the tongue, and in severe tooth-ache. Ground cinnamon shows lipolytic activity. It is reported to have antibacterial activity comparable to standard antibiotics. It is also an expectorant.

Clove (*Syzygium aromaticum* (L.) Merrill & Perry.

Vernacular names: *Laung, Lavanga, Krambu, Grambu.*

Flavour characteristics: Cloves with their warm, pungent aroma are used whole to season a wide variety of regular food preparations including 'pulaos', curries, meat preparations, snacks, etc. as an ingredient of garam masala they lend their characteristic mouth watering aroma to the dish. The principal chemical constituent producing the aroma is eugenol present in varying quantities in all parts of the tree.

Medicinal properties: Cloves are aromatic, carminative, stimulant. They are curative in various forms of gastric irritation and dyspepsia, relieving nausea and vomiting even in cases of cholera and correcting flatulence and exciting languid digestion. They prevent gas due to alcohol consumption. Cloves have bactericidal property. They are analgesic to hypersensitive dentines and cavities.

Coriander (*Coriandrum sativum* L.)

Vernacular names: *Dhaniya, Kothambiri, Kottumilli*

Flavour characteristics: Coriander leaves are added to many savoury preparations as a garnishing to give a fresh aroma due to the presence of dodecenal. The seeds after roasting are used whole or as powder as a chief ingredient of pickling spices, curry powders, etc. It serves mainly as a thickener of gravy in curries. The flavour constituents are mainly linalool and linalyl acetate.

Medicinal properties: Green coriander leaves are a rich source of vitamin A and C. The spices is carminative, stomachic, tonic, and stimulant. It corrects foul breath. It is also a natural anthelmintic, and control indigestion, diarrhoea, dysentry.

Cumin (*Cuminum cyminum* L.)

Vernacular names: *Jeera, Jeerige, Jeerakam*

Flavour characteristics: The seeds are popped in oil as a seasoning for curries and chutneys. The roasted, ground seeds impart a warm, characteristic aroma to vegetables, snacks, and yoghurt preparations. Cumin is an ingredient of the curry masala used in everyday cooking. The characteristic odour of cumin is attributed to the presence of cuminaldehyde.

Medicinal properties: Cumin is a carminative, stomachic, stimulant and astringent. It prevents indigestion, diarrhoea, and dysentery.

Ginger (*Zingiber officinale* Rosc.)

Vernacular names: *Adrak, Harishunti, Inji*

Flavour characteristic: The characteristic warm and aromatic odour and pungent flavor of fresh ginger makes it a widely used spice for food flavoring in Indian cuisine. It particularly sets off the sour and hot taste of many curries and chutneys. Dry ginger is an important ingredient of garam masala. Powdered dry ginger is a favorite spice in everyday cooking in certain regions. The important aroma character compounds responsible for the flavour of ginger is gingerols.

Medicinal properties: Ginger is a valued as carminative, tonic and stimulant of the gastro-intestinal tract; it checks flatulence and colic. It is the source of a protoelytic enzyme. It controls gastric ulcers. It stimulates the heart, vasomotor and respiratory centres, stimulating peripheral blood flow in rheumatoid arthritis. Its regular ingestion wards off malaria and has an overall anti-depressant effect.

Large Cardamom (*Amomum subulatum* Roxb.)

Vernacular names: *Bara elaichi, Dodda yelaki.*

Flavour characteristic: Large cardamom is used whole as a seasoning in 'pulaos', curries, or snacks, or the shelled seeds are used to garnish sweet preparations. The sharp pleasant aroma of cardamom enhances the flavour of garam masala when ground in it as a spice. The principal constituent associated with the flavour is cineol.

Medicinal properties: Cardamom seeds are stimulant, stomachic, alexipharmic, and astringent. They are useful in checking indigestion, vomitting, biliousness, abdominal pains and rectal diseases. They are also diuretic. They promote elimination of bile and clear congestion of liver. Chewing cardamom helps prevent affections of teeth and gums. Seeds are curative in throat trouble.

Turmeric (*Curcuma longa L. Syn. C. domestica* Val.

Vernacular names: *Haldi, Arishna, Manjal*

Flavour characteristic: Turmeric, whole or powdered, is extensively employed in cooking vegetables, pulses, snacks, etc. It lends a bright yellow colour to the dish besides giving it a pungent flavour. In combination with red chilli powder it gives a bright orange - red colour to the food, characteristic of Indian curries and other vegetable preparations. The chemical constituents responsible for the flavour are mainly turmerons and zingiberine.

Medicinal properties: Turmeric when taken internally is carminative, stomachic, and tonic. It is antiseptic, antacid, and prophylactic preventing ulcer formation due to aspirin ingestion. It is anthelmintic, choleretic and anti-inflammatory to the gastric lining. Also hypocholeseroemic regulating fat metabolism and therefore obesity. It checks liver and gall bladder problems also. Turmeric prevents cold and cough. It checks malaria and is a blood purifier.

Conclusion

All the spices essential in everyday Indian cooking (dealt with here) individually as well as collectively impart the characteristic colour, aroma and taste to the food, that is typical of Indian cooking. The amazing fact is that individually as well as collectively, all these spices are carminative, stomachic and gastric stimulants besides having many other therapeutic properties. So even while the consumer is enjoying the taste and aroma of the food, all the organs of the alimentary system beginning with the oral cavity and going down the food pipe, the stomach, the intestine, the liver, the gall bladder, the rectum-all are stimulated and protected from infection. Thus many ailments encompassing digestion such as dyspepsia, flatulence, nausea, etc. which are incidental to intake of many types of food are taken care of by default. Other associated problems such as diarrhoea, dysentery, constipation are also kept in check to some extent by the ingestion of spices. It is diabolical how man could evolve a recipe cum prescription to satisfy his daily wants and still keep himself faily fit.

Acknowledgements

The author wishes to place on record her thanks to the Director, National Institute of Science and Communication and Head, Wealth of India Division for their support in writing this paper.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 286 -290 , 1999

Scientific evaluation of seeds of *Cardiospermum halicacabum* L. - a Unani medicine

A. LATIF, S. H. AFAQ & S. Z. RAHMAN

Department of Ilumul Advia, A.K. Tibbia College, Aligarh Muslim University Aligarh – 202 002, Uttar Pradesh.

Abstract

Seeds of *Cardiospermum halicacabum* L. is an important unani medicine used against rheumatism, arthritis and obesity. The genuine seed *Hab-e-Quqil* is compared with market samples based on morphology, chemistry and pharmacology.

Introduction

The unani herbal drugs are playing an important role in pharmaceutical industry. But their efficacy and potency are not ascertained due to lack of standard drugs. Phytochemical, pharmacognosical, biological and biochemical methods are to be adopted to standardize the medicinal plants and in ascertaining the standard. These methods can be proved helpful in Unani drugs for analyzing their active constituents. These devices will improve the efficacy and potency of herbal drugs and will give an idea about their toxicity.

Cardiospermum halicacabum L. belongs to the family Sapindaceae. The seeds of *C. halicacabum* is commonly known as *Hab-e-Qilqil* in Unani medicine. The plant is known as 'Uzhinja' in Malayalam, 'Chakraletha' 'Inderavath' in Sanskrit, 'Khasatha' in Hindi and 'Modakithai' in Tamil. It is a cosmopolitan plant. The seed of *C. halicacabum* is widely used as aphrodisiac and stimulates the coital functions (Baitar, 1248, Ghani, 1917). It reduces obesity and is used in general debility and in convalescence (Baitar, 1248, Avicenna 980-1037). Keeping in mind, the high medicinal importance of the drug, a comparative phytochemical and quality evaluation of the market sample and authentic sample was carried out.

The drug under the name *Hab-e-Qilqil* was procured from Dawakhana Tibbiya College, AMU, as well as from local market, and an authentic seed lot was also sown in pots.

Macroscopy of the seeds and plants was done as per general methods. Ash content, extractive values and studies on fixed oil (refractive index, acid value, iodine value, saponifications value), TLC were determined according to standard methods. The moisture content was determined by the method of Jenkins *et. al.,* (1967). The phytochemcial screening was done by flow chart of Bhattacharya and Das (1969). Quantitative estimation of alkaloids, nitrogen (Linder and Harely, 1942); sugar (Peach and Tracey, 1955), sterols/terpens (King, 1951) and fluorescence analysis of powdered drug (Chase and Pratt 1949) was also done. The infrared spectroscopy pattern was also performed as described by Paperno *et. al.,* 1979.

Observations

1. Macroscopy

The seeds were sown in pots. The plant was identified with the help of literature (Hooker, 1875 and Hussain, 1970).

a) Flower: Peduncle with pair of forked tendril, the flowers are tiny, white, 5.0-6.0 cm across in corymbose cymes; zygomorphic, polygamous; sepals 4;2 free anteriorly and 1 smaller, of the 2 posterior 1 bigger, slightly petaloid; petals 4, obovate, unequal with basal scales and a prominent yellow crest, stamens 8, filamentous, unequal and hairy; anthers 2-celled, split length wise, disc made up 2 glands; carpels 3, fused; ovary 3 celled, 1 ovule in each cell; style short, stigma 3, linear; fruit membranous, inflated bladdery; capsule 3, loculicidal capsule, 2-3 across and 3 seeds attached together.

b) Seeds: The seeds of *C. halicacabum* L. was found to be globose, black in colour, having a white heart shaped triangular aril at the base, 1.0-2.0 mm across, testa crustaceous, cotyledons large transversely conduplicate, having the average weight 0.72 g.

c) Leaf: The leaves are bitter, alternate, exstipulate, petiole, 1.4 – 3 cm long. Leaflets 4.3 – 7 cm, elliptical – lanceolate, coarsely hairy above, densely on beneath veins; petiole 10 mm long and slightly winged.

d) Stem: Branched, annual climbing herb of about 1.0 – 2.5 mm, having spiral tendril.

2. Phytochemical screening

The phytochemical screening of different extract of the seeds was carried out systemically as per flow chart. These fractions were tested for presence of chemical constituents. The qualitative analysis of drug reveals that the aqueous extract fractions showed the presence of alkaloid, sugars (reducing & non-reducing), amino acid, proteins, saponins and tannins in traces.

The ethonolic extract fraction shows +ve test for alkaloid, glycosides, sugars, amino acid, protein, steroids/terpenes, saponins and tannins in traces. Petroleum ether fraction showed a good quantity of sterols/terpenes.

3. Physio-chemical study

a Ash value

Total ash value	3.36%
Acid insoluble ash	1.40%
Water soluble ash	1.05%

b Successive extraction in:

Petroleum ether	18.78%
Ether	0.96%
Chloroform	2.85%
Ethyl alcohol	4.60%
Benzene	0.92%
Water	8.30%

c Moisture content 7 - 8%

d Studies on fixed oil

Fixed oil	18.8%
Refractive index nD, 24^0	1.47
Acid value	34.00
Saponification value	297.00
Iodine value	91.00

e TLC analysis

Under S/S – Petroleum: ether (4:4 v/v) The TLC plates were sprayed with 20% perchloric acid. R_f values of different fractions of extract of *C. halicacabum* L. seed are given below.

Table 1. TLC analysis of *C. halicacabum*

Extract	No. of spot	R_f values
Petroleum	3	0.86, 0.62, 0.46
Ether	3	0.82, 0.52, 0.35
Chloroform	3	0.70, 0.48, 0.32
Benzene	3	0.87, 0.70, 0.67
Ethanol	2	0.87, 0.11

b) TLC analysis of alkaloidal fractions Under S/S Petroleum : ether of 4:1 ratio with few drops of methanol and spraying reagent was dragandroff.

Table 2. TLC analysis of alkaloid extract of *C. halicacabum*

Extract	No. of spot	R_f values
Ethanole	3	0.86, 0.30, 0.13

4. Quantitative estimation of chemical constituents present in *C. halicacabum* L. seed

Table 3. Quantitative estimation of chemical constituents of *C. halicacabum*

Constituents	% (mg/100 g)
Alkaloid	0.082
Nitrogen	2.656
Protiens	16.625
Sterols/terpenes	2.350
Sugars	3.780

5. Study of powdered drug

a) The powder of *C. halicacabum* seeds look oily in nature, the colour of powder is white, slightly pinkish and some black colour of hard pieces of its crustacaeous testa is seen. It is sweet in beginning and turns slightly bitter in taste..

6. Infrared spectroscopic (I.R.) pattern

The I. R. spectra of the drug *C. halicacabum* L. seeds oil & alcoholic fractions were recorded by making a liquid neat film oil, in range of 4000-400 cm^{-1} and a liquid neat film in CCl_4 of alcoholic fraction within the range. The absorption bands of the seed oil were noted and frequencies (cm^{-1}) of the spectra obtained were in between the range of 3550 – 1135 cm^{-1}, while alcoholic fractions were found in between the range of 3500-880 cm^{-1}.

Table 5. Fluorescent characters of the power of *C. halicacabum*

Treatment	Fluorescence
Dry powder as such	Light yellow
Sodium hydroxide in methanol	Greenish yellow
Nitrocellulose (mounted)	Light yellow
Sodium hydroxide in methanol and mounted in nitrocellulose	Greenish yellow

Discussion and conclusion

The seed under the name *Hab-e-Qilqil* of market and Dawakhana Tibbiya College, AMU samples along with authentic seed of *Hab-e-Qilqil* were sown in pots. The mature plants were studied and all the seeds were identical except the little difference which exists in the market sample that contained some of small size. The small sized seeds may be of immature seeds of *C. halicacabum microphylum* variety that got mixed up.

The I.R. spectrum provides a sensitive characteristic of a compound that can be used as a criterion for determining whether two compounds are identical or not since each compound has its own absorption spectrum, particularly in "finger prints range". Of course, spectroscopic absorption methods are also frequently used as identification test for pharmaceutical substances (Jenkins, *et. al.,* 1967), The I.R. spectra of oil of *C. halicacabum* L. seed, showed absorption band and frequencies (cm^{-1}) of the spectra in the range of 3550-1135 cm^{-1}, and also shown the presence of cyanogen (2240 cm^{-1}) as reported by other workers (Mikolajozek *et. al.,* 1970). In this study the drug sold in the market under the name of *Hab-e-Qilqil* has been investigated and compared with its authentic source which lead us to conclude that market sample is the seed of *C. halicacabum* L.

References

Avicenna. 980-1037. "Al-Qanoon-Fit-Tib" (Urdu edition) translated by Hussair, S.G., Naval Kishore, Lucknow, 1887. Vol. 2, p. 114.

Baitar, I. 1248. Jame-ul-Mufredat-al-Advia Wal-Aghzia, Amra Press, Egypt, Vol. 4 pp. 28-29.

Bhattacharya, A. K. and Das, A. K. 1969. Phytochemical screening of some Indian Plants, J. Crude Drug. Res., Vol. IX (3): 1408-1412.

Chase, C. R. and Pratt, R. 1949. Fluorescence of powdered vegetable drugs with particular reference to the development of system of identification: J. Amer. Pharm. Assoc. (Sec. ed.) 38 : 324.

Ghani, M. N. 1917. Khazeenat-ul-Advia, Naval Kishore, Lucknow, Vol. I. pp. 440-441.

Hooker, J. .D. 1875. Flora of British India, L. Reeve and Co. Ltd. The Forest House, N.R. Ashford. Kent. England. Vol. I:pp. 669-670.

Hussain, Wazahat. 1970. Systemic study of plants in Aligarh Tehsil. Ph. D. Thesis, Department of Botany, AMU, Aligarh, pp. 292-293.

Jenkins, G. L. Knevel, A. M. and Digangi, F. E. 1967. Quantitative Pharmaceutical Chemistry (6^{th} ed.). M.L. Graw-Hill Book Co. New York, 225, 235, 240, 243 -44, 348, 457.

King, E. J. 1951. Microanalysis in Medicinal Biochemistry, (II nd ed.) J. and A. Churchill Ltd. London.

Linder, C. and Harely, C. P. 1942. A Rapid method of determination of nitrogen in plant tissue. Science, 96 : 565-566.

Mikolajezak, K. L., Smith, Jr. C. R. and Tjarks L. W. 1970. Cyano-lipids of *Cardiospermum halicacabum* and other sapindaceaceous seed oil. Lipids, 5, p. 812.

Paperno, T., Ya Pozdnyakov Smirnova and Elgin, L. M 1979. Physico chemical laboratory technique in organic and biological chemistry. English translation (Ist ed.) Mir Publishers, Moscow, pp. 77 : 86-87.

Peach. G. E. and Tracey M. V. 1955. Modern Methods of Plant analysis, Vol. pp. 37 : 293.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 291 -295, 1999

Antifertility properties of *Cleome viscosa* L. - a common folklore plant

SUSAN THOMAS, S. JOY & M. M. ALAM

Drug Standardisation Research Unit (Siddha)
Captain Srinivasa Murti Drug Research Institute for Ayurveda,
Central Council for Research in Ayurveda & Siddha,
Arumbakkam, Chennai – 600 106.

Abstract

Alcoholic extract of *Cleome viscosa* was found to have antiimplantation activity and progestational activity but was devoid of abortifacient activity in rats.

Introduction

'Pasugandha', botanically identified as *Cleome viscosa* L. belongs to the family Capparaceae. It is a weed found throughout the plains in India. It is an annual sticky herb with a strong penetrating odour and clothed with glandular and simple hairs, leaves 3-5 foliate, gradually becoming shorter upwards, flowers yellow in colour, fruits capsules, compressed, hairy throughout, seeds brownish black when ripe. The whole plant is used as acrid, thermogenic antihelmintic and sudorific. The roots are stimulant, anti scorbutic, and vermifuge. The seeds are antihelmintic, carminative, constipating, febrifuge and cardiac stimulant and are useful in fever, diarrhoea, worm infestation, and dyspepsia.

The present communication deals with the screening of the alcoholic extract of *C. viscosa* for progestational, antiprogestational, antiimplantation and abortifacient activities.

Collection of the plant and extraction of the principle

The whole plant was collected from the gardens of Central Research Institute, Chennai in January and authenticated by the Botany Department of our Institute. Freshly collected plant (500g) was shade dried, powdered and extracted by the cold percolation method with 90% alcohol for 48 hours. Solvent was distilled off and the final extract was dried in air oven at 50^0C. Extract was suspended in propylene glycol to give a concentration of 100mg/ml.

Adult albino rats of either sex (100-150g, of the Institutes colony was used for the study. The animals were fed on Hindustan lever rat feed, cabbage, bengal gram and allowed to drink tap water *ad libitum.* The drug was administered as suspension in propylene glycol.

Antiimplantation studies

Proven fertile albino rats of Wistar strain weighing 100-150g of normal estrous cycle were chosen from the Institutes animal colony. The method of Khanna and Chowdhury (1963) was followed with necessary modifications. The proven fertile female rats were mated with proven fertile male rats in the ratio 3:1. The appearance of sperm clog in the vaginal smear was recorded as Day 1 (D_1) of pregnancy. The rats showing positive smear were divided into two groups of 8 animals each. One group served as control and received the vehicle alone from D_1 - D_7 of pregnancy. The second group served as test, which received alcoholic extract of plant *Cleome viscosa* orally at 100mg/kg-body weight from D_1-D_7.

On D_{10} laparatomy was performed under light ether anesthesia using semi sterile conditions and uteri were observed for implant size and number. The abdominal incision was closed and the rats were allowed to recover and deliver after full term of pregnancy. Those rats showing implants but not delivering were once again laparatomised on D_{25} and the uteri were examined for implantation sites.

Abortifacient activity

Alcoholic extract of *C. viscosa* was tested for its abortifacient activity as described under antiimplantation activity with the following modifications. The female rats which showed the presence of spermatozoa in the vaginal smear were divided into 3 groups of 8 animals each. One group is treated as control group received the vehicle from D_1-D_{21}. The second group received alcoholic extract of *C. viscosa* at 100mg/kg body weight orally from D_8-D_{14}. Third group received the extract orally from D_{14}-D_{21}.

Everyday the animals were checked for vaginal bleeding till the day of delivery.

Progestational/antiprogestational activity

Progestational/antiprogestation activity was studied by the method of Zannow *et al.* (1958) with the following modifications

Virgin adult female rats were ovariectomised and one week later treated with estradiol benzoate at 0.1 mg/day/rat for 3 days. The ovariectomised, estrogen primed animals were divided into 4 groups of 8 animals each as follows.

Group I : Control (propylene glycol orally and olive oil subcutaneously for 9 days)

Group II : Progesterone at 1mg/day/rat subcutaneously for 9 days.

Group III : Progesterone at 1mg/rat/day subcutaneously and alocoholic ext of *C. viscosa* at 100 mg/kg body weight orally for 9 days.

Group IV : Alcoholic extract of *C. viscosa* at 100mg/kg/ body weight orally for 9 days.

All the above groups of animals were laparatomised on the 5th day of treatment. Histamine Hcl solution (1mg/rat) was administered into the lumen of one uterine horn of each rat to provide chemical stimulus for inducing deciduoma.

Twenty four hours after following the last day of treatment as per the above schedule animals were sacrificed, uterine horns were weighed, sliced and sectioned for histopathological studies.

Results were analyzed statistically employing student's 't' test.

Implantation study

Alcoholic extract of *C. viscosa* when fed from D1-D7 orally at 100 mg/kg/ body weight reduced the number of implants to about 55.5%. The rats treated with the extract showed the presence of regressed implants (subnormal size) with swelling on the uterus simulating under developed implants. This evinced a resorption tendency of the foetus and led to the reduction in litter number. However the extract on administration during different periods of pregnancy that is from D_8-D_{14} and D_{14}-D_{21} did not exhibit abortefacient activity. (Table 1).

The results of the progestational activity are summarised in the Table 2. The weight of traumatised uterine horn of vehicle treated group was 11.23% more compared to control horn weight. This difference was statistically insignificant. Traumatised horn weight of progesterone treated animals was significantly increased (154%) compared to that of control horn. A similar response was seen in the group treated with combination of progesterone and the alcoholic extract of *C. viscosa* (230.29%). There was significant increase in the traumatised horn weight in animals treated with the extract alone (66%).

Table 1. Aborifacient activity of *Cleome viscosa*

Status	Dose mg/kg body weight	Period of treatment	Number of implants on D_{10}	Number of litters on D_{23}	Resorp -tion (%)	Animals with abortifacient activity (%)
Control	-	D_8 – D_{21}	9.20	8.50	6.25	Nil
Alcoholic extract of *C. viscosa*	100	D_8 – D_{14}	9.42	7.33	20.04	Nil
"	100	D_{14} – D_{21}	9.66	7.0	25.25	Nil

Histopathological examination of the uterus

The haematoxylin and cosin stained sections of both the horns in control group showed normal uterine structure with proliferative endometrial glands. The control horns of all the other groups showed similar response.

The test (traumatised) hornes of both

progesterone, progesterone + extract of *C. viscosa* combination, extract of *C. viscosa* treated groups showed enhanced decidual response. Larger groups of these cells were seen compared to their counterparts in the test horns. Within the groups of these decidual cells, glands were totally absent. These difference were as marked in the progesterone group as in progesterone + extract combination and extract treated groups. Two types of cells could be distinguished larger viz., (1) polyhedral cells with prominent nuclei almost filling the cells, they were discrete with well defined margins and (2) much bigger cells which appear as masses of pale staining cytoplasm in which nuclei were small and less conspicuous, these cells did not have any sharp outlines. decidual cells. The group treated with *C. viscosa* also showed an enhanced decidual response.

It was observed that injury to the uterus in progesterone treated guinea pigs provoked a rapid appearance and growth of endometreal cells which were identical to decidual cells of pregnancy thereby forming deciduoma. The requirements necessary for decidualisation are (1) responsive endonatrium (2) traumatic stimulus. (Zannow *et al.* 1958). By means of direct trauma to the uterus a remarkable change parallel to the formation of implantation chambers of pregnancy occurs (Label *et al.*, 1961). After induction an exponential increase in uterine mass, protein and nucleic acid took place as much as 3.5 g of decidual tissues produced within 72-96 hours. This corresponds to a 10 fold increase in the uterine mass (Sheleshyak and Tic, 1963).

Corpus luteum is the primary ovarian tissue of pregnancy since it secretes progesterone in amounts adequate to maintain gestation. Fertilization may be affected by corpus luteum function since it has been shown that progesterone administration may inhibit fertilization (Boyarsky *et al.*, 1947). Anything which acts to prevent normal corpus luteum function will function as anti fertility agents. In addition to agents acting directly on the ova, substances or conditions

Table 2. Progestational activity of *Cleome viscosa*

Group	Status	Traumatised horn	Control horn	Increase in weight (%)
I	Control	32.57 ± 2.18	29.28 ± 2.91	11.23
II	Progesterone 1mg/rat/day	97.37 ± 4.32	38.33 ± 3.41	154.00
III	Alcoholic extract of C. *viscosa* 100 mg/kg body weight	46.75 ± 2.51	28.6 ± 1.34	66.96
IV	Progesterone 1mg/rat/day Alcoholic extract of *C. viscosa* 100mg/kg body weight	104.57 ± 8.9	31.56 ± 3.7	230.9

Values are man ± S.D

affecting normal hormonal action upon the uterus will affect fertility. Normally estrogen and progesterone act synergistically upon the uterine endometrium to prepare it for nidation although progesterone alone may accompling this (Pincus and Werthessen 1938). An upset of hormonal imbalance essential to progestational proliferation may be accomplished by excess of estrogen or other antiprogestins or perhaps by antiestrogens or even by an excess of progesterone. The inhibition of abortion in women by gestagens or progestin estrogen combination has been studied. This drug may be due to its progestational activity does not possess abortifacient activity.

Acknowledgement

The authors thank the Director, Central Council of Research in Ayurveda and Siddha, New Delhi, India for financial support.

References

Boyarsky, L. H., Baylies, H., Casida, L. E. and Meyer, R. K. 1947. Endocrinology 41 : 312.

Khanna, U. and Chaudhary, R. R. 1975. Ind. J. Med. Res. 56 : 1963.

Label, B. L, Levy, E and Shelesnyak, M. C. 1967. Acta Endocrinol (KBH), 56 (Suppl). 123.

Meyerhof, K. H., Brown, W. H., and Cioffi, L. A. 1962. Current Therap Res. 4 : 499.

Pincus, G. and Werthessen, N. T. 1938. Am. J. Physcol., 124 : 484

Sheleshyak, M. C. and Tic, L. 1963. Acta Endocrinol., 42 : 465.

Zannow, M. X., Peters, L. E. and Calwell, A. Z. 1958. Ann. N.Y. Acad. Sci., 71 : 532.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants 296 -302, 1999

Identity of crude drug - *Hypericum perforatum* L.

H. B. SINGH

Raw Materials Herbarium & Museum (RHM)
National Institute of Science Communication
Dr. K. S. Krishnan Marg
New Delhi – 110 012.

Abstract

Hypericum perforatum L. (Hypericaceae) western temperate Himalayan plant, contains hypericin, an active constituent used in medicines, cosmetics, dyes etc. The plant has shown antiviral, antibacterial, anti depressant, anticancer, antiseptic and antiulcerative activities, besides exhibiting skin tightening and hair restoring properties. Therefore, a lot of interest in trading of this plant has been generated globally. Under our consultancy services programme of identification of crude drugs, we received nine samples from various pharmaceutical companies and plant drug traders. It was found that among them only one sample was the genuine *H. perforatum* whereas seven of the samples were of its allied species *viz.*, *H. dyeri, H. oblongifolia, H. elodeoides,* while the remaining lone sample was that of *Reinwardita indica* belonging to the family *Linaceae.* It is interesting to note that none of the species studied here, has been reported to contain hypericin and other active principles, responsible for the medicinal properties, as *H. perforatum.* In this paper, the correct identity of the drug is discussed.

Introduction

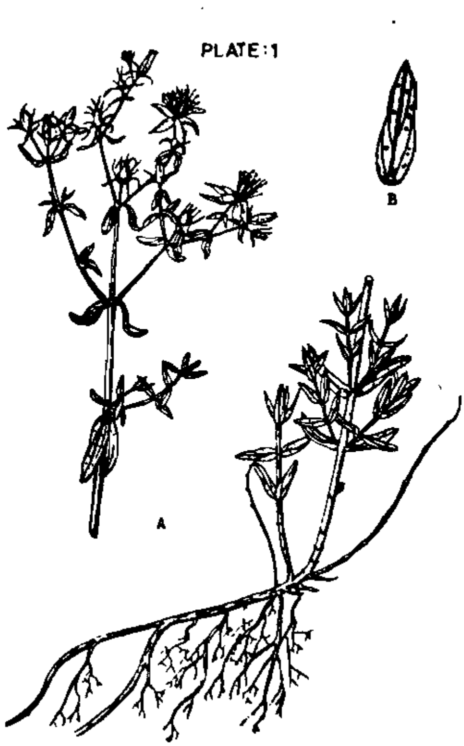
In the days of yore, a *Vaidya* was a self contained medical unit for he not only used to collect medicinal plants from the nearby forests but also prepared the various drug formulations himself. Therefore, there was least chance of using materials other than the genuine one for medicine. But during recent years due to population explosion there is a proportionate increase in demand for phytomedicines. The crude drug business has fallen into the hands of unscrupulous, inexperienced and profiteering community of traders. Most of the herbal practitioners and pharmaceutical companies largely depend upon these crude drug dealers to meet the requirement of raw plant materials. Since there is no government control over these traders, they take full advantage of this and sell to their customer anything that resembles or may be made to resemble the genuine drug. For example the drug 'Brahmi' *Bacopa monnieri* (L.) Wettst., sold in Delhi market was found to contain 'Khubasi' (*Malva rotundifolia* L.) either in pure form or intermixed with 'Mandukparni' (*Centella asiatica* (L.) Urban (Mehta *et. al.*, 1991). Many such examples can be cited. Thus usage of such adulterated or spurious raw material for manufacturing medicine, affects the efficacy of the finished product and could cause deleterious effect on human health. Hence correct identity of the raw materials is essential.

Herbarium is a place where well identified plants are kept in the form of dried specimens and their raw material samples. These can be used as standard reference materials while identifying the crude drug samples. The bulk users of raw materials should seek the advice of the established herbarium for proper identification of the raw material. Therefore, keeping this in mind NISCOM has established the Raw Materials Herbarium and Museum (RHM) and started consultancy services for correct identification of crude drugs.

Hypericum perforatum L., known commonly as St. John's Wort, is a Mediterranian plant, widely distributed in Europe, North Africa, USA, Canada, Australia, New Zealand and Asia. In India it is commonly found in Western temperate Himalayas in Jammu & Kashmir, Himachal Pradesh and in Garhwal and Kumaon regions of Uttar Pradesh.

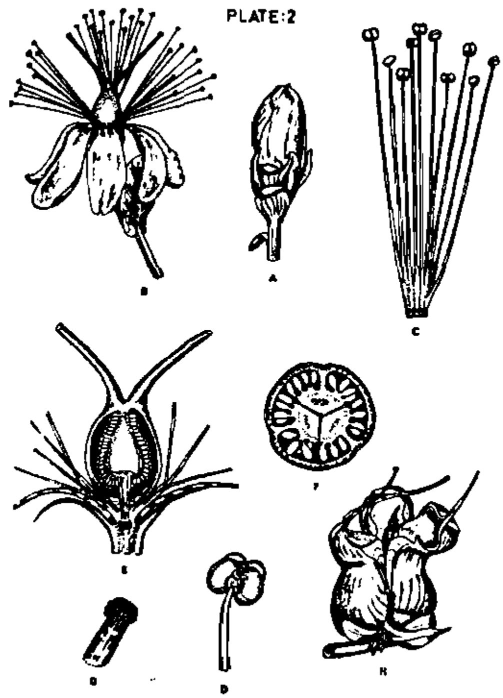
H. perforatum (Plates 1 & 2) has been used as medicinal plant since ancient times. The plant was considered as diuretic, emmenagogue and as antimalarial; it was particularly recommended for the treatment of burns and scalds. The plant was widely used in the folk medicine in a number of European countries as a soothing agent, antimicrobial, antiphlogistic, in the treatment of inflammation of the bronchi and the urinogenital tract, haemorrhoid treatment, a healing agent and in the treatment of traumas, various kinds of ulcers and cancers and other local and general illnesses Barbagallo & Chisari, 1987, Brantner *et. al.* 1994[a], Bombardelli & Morazzoni, 1995). In homoeopathy, hypericum tincture is a well reputed medicine for treatment of compound fractures, gunshot wounds, hypersensitivity, neuralgia, etc (Duke, 1985; Banerji *et. al.*, 1995).

Besides, these traditional uses it is largely used for the treatment of depression (Holzl *et. al.*, 1989; Sparenberg, 1993; It is also under extensive investigation as a potential anti-AIDS drug plant as hypericin and pseudohypericin exhibited inhibitory effects against a wide spectrum of viruses like Vasicular stomatitis, Influenza Virus, Herpes Simplex Virus Type I and II, Retrovirus, Friend Leukemia Virus, Moloney Murine Leukemia Virus and Anemia Virus, a retrovirus genetically related to HIV (Bombardelli & Morazzoni, 1995).



A. *Hypericum perforatum plant with flowers and fruits.*

B. *A leaf*



A. A flower bud; B. A fuly opened flower; C. A facicle of stamens; D. Anther; E. L.S. of ovary; F. T.S. of ovary; G. Apex of style; H. A fruit, a septicidal capsule

Hypericin is also used as a red dye and in cosmetics as a skin tightening agent and as hair restorer (Bergwein, 1967; Bombardelli and Morazzoni, 1995).

Besides hypericin and pseudophypericin, a number of other biologically active constituents have also been isolated from various parts of the plant (Biochinor, 1965, Brondz *et. al.,* 1982; Berghofer & Holzl, 1987 and 1989; Borkawski, 1992; Brantner, *et. al.,* 1994[b]. (Table 1).

Therefore, because of the wide spectrum of biological activities and multifarious medicinal and cosmetic uses a lot of interest in trading of this plant has been generated globally. Consequently, under our consultancy services programme we started receiving several samples of *H. perforatum* from various traders and pharmaceutical companies for correct identification.

Under our consultancy services programme for identification of crude drugs, nine samples from various pharmaceutical companies and traders, were received in our laboratory. Each and every sample was thoroughly studied under binocular microscope.

Table 1. Chemical constituents and biological activities of *Hypericum perforatum* L.

Chemical constituents	Activity showed
Hypericin & pseudohypericin	Antiviral, antidepressant, antianxiety, hepatoprotective.
Hyperforin	Antibiotic (main constituent of hyperici oleum oil, exhibits wound healing property), antibacterial (against gram-positive bacteria).
13', II8-Biapigenin (Amentoflavone)	Anti-inflammatory, antiulcerogenic and Vit. P. activity
Proanthocyanidin	Positive inotropic effect and a transient decrease in coronary resistance in isovolumically diffused Guinea pig heart.
Total flavonoid-extract from the shoot (may be due to quercetin)	Analgesis activity
Caffeic acid and chlorogenic acid	Immunomodulatory activity.
Anthocyanosiline	Antiviral, against genital herpes and papilloma virus
Essential oil	Antifungal against some dermatomycotic and plant fungi.
A polyphenol preparation	Immunostimulating activity.
A lipophilic preparation	Immunosuppressing activity.
Rutin	Anti-dieuretic effect.
Hyperoside	Diuretic.

Description

To enable the correct identification of *H. perforatum*, details of its exomorphic characters are provided. Herb, 30 to 100 cm long, glabrous throughout; green or sometimes glaucescent; stems erect, two angled or ribbed, branched at top. Leaves elliptic or ovate or oblong ovate, 0.7 to 3 cm long, 0.3 to 1.5 cm broad or broadly elliptic, subcordate or rather narrow, sessile, linear oblong subobtuse, flat or more or less revolute margined, with numerous pellucid and few black glandular dots. Flowers numerous, yellow. Bracts lanceolate, acute. Calyx deeply parted, 5 mm long, shorter than corolla; sepals lanceolate or narrowly lanceolate, 4-5 cm long, 1 mm broad, as long as ovary, acute or acuminate, sparingly furnished with black glandular dots, margins smooth or sparsely toothed; petals oblong to oblong elliptic, enequilaterally 1.2 to 1.5 cm long. 0.5 to 0.6 cm broad with numerous black glandular dots and lines. On margins in upper part, surface with numerous yellow glandular dots, thin lines and stripes, or without black dots. Stamens numerous, in 3 bundles; ovary is ovoid, 3 to 5 mm long; styles 3, distinct, twice as long as ovary. Capsule oblong-ovoid 0.6 mm long, 0.5 mm broad, or small, rounded, or ovoid brown with yellow glandular longitudinal streaks and lines; seed cylindrical, brown, minutely pitted longitudinally.

The comparative distinguishing characteristics of samples are summarized in Table 2.

Table 2. Comparative characters of raw material samples received for identification

Sample No.	Distinguishing character		Identified as
1 & 3	Stem	: 4 angled or 4 ribbed	*Hypericum dyeri* Rehder
	Leaves	: ovate, lower surface pale blackdotted	Syn. *H. lysimachiodes* Wall
	Stamens	: numerous, in 5 bundles	
	Style	: 5 numbers	
2	Stem	: 2 angled or ribbed	
	Leaves	: sessile, elliptic or ovate to linear, translucent gland dotted	
	Stamens	: numerous, in 3 bundles	*H. perforatum* L.
	Style	: 3 in numbers, distinct	
4,5,6&7	Stem	: terete	*H. oblongifolium* Choisy
	Leaves	: ovate-lanceolate, minutely dotted	Syn. *H. cernuum* Roxb.
	Stamens	: numerous, in 5 bundles.	
	Style	: 5 in numbers	
8	Stem	: cylindrical	*Reinwardita indica*Dumortier
	Leaves	: ovate-lanceolate, entire, tip obtuse or acute, minutely mucronate	Syn. R. *trigyna* Planch
	Stamens	: 5 in two sets; 3 long, 2 short	
	Style	: 3 in numbers, united	

contd...

9	Stem	: terete	*H. elodeoides* Choisy
	Leaves	: ovate, obtuse or broadly acute, margins black dotted, bracts fringed with stalked glands.	
	Sepals	: fringed with stalked glands	
	Stamens	: numerous, in 3 bundles	
	Style	: 3 in numbers	

Conclusion

It has been concluded that out of the nine crude drug samples received for identification, only one sample was the genuine *H. perforatum* whereas seven other samples were of its allied species *i.e. H. dyeri* (2), *H. oblongifolium* (4) and *H. elodeoides* (1) and the lone remaining sample was that of *Reinwardtia indica* belonging to the family Linaceae.

Further, literature survey reveals that none of the *Hypericum* species as identified here and *Reinwardtia indica* contain hypericin and other biologically active constituents as *H. perforatum*. However, volatile constituents of *H. elodeoides* have been studed.

References

Banerji, P. S., Mukherjee and Singh, S. K. 1995. Amazing effect of *Hypericum perforatum* L. in curing neuralgia. Int. Conf. Curr. Prog. Med. Arom . Pl. Res., Calcutta, Dec. 30 to Jan. 1, 1995.

Barbagallo, C and Chisari G. 1987. Antimicrobial activity of three *Hypericum* species. Fitoterapia, 58 : 175-183.

Berghofer, R and Holzl, J. 1987. Bioflavonoids in *Hypericum perforatum* part I : Isolation of 13, 18 – Biapigenin. Planta Medica, 53 : 216-217.

Berghofer, R and Holzl, J. 1989. Isolation *of 13, II8 – Biapegenin* (amentoflavone) from *Hypericum perforatum.* Planta Medica., 55 : 591.

Bergwein, K. 1967. Oil of St. John's Wort in therapy and cosmetics. Perfum. essent. oil Res., 58 : 164-165.

Biochinor, A. 1965. Bioflavonoid from *Hypericum perforatum* L. possessing Vitamin-P. activity. Farmatsia (Sofia), 15 : 92-96.

Bombardelli, E. and Morazzoni, P. 1995. *Hypericum perforatum.* Fitoterapia 66 : 43-67.

Borkawski, B. 1992. Biological activity of caffeic acid and its derivatives. Acta. Pol. Pharm., 44 : 89.

Brantner, A. R., Della Loggia, S., Sosa and Kartnig, T. H. 1994[a]. Study of antiphloistic activity of *Hypericum perforatum* L. Scientia Pharm., 62 : 97-98

Brantner, A., Kartnig, T. H and Quehenberger, F. 1994b. Comparative phytochemical investigations of *Hypericum perforatum* L. and *H. maculatum* Crantz. Scientia pharm., 62 : 261-276.

Brondz, I., Greibrekk, T., Groth. P. A. and. Aasen, A. J. 1982. Relative stereochemistry of hyperforin – A antibiotic from *Hypericum perforatum* L. Tetrahedron lett., 23 : 1299-1300.

Duke, J. A. 1985. *Handbook of Medicinal Herbs*. CRC Press. Inc. Boca Raton, Florida, USA, pp. 242-243.

Gaind, K. N. and Ganjoo, T. N. 1959. Antibacterial principle of *Hypericum perforatum* Linn. Ind. J. Pharm., 21 : 172-175.

Holzl, J., Denisch, L. and Gollnik, B.1989. Investigations about antidepressive and Mood changing Effects of *Hypericum perforatum*. Planta Medica, 55: 64.

Mehta, S. P., Viswanathan, M. V. and Singh, H. B. 1991. On the Identity of Market Sample of 'Brahmi' in Delhi. Bull. Med. Ethno. Bot. Res. 12 : 83-86.

Sparenberg, B. 1993. Antidepressive constituents of *Hypericum perforatum* PZ Wiss, 6 : 50-54.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants 303 - 305, 1999

Chemical examination of essential oil of *Ocimum basilicum* L. raised on saline alkali soil

A. R. CHOWDHURY

National Botanical Research Institute
Lucknow - 226 001, Uttar Pradesh.

Abstract

Ocimum basilicum L. could be raised successfully in saline alkaline soil. Alkalinity did not have any effect on the yield and quality of the oil. On hydrodistillation the fresh herb yielded 0.4 per cent oil. The oil contained mainly methyl chavicol, linalool, methyl eugenol and 1:8 cineole.

Introduction

Ocimum basilicum L. (Labiatae), popularly known as basil is a native of central Asia but also widely cultivated throughout the world particularly in India, Bulgaria, Romania, Egypt, Israel, Camoros, Yugoslavia, U.S.A., Madagascar and Pakistan. The plant is reported to be of medicinal value and find use in Indian system of medicine. It is reported to have stomachic, anthelmintic, antipyretic and expectorant properties. Oil is used in food, flavour and pharmaceutic.l industries.

Several chemotypes of basil are reported by Sobti and Pushpangadan (1982) like methylcinnamate/methyl chavicol/ eugenol/graniol and linalool types. Khanna *et al.* (1997) examined the composition of the oil from plant cultivated on normal soil and reported constituents containing mainly methyl chavicol and linalool. Indian basil type is cultivated as a commercial crop for its essential oil (methyl chavicol). Its production in India is estimated to be about 10 tonnes annually. Methyl chavicol is a chemical of multiple applications particularly in food, flavour and pharmaceutical industries. (Gunther, 1975). It is also used as a starting material for the synthesis of anethole. Considering the economic importance of oil, the plant was raised underused land utilization plan on alkaline soil which is not suitable for cultivation of food crops. The material for study was obtained from Western U.P. areas where it is in commercial cultivation and planted at Banthra Research Station of the Institute. The soil at Banthra is clayee saline having pH 9-10 and exchangeable sodium more than 20%. The crop came up at Banthra quite successfully under the prevailing agro climatic condition.

On hydrodistillation, it gave 0.4% of a volatile oil on fresh weight basis possessing a sweet odour resembling to that of fennel. Taste of the oil was lightly sweet. Chemical composition of the oil was determined by GCMS on Hewitt packard GCMS Model H.P. 5996 coupled with computer library of 80,000 compounds and fitted with a WACOT SE 30 (Methyl silicon gum) capillary column of 12 m X 0.32 mm. Other conditions of the experiment were maintained as given below.

Carrier gas	Helium
Flow rate	40 ml/sec
Injector temp.	230^0 C
Chromatographic temp.	5^0 to 290^0 with rising rate 10^0/min
Mass range	40-800

The constituents were identified by comparing GC MS spectra of the peaks with those of the given in the library and reported literature. The major constituents were further confirmed by GLC and TLC.

Effect of alkalinity on the quantity and quality of oil

It was observed that the alkalinity of the soil practically had no effect on the yield and quality of the oil. The oil contains phenolic ethers in major concentration, as is clear from the Table 1. In addition, it contains fairly good amount of linalool (17.56%), 1:8, cineole (3.67%) and generally acetate. Their presence contributes to the sweet and fine odour of the oil. Anethole, methyl-iso-eugenol add to its delicacy. The terpene and sesquiterpene content is fairly low. High concentration of methyl chavicol (61.50%) contributes to sweet taste and fennel like odour of the oil. Methyl chavicol is a starting material for the synthetic preparation of anethole which is a largely wanted chemical in the pharmaceutical and flavour industry. The oil under investigation can form a potential raw material for anethole. Besides, it can directly be used as a flavouring material and in perfume blending.

Table 1. Chemical composition of essential of *Ocimum basilicum* grown on alkali soils.

Compound identified	Percentage
Hydrocarbons	
Ocimines	0.55
Camphene	0.75
α-pinene	0.31
Caryophyllene	0.32
Zingeberene	0.68
Humelene	2.45
β-Bisabolene	0.10
Oxide	
1 : 8, cineole	3.60
Carophyllene oxide	0.30
Linalool oxide	0.20

Alcohol	
Iso menthol	0.24
Linalool	17.56
Nerol	0.15
Iso-neo-menthol	0.24
Trans geraniol	0.10
Aldehyde	
Citral	1.56
Ketones	
Camphor	1.22
Methyl heptenone	0.11
Esters	
Geranyl acetate	0.14
Phenols	
Eugenol	1.20
Phenolic ethers	
Methyl eugenol	3.10
Methyl iso eugenol	1.50
Anethole	0.12
Methyl chavicol	61.50

Acknowledgement

The author is grateful to the Director, National Botanical Research Institute, Lucknow for his keen interest in the investigation.

References

Gunther, E. 1975. Essential oils. Vol. II, p. 506-507 and Vol. III p. 415-423. Robert E.K. (ed.) Publishing Co., Huntington, New York.

Khanna, R. K., Chowdhury, A. R., Raina, R. M. and Sharma, M. L. 1997. J. of Non-Timber Forest Products, 4 (1/2), p p. 32-33.

Sobti, S. N. and Pushpangadan, P. 1982. In: Cultivation and utilization of medicinal and aromatic plants, RRL, Jammu (ed). C.K. Atal & B.M. Kapoor, pp. 457-472.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 306 -312, 1999

Scientific appraisal of 'Chaksini' (*Peristrophe bicalyculata* Nees.) - A lesser known drug of Unani system of medicine

M. SADRUL HODA, TAJUDDIN & S. H. AFAQ

Faculty of Unani Medicine
Aligarh Muslim University
Aligarh – 202 002, Uttar Pradesh.

Abstract

Correct identification of the source of 'Chaksini', the pharmacological properties of the drug and results of clinical investigation are presented.

Introduction

During the ethnomedico botanical survey of Aligarh District and adjoining areas, many plants were recorded to have medicinal values. These plants are neither mentioned in the literature nor are used as medicine in general practice by the Unani physicians. It is also noted that there are certain plants which are in little use by a few Unani practioners and referred to in some classical Unani literature. 'Chaksini' is one of the plants that comes under the above criteria. The plant 'Chaksini' and 'Chaksini' is mentioned by Ghani (1921), Khan (1882) and Qadir (1931) but its correct botanical identity remains always controversial. The grand son of Hkm. Abdul Qadir, the author of Mujarrabat-e-Qadri, Hakim A.Q. Khan was consulted regarding the identity of 'Chaksini'. The plant pointed out by A.Q. Khan was collected and compared with the description mentioned in Unani books and finally cultivated for its botanical identity in the herbal garden of the Department of Ilmul Advia, A.M.U., Aligarh. The morphological comparison of cultivated and wild plants was also made.

Out of 15 species of *Peristrophe* only six species are found in India (Maheshwari 1976 and Anonymous, 1955-56), but all the species are stated to be therapeutically inert except *P. bicalyculata*, Nees (Kritikar & Basu, 1987). It is reported that the essential oil of the plant has tuberculostatic activity in the concentration of 20 mg /CC. (Chopra *et. al.,* 1956). In the classical Unani literature it is reported to be useful in pneumonia and promotes healing in fractures. The seeds produce anoxeia (Ghani, 1921). It is mentioned to be useful in leucoderma and hysteria (Qadir, 1931). The whole plant macerated in an infusion of rice is said to be good antidote for snake poison (Chopra, *et. al.,* 1956).

Cultivation

The seeds of 'Chaksini' were collected in winter from the field and sown in the first week of July in earthen pots filled with a mixture of FYM and clay (50:50). Irrigation was given as and when required. The seedlings emerged in the mid week of July in agroclimatic condition of Aligarh. Flowering had started in the first week of September and the maximum flowers were counted in the third week of September. The fruiting occurred in November and the plant died in April.

Identification

On the basis of morphological characteristics and comparison with the description of plant in various floras (Hooker, 1885; Kritikar and Basu, 1987) and with herbarium specimen of Department of Botany, A. M. U., Aligarh, the plant was identified as *Peristrophe bicalyculata*, Nees; Family, Acanthaceae.

Methodologies

The quantitative microscopy was made according to the methods mentioned in Trease and Evans (1972). The stomatal size, palisade ratio, vein islet number and trichome size were recorded. Ash values, extractive values and moisture contents were determined by the methods mentioned in B. P. (Anonymous, 1968). Nitrogen percentage was determined by the method given by Lindner (1944). The protein, sugars and sterols were determined by the standard methods mentioned by Afaq and Ansari (1984). The oil percentage and its contents were determined by the methods mentioned in B.P. (Anon. 1968 & Jenkins *et. al.,* 1967). Paper chromatography for determination of amino acids and sugars was made by the methods previously established in the laboratory (Afaq & Siddique 1983, Afaq & Ansari 1984). A glycoside was isolated using the method mentioned by Peach & Tracey (1955).

For the study on antivenom activity of 'Chaksini', plasma fibrinogen levels were estimated after Russell's viper envenomation (2mg/kg b.w. intraperitoneally) in rabbits in the control and drug-treated groups (250mg/kg b.w. orally) at 0, 1st, 3rd, 6th and 24th hour.

Observations and discussion

The stem and leaves of the plant are hairy containing uniseriate multicellular trichomes of different sizes. The stomata are sunken diacytic nature. The vein islet number and palisade ratio were also determined and the data are mentioned in Table 1. These observations can be used for tentative identification of the plant whenever obtained in powder form or in broken pieces.

Table 1. Quantitative microscopy of leaves of *Peristrophe bicalyculata*

Parameter	Range	Average ± S.D.
Stomatal size (15 x 100)		
Length (mm)	960 – 1280	1146.66 ± 148.95
Width (mm)	640 – 800	720.0 ± 87.63
Palisade ratio (15 x 100)	3 – 5	0.4 ± 0.89
Vein islet number (15x10)	3 – 8	0.52 ± 1.72
Trichome size (10 x 10)		
Length	510 – 680	563.33 ± 68.23
Width	5.10 – 8.5	7.08 ± 1.27

The qualitative studies of whole plant were also made and noted that sugars, glycosides, tannins, sterols/terpenes, amino acids, flavonoids and phenols are present, justifying the use of this plant for medicinal purpose (Table 2). The isolation of a TLC pure glycoside (M.P. 220-222 ^{0}C) indicates towards the use of this plant in cardiac problems. The phenols appear to be of cumerin nature and therefore, justifying the

Table 2. Qualitative tests for various organic substances in the extract of 'Chaksini'

Constituent(s)	Results
Alkaloids	-
Reducing sugars	+
Non-rducing sugars	+
Glycosides	+
Tannins	+
Sterols/terpenes	+
Resins	-
Saponins	-
Amino acids	+
Flavonoids	+
Phenols	+

+ positive - negative

use of this plant in leucoderma. The different physico-chemical parameters so far recorded can be used as standards (Table 3). The acid value is 8.05±0.15 showing that the free acids are less in quantity, 185.66±2.13 iodine value indicates that the oil comes under the category of semi drying oil but oil can not be exploited for industrial use as the oil content in plant is very less (0.6±0.25%). The results of fluorescence analysis of the whole plant powder, as mentioned in (Table 4), can be used as a tool for identification of the powder of the plant if and when required. Thirteen amino acids and three sugars were identified on the basis of the paper chromtagraphy and their percentage composition were calculated using the densitometer. One amino acid (21.56%) and one sugar (37.54%) remained unidentified (Table 5). The column chromatography of the ethnolic extract of the plant was made on silica gel and various fractions starting from

Table 3. Physico-chemical & quantitative studies of *Peristrophe bicalyculata*

Parameter	Value		
Total ash (%)	10.80	±	0.209
Acid insoluble ash (%)	3.04	±	0.054
Water soluble ash (%)	2.32	±	0.075
Moisture content (%)	7.762	±	0.243
Extractive values (%)			
Pet. ether	0.583	±	0.016
Chloroform	0.745	±	0.05
Ether	0.490	±	0.059
Benzene	1.373	±	0.142
Alcohol	2.955	±	0.084
Water	14.158	±	0.652
Nitrogen (μg/g)	25.340	±	0.28
Protein (mg/g)	156.400	±	0.12
Sugars (μg/g)	.25.33	±	0.24
Sterols (mg/g)	3.10	±	0.089
Phenols (μg/g)	6.40	±	6.12
Oil percentage	0.60	±	0.25
Acid value	8.05	±	0.15
Iodine value	185.66	±	2.13
Saponification value	361.28	±	0.92

Table 4. Fluorescence characteristics of powder of whole plant 'Chaksini' under ultraviolet light.

Treatment	Colour observed
Dry Powder (with naked eye)	ashy
Dry powder (under U.V. light)	whitish green
N-sodium hydroxide in methanol	dark green
Mounted in nitrocellulose in amylacetate	deep dark green
Treated with N-Sodium hydroxide in methanol and mounted in nitrocellulose	yellowish green

Table 5. The Percentage composition of amino acids and sugars in "Chaksini".

A. Amino Acids	Percentage
DL-Alanine	54.54
L-2 Amio-n-butyric acid	45.41
L-Arginine- Hcl	61.53
DL-Aspartic acid	38.46
L-Dopa	62.68
lycine	37.31
DL-Isoleucine	52.98
DL-Nor-leucine	47.70
DL-methionine	46.15
L-Proline	53.84
DL-Tryptophan	64.47
a-Tyrosin	35.52
L-Hystidine Hcl	78.43
Unidentified	21.56
B. Sugars	
Rhamnose	66.84
Sucrose	33.16
D-galactose	62.46
Unidentified	37.54

petroleum ether to methanol were obtained. The ethyl acetate and acetone fractions each gave the single spot of Rf value of 0.92 and 0.74, respectively. The maximum number of spots were noted in petroleum ether fraction with the Rf values of 0.43, 0.23, 0.06, 0.03 and 0.07 (Table 6).

Table 6. TLC of different fractions obtained by column chromatography 'Chaksini'

Solvent system						
Pet. ether :	Solv ether	Benzene : Chloroform	Ethylacetate : Methanol :	Benzene: Chloroform	Methanol Acetone	Methanol: Chloroform
	1:1	1:1	1:2	3:1	3:1	2:1
Pet. ether fraction	Solvent ether fraction	Chloroform fraction	Ethylacetate fraction	Benzene fraction	Acetone fraction	Methanol fraction
0.43	0.41	0.25	0.92	0.25	0.74	0.85
0.23	0.25	0.21		0.15		0.44
0.06	0.12	0.14		0.16		0.18
0.03		0.10		0.09		
0.07						

A significant decrease in plasma fibrinogen level was observed in the treated group but when compared with the control group it was significantly higher (Table 7) causing the death of only one animal after twenty four hours, whereas in control group only one animal survived and rest died, therefore, justifying the use of plant in snake-bite.

In authors opinion the scientific evaluation of the lesser known and folk medicine is the prime need for the development of new medicines for the benefit of human beings. The hidden treasure must be exploited because the possibilities of certain magical remedies from them are very bright.

Table 7. Effect of aqueous extract of 'Chaksini' on plasma fibrinogen level (mg / 100ml of blood) after Russell's viper envenomation in rabbits

	0. hr	1h	3h	6h	24 h
Control group	202.55 ± 3.052	167.51 ± 608	94.461 ± 10.610	77.22 ± 9.583	36.30**
Treated group	208.83 ± 3.32	169.60 ± 3.72	152.85 ± 4.21	111.51±4.50	1.96±3.94***

** of only one animal, 5 died

*** mean of 5 animals

References

Anonymous. 1955-56. The wealth of India 'Raw Materials. Council of Scientific and Industrial Research, (CSIR), New Delhi, Vol. 9, p. 45.

Anonymous. 1968. British Pharmacopoea, General Medical Council Pharmaceutical Press, London, pp. 1137, 1165, 1266, 1268.

Afaq, S. H. and Siddiqui, M. M. H. 1983. Geobios New Reports, 2: 163-164.

Afaq, S. H. and Ansari, Z. U. 1984. Geobios New Reports, 3: 179-181

Chopra, R. N., Nayar, S. L. and Chopra, I. C. 1956. Glossary of Indian Medicinal Plants. C.S.I.R., New Delhi, pp. 189, 515.

Ghani, M. M. 1921. Khazinatul Advia (Persian), Mataba Munshi Nawal Kishore, Lucknow, Vol. II, pp. 350-51.

Hooker, J. D. 1885. Flora of British India, The Forest Book House, N.R. Ashford Kent, England, Vol. IV, p. 554

Jenkins, G. L., Khevel, A. M. and Digangi, F. E. 1967. Quantitative Pharmaceutical Chemistry, (3rd Ed.) Grew- Hill Book Co. New York, pp. 257, 236.

Khan, M. A. 1882. Muheet-e-Azam, Mataba Nizami, Kanpur, Vol. II, p. 77.

Kritikar, K. R. and Basu, B. D.1987. Indian Medicinal Plants, International Book Distributers, Dehradun, Vol. III, pp. 1910-11.

Lindner, R. C. 1994. Plant Physiol. 19. pp. 76-89.

Maheshwari, J. K. 1963. The Flora of Delhi, Council of Scientific and Industrial Research, New Delhi, p. 269.

Peach, K. and Tracey, M. V. 1955. Modern Methods of Plant Analysis, Berlin, Vol. II, pp. 310-11.

Qadir, A. K. 1931. Mujarrabat-e-Qadri, Mohan Printing Press, Aligarh, pp. 307, 351.

Trease, G. E. and Evans, W. C. 1972. Text Book of Pharmacognosy, England, pp. 662- 664.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 313 -314, 1999

Curcuma caesia Roxb., a promising plant - retrospects and prospects

ASHOK K. PANDEY & R. B. LAL

Centre for Forestry Research and Human Resource Development
Tropical Forestry Research Institute
Chhindwara – 480 001, Madhya Pradesh.

Abstract

Curcuma caesia (*Kali haldi*) grows in West Bengal, Madhya Pradesh, Orissa, Bihar and Uttar Pradesh and is being used by the tribal people to cure their various ailments. In Madhya Pradesh, the plant is regarded very auspicious and it is stated that the person, who possesses it never experiences shortage of cereals and food. *Curcuma caesia* also finds an important place in our traditional system of medicine. The rhizome of the plant yields an essential oil. The present study is an attempt to standardize the propagation techniques of the plant and evaluate essential oil for its chemical constituents.

Introduction

Curcuma caesia Roxb. commonly known as *Kali haldi* belongs to Family Zingiberaceae. The plant is being used by the tribals in West Bengal, Madhya Pradesh, Orissa, Bihar and Uttar Pradesh to cure their various ailments. It is also used in folk medicine, folk cosmetic and in traditional system of medicine. In West Bengal, it is also used as a substitute of turmeric in the fresh state. It occurs chiefly in West Bengal, Bihar and Madhya Pradesh *C. caesia is* cultivated also in some parts of West Bengal.

Description

C. caesia Roxb. is a annual herb with tuberous rootstock, leaves characterized by black coloured grooves on the mid rib of the lamina. Leaves are 30-60 cm long, 12.5-15 cm, wide, broadly lanceolate or oblong glabrous, sheath is about as long as the blade. Spikes appear rather before the leaves, about 15 cm long or altogether about 30 cm alongwith the peduncle. Flowering bracts are green with a ferruginous tinge, coma deep bright red, tending to crimson. Flowers are of pale yellow in colour, reddish at the outer border and shorter than their bracts.

Rhizomes are aromatic, stimulant, carminative and used externally for sprains and bruises. The 'Turkomans' employ these tubers as a rubifacient, to rub their bodies after Turkish bath (Kiritikar and Basu, 1935). The inner part of the rhizome is bluish black in colour which emits a characteristics sweet smell, due to the essential oil present. The tubers are also rich in starch. Dry rhizomes rubbed with little water and extract prepared is taken internally to relive asthma. The rhizome contains essential oil containing d-camphor.

Cultivation

Experimental trials were conducted for the cultivation/propagation of *C. caesia* at the Centre to develop cultivation package for the species.

Rhizomes are planted at a spacing of 30 cm x 30 cm in June – July. In the areas where rainfall is less, three to four irrigations are required as'*Kali haldi*' is moisture loving crop. The crop should be kept free from weeds by repeated weeding and hoeing. Mulching with green leaves has been found beneficial both for weed control and for retaining moisture.

C. caesia can be propagated by rhizomes which possesses a growing bud. It requires well drained light sandy loam, friable soil rich in humus. It grows best in humid tropical and subtropical climate with an average rainfall of 1500 mm. Certain amount of shade is beneficial for the growth of plant. Therefore it can be taken as one of the intercrops in different agoforestry systems. The soil should be ploughed about 30-40 cm deep 2-3 times. It should be harrowed to make it loose and friable.

Harvesting and processing

The crop is harvested after 8-9 months in January when the top leaves start turning yellow. The dry leaves are cut close to the ground. The rhizomes are taken out from the soil by digging the soil or with the help of crow bar. The rhizomes are washed and allowed to dry in shade. The mother rhizome is kept for seed.

For extraction of essential oil fresh rhizomes were cut into small pieces and steam distilled. The small pieces of the rhizomes were distilled in Clevenger apparatus for 10-15 hours and oil samples were dried using anhydrous sodium sulphate. The yield of essential oil was found 1.2 - 1.5%. The essential oil of *C. caesia* contains 76.6% d-camphor besides other chemical constituents.

References

Kirtikar, K. R. and Basu, R. D. 1935. Revised by Blatter, E., Claius, J. F. and Mhaskar, K. S. 1935. Indian Medicinal Plants Vol. IV, 2422.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants 315 -321, 1999

Use of medicinal plants for management of bacterial blight in rice and bacterial wilt of tomato in Assam

L. C. BORA & JAYA SAMUEL

Department of Plant Pathology
Assam Agricultural University
Jorhat – 785 013, Assam.

Abstract

Twenty six medicinal plant species commonly used for curing human health ailments in Assam were tested for their inhibitory property against bacterial wilt in tomato *Ralstonia solanacearum* and *Xanthomonas oryzae pv, oryzae*, the bacterial leaf blight pathogen in rice. Aqueous extracts of twelve of these medicinal plants *viz., Pterdium aquilinum, Allium sativum, Abrus precatorius, Mentha* Spp., *Curcuma longa, Zingiber officinale, Psidium guajava, Aloe vera, Moringa olifera, Spilanthus paniculata, Allium cepa, Camellia sinensis* @ 20 per cent could produce significant degree of inhibition against *R. solanacearum* when tested by paper disc assay method. Similarly, aqueous extracts of sixteen medicinal plants including *Datura stramonium. Phlogacanthus thyrisiflorus, Leucas indica, Nyctanthes arbortristis, Paederia foetida, and Houttuynia cordata* could inhibit the growth of *X. oryzae* pv. *oryzae* significantly. Under field condition, extracts of *Aloe vera, Psidium guajava* and *Allium sativum* (20%) used as root dip treatment of tomato (cv. Pusa Ruby) seedlings reduced the bacterial wilt incidence by 80.0, 75.99 and 72.01 per cent, respectively. On the other hand, extracts of *D. stramonium* (97. 54%), *P. guajava* (81.98%). *L. indica* (8.46%) and *A. sativum* (24.78%) were significantly effective in reducing the bacterial blight severity in rice (cv Jaya) when these were sprayed @ 20 per cent over crop foliage 72 hours before inoculation with the pathogen. The aqueous extract of *A. vera* against *R. solanacearum* and *D. stramonium* against X. *oryzae* pv. *oryzae* were found to be most effective treatment in reducing bacterial wilt in tomato and bacterial blight in rice, respectively.

Introduction

The State of Assam is endowed with natural wealth of medicinal plant species and number of these plants have been successfully exploited for curing human and animal diseases. Moreover, many of these indigenous plant species occupy important place in Assamese tribe's health, religion, culture and economy. As such, medicinal plants have been an integral part of Assamese socio-cultural tradition since time immemorial due to the natural and agroecological situation of the state.

In the recent years, medicinal plant extracts have assumed special significance in the strategy of developing environmentally safe method of plant disease control. Plant derivates are effective alternatives of microtoxic chemicals; in addition to their non hazardous nature and selective properties their cost is also low. Many plant products have been identified to be effective in the control of different plant diseases due to the presence of insecticidal, fungicidal, antibacterial and antiviral properties in them. Studies have been carried out by plant pathologists throughout the world and elsewhere in the country to identify plants with antimicrobial properties with a view to exploit them in management of plant diseases. (Chary *et. al.*,1984). Some of the plant species which are under extensive studies to exploit their medicinal properties include, *Eucalyptus citriodora, Ocimum sanctum, Allium sativum, Polygonum quiseteforme, Thalictum foliolosum* etc. (Low *et. al.*, 1984 and Rawat *et. al.*, 1992). In the present study, 26 plant species known for their medicinal value and generally used for curing different human health ailments were screened for their antimicrobial activity against *Ralstonia solanacearum,* the incident of bacterial wilt in many vegetable crops and *Xanthyomonas oryzae pv. oryzae* the causal agent of bacterial blight in rice.

Isolation of the pathogen

Diseased tomato plants were collected from the wilt sick plots of Horticultural orchard and diseased rice plants from Agronomy fields of Assam Agricultural University, Jorhat. Isolation of *R. solanacearum* was made in triphenyl tetrozolium chloride (TTC), while isolation of *X. oryzae* pv. *oryzae* was made in Wakimoto media by incubating both the cultures at $28 \pm 1^{0}C$ for 24 hours. The virulent individual colonies of these bacteria were further streaked on their specific media plates to get pure cultures which were preserved in a refrigerator for further studies.

Preparation of the plant extract

Medicinal plants selected for preparation of aqueous extracts are listed in Table 1. Fresh plant material were thoroughly cleaned, surface sterilized with ethanol and washed in sterile distilled water. The cleaned tissues were then ground, mixed with sterilized water @ 1ml/g of tissue. The extracts were first filtered through muslin cloth and later through Whatman No 1. filter paper. Finally these were passed through Seitz's filter to free them from the bacterial contamination. The final extraction was taken as the standard plant extract solution (100%). The dilution of the plant extracts was done by adding sterile distilled water to get 20 per cent concentration.

Table 1. List of medicinal plant extracts tested against *Ralstonia solanacearum* and *Xanthomonas oryzae* pv. *oryzae in vitro*

Botanical name	Enlglish name	Local name	Plant part used
Ageratum conyzoides L	Goat weed	Gondhwabon	Leaves
Allium sativum L.	Garlic	Nohoru	Bulb
Allium cepa L.	Onion	Piyaj	Bulb
Abrus precatorius L.	The crab's eye	Bagalatumoni	Leaves
Aloe vera L.	Indian Aloe	Chalkuori	Leaves
Camellia sinensis (L.) Kuntz	Tea-leaf	Sah-pat	Leaves
Curcuma longa L.	Turmeric	Halodhi	Rhizom
Cucumis sativus L.	Cucumber	Tioh	Leaves
Datura stramonium L.	Thorn apple	Datura	Leaves
Houttuynia cordata Thumb	-	Masundori	Leaves
Leucas indica (L.)	Sweet motherwort	Boga doron	Leaves
Mangifera indica L.	Mango	Aam	Leaves
Moringa olifera Lamk	Drumstick	Sojina	Leaves
Mimosa pudica L.	Sensitive plant	Lajukibon	Leaves
Mentha Spp.	Field mint	Podina	Leaves
Murraya koenigii (L.) Spr	Curry leaves	Norosingha	Leaves
Nyctanthes arbortristis L.	Tree of sadness	Sewali	Leaves
Polygonum plebium R. Brown	Polygonum	Banjaluk	Leaves
Phlogacanthus thrysiflorus (Roxb.) Nees		Titaphool	Leaves
Paederia foetida (L.) Mant.	-	Vedailata	Leaves
Phyllanthus traternus Webster	Ground embelic	Bonamlukhi	Leaves
Pteridium aquilinum (L) Kuhn	Smart weed	Bihlokhoni	Leaves
Psidium guajava L.	Guava	Madhuriam	Leaves
Spilanthes paniculata Wallex	-	Suhinibon	Leaves
Wedelia chinensis (Osheck) Merr.	Bhringraj	Mohavingaraj	Leaves
Zingiber officinale Rosc.	Ginger	Ada	Rhizome

In vitro studies

The aqueous extract of different medicinal plants was assayed *in vitro* for their inhibitory effect against *R. solanacearum* and *X. oryzae* pv. *oryzae* by paper disc assay method (Blair *et. al.*, 1971). Filter paper discs soaked in sterile distilled water served as control. Nutrient agar (NA) medium was used throughout the laboratory studies. Each treatment was replicated 4 times. Inhibition zones were produced by the aqueous plant extracts were recorded 48 hours of incubation at 28 ± 1^0 (Table 2).

Table 2. Inhibition zone produced by aqueous extract of some medicinal plants against *Ralstonia solanacearum* and *Xanthomonas oryzae* pv. *oryzae in vitro*

Plant extracts		Inhibition zone (mm)	
	Concentration (%)	*R. solanacearum*	*X. oryzae* pv *oryzae*
Abrus precatiruys	20	11.0	14.6
Allium cepa	20	10.4	9.1
Allium sativum	20	32.0	17.6
Aloe vera	20	50.7	16.4
Camellia sinensis	20	10.4	11.8
Curcuma longa	20	15.6	16.6
Datura stramonium	20	0.0	22.4
Houttuynia cordata	20	0.0	0.0
Leucas indica	20	0.0	32.5
Mentha Spp.	20	7.4	0.0
Moringa olifera	20	5.9	10.0
Nyctanthes arbor-tristis	20	0.0	8.4
Psidium guajava	20	41.4	28.0
Pteridium aquilinum	20	7.2	10.5
Phlogacanthus thyrisiflorus	20	0.0	7.2
Paederia foetida	20	0.0	6.9
Spilanthus paniculata	20	8.0	0.0
Zingiber officinale	20	7.4	10.0
Control	Water	0.0	0.0
CD (P=0.05)		2.1	1.6

In vivo studies

The plant extracts found effective *in vitro* were further tested *in vivo* for their efficacy in reduction of bacterial wilt symptoms on tomato plants (cv. Pusa Ruby) and against bacterial blight severity in rice (cv. Jaya). The tomato seedlings were first dipped in the aqueous extract (@20%) for 30 minutes and were transplanted to earthen pots containing field soil. After 30 days of transplanting *R. solanacearum* (10^9 cfu/ml) was applied @ 20 ml at the base of each seedling following root injury. Observations on bacterial wilt incidence were made at regular interval and the per cent wilt incidence was calculated.

Thirty days old rice plants were first sprayed with aqueous extracts of different medicinal plants @ 20 percent. After 24 hours of this application, virulent cells of *X. oryzae* pv. *oryzae* @ 1 x 10^8 cfu/ml were spray inoculated over the crop foliage. Observations on appearance of disease symptoms were made at regular interval and the disease severity was calculated. In both the experiments plants inoculated with sterile distilled water served as control.

Effect of plant extract against *R. solanacearum* and *X. oryzae* pv. *oryzae*

Efficacy of different plant extracts against growth of *R. solanacearum* and *X. oryzae,* pv. *oryzae* were assessed and the results are presented in Table 3. Among the twenty six different medicinal plant extracts tested, aqueous extracts of twelve plants were found significantly effective in inhibiting the growth of *R. solanacearum in vitro.* Leaf extracts of *Aloe vera* could produce highest inhibition (50.7 mm) of *R. solanacearum* at 20% concentration followed by *Psidium guajava* (41.4 mm), *Allium sativum* (34.45 mm) and *Curcuma longa* (15.6 mm). Presence of some antimicrobial compounds, aloniside in *Aloe vera*, limonene, caryophyllene, eugenol in *P. guajava,* allicin in *A. sativum* and curcumin in *Curcuma longa* have been detected which may be responsible for inhibition of the *R. solanacearum* growth (Rastogi and Mehrotra, 1990). The inhibition exhibited by most other plant extracts ranged within 5.9 to 11mm. *A. vera* extract has been reported to be toxic against certain plant pathogenic micro-organisms (Sak and Barkai - Golan, 1995). Similarly, extracts of *A. sativum* (Hatagalang, 1988), *C. longa* and *Ferula foetida* (Bora, 1995) were found effective in suppressing the growth of *R. solanacearum* and reducing bacterial wilt incidence in tomato.

The aqueous extracts of 16 medicinal plants were significantly effective in reducing the growth of *X. oryzae* pv. *oryzae in vitro* (Table 3). The extracts of *L. indica* (32.5 mm), *P. guajava* (28.0 mm), *D. stramonium* (22.4 mm), *A. sativum* (17.6 mm), *A. vera* (16.4 mm), and *C. longa* (16.6 mm) were found comparatively more effective in inhibiting the growth of the bacterial pathogen. Remaining plant extracts could produce inhibition zones ranging from 7.2 to 14.6 mm. Earlier, *D. stromonium* (Bambawale *et. al.,* 1995) *P. guajava* (Mohammed *et. al.*, 1994) and *A. sativum*

(Kasem and Vijay, 1991) extracts have been found inhibitory to many microorganisms including gram negative bacteria like *X. campestris* pv. *malvacearum*.

The medicinal plant extracts which could effectively inhibit the growth of the pathogens *in vitro* were further tested *in vivo*, for their ability to control bacterial wilt in tomato (cv Pusa Ruby) and bacterial blight in rice (cv. Jaya). It was found that the extracts of *A. vera* (@ 20%) was highly significant in reducing the incidence of bacterial wilt in tomato (80.00%) followed by the extracts of *D. stramonium* (97.54%) significantly most efficient in reducing the bacterial blight severity in rice followed by extracts of *P. guajava* (81.98%), *L. indica* (83.46%) and *A. sativum* (24.78%) (Table 3).

Table 3. Effect of aqueous extract of medicinal plants on bacterial wilt of tomato and bacterial blight of rice.

Plant species	*Ralstonia solanacearum*		*Xanthomonas oryzde* pv. oryzae	
	Disease incidence	Disease reduction	Disease severity	Disease reduction
Aloe vera	15.63	80.00 (63.44)	-	-
Allium sativum	21.87	72.01 (58.05)	32.39	24.78 (29.87)
Datura stramonium	-	-	1.06	97.54 (80.90)
Leucas indica	-	-	7.12	83.46 (66.03)
Psidium guajava	18.75	75.99 (60.60)	7.76	81.98 (64.90)
Control	78.12	0.50 (4.05)	43.06	0.50 (4.05)

The antimicrobial components detected in these plant extracts have been alkaloids hyoscyamine and hyoscine (*D. stromonium*), β - sitosterol and α-sitosterol (*L. indica*), quercetin and avicularin (*P. guajava*) (Rastogi and Mehrotra, 1990). These antimicrobial compounds may be responsible for inhibition of the two bacterial plant pathogens as well as for reduction of disease incidence/severity caused by them.

The inhibitions demonstrated by different medicinal plant extracts in the present study against two very important pathogens of crop plants prevailing in Assam as well as their effectiveness in green house condition promises a new dimension in the field of plant disease management with nonhazardous and ecofriendly methods. The success promises more significance in a state where medicinal plants are already a part of people's tradition.

References

Bambawale, O. M., Mohan, P. and Chakraborty, M. 1995. Efficacy of some medicinal plants against cotton pathogens. Ad. Plant. Sci. 8 : 224-229.

Blair, J. E., Zenette, E. H. and Truant, J. P. 1971. *In Laboratory exercise in Microbiology*. Ed M.J. Plecaer and E.C. Chani. Mc Graw Hill Book Co., Berlin, pp. 356.

Bora, L. C. 1996. Management of bacterial wilt of tomato with an organic formulations. Plant Health 1 : 74-76.

Chary, P. M., Reddy, E. J. S. and Reddy, S. M. 1984. Screening of indigenous plants for their antifungal principle. Pesticides 18 : 17-18.

Hatagalang, L, 1988. Garlic bulb as a material for suppressing the incidence of bacterial wilt (*Pseudomonas solanacearum* E. F. Smith) on tomato, *Bull.* Penelition Hortikultura, 16 : 84-93.

Kasem, S. and Vijay, R. 1991. Effect of some medicinal plants *Croton tigitium, Eugenia caryophyllus, Allium sativum, Cymbopogon citratus, Datura metel, Stemona, Strychnos* nux-vomica, *Derris elliptica, Illicium verum* on growth of fungi and potential in plant disease control. 3rd Annual Conference on Methodological Techniques in Biological Sciences, Thailand, 12-13 Nov, 1985.

Low. D., Rawal, B. D. and Griffin, W. J. 1974. Antimicrobial action of the essential oils of some Australian Myrtaceae with special reference to the activity of chromatographic fraction of oils of *Eucalyptus citridora.* Planta Medica, 26 : 184-189.

Mohammed, S., Hassan, Z. and Hamid, N. A. 1994. Antimicrobial activity of some tropical fruits wastes. Pertanika J. Trop. Agri. Sci. 17 : 219-227.

Rastogi, R. P. and Mehrotra, B. N. 1990. *Compendium of Indian Medicinal Plants* : Vol. I Central Drug Research Institute, Luknow.

Rawat, A. K. S., Mehrotra, S. and Shome, V. 1992. Antimicrobial activity of *Thalictrum foliolosum*. Fitoterapia, 63 : 545-546.

Sak, Y. and Barkai – Golan, R. 1995. *Aloe vera* gel activity against plant pathogenic fungi. Post Harvest Biology and Technology. 6 : 159-162.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants 322 -333, 1999

Plant wealth of India: Economic dimensions of patenting and plant varieties protection

A. DAMODARAN

Indian Institute of Plantation Management
Bangalore, Karnataka.

Abstract

For more than two years India has been working on changing its patent laws and formulating its Plant Variety Protection Legislation. The WTO Dispute Settlement Body's ruling in 1997 about India not conforming to the rules of TRIPS, has put the patent agenda on a fast track. India's acceding to the Paris Convention in 1998 speaks of sudden urgency the patent issue has assumed. The stage is now set for a new Patent Law in India. However, its cousin, the Plant Varieties Protection Legislation which was also one of the major focus areas in the post-WTO agreement phase does not seem to have taken off ground. Our procrastination in the matter of plant varieties legislation affords an opportunity to debate and think now on the structure of *sui-generis* legislation of protection of plant varieties. This is particularly essential from the point of view of economic implications of different protection regimes. Unfortunately the economic implication of Plant Patents and Plant Varieties Protection have not been analyzed so far. In this paper an attempt is made to identify the principal issues involved in Plant Patents and Plant Varieties Legislation, and to propose an economic framework for analyzing the implications, arising from different IPR regimes for plants and plant varieties. Based on these elements, the paper proposes the broad directions on which the *sui-generis* plant varieties legislation needs to be structured in the Indian context.

Viewpoints on TRIPS – wheels within wheels

The WTO agreement on TRIPS specifies patentable subject matters. Article 27 (1) of the TRIPS states that patents shall be available for any invention, whether products or processes in all fields of technology provided they fulfil the criteria of 'novelty', involve an 'inventive step' and are 'capable of industrial application'. The terms 'inventive step' and 'capable industrial application' could be considered as synonymous with the terms 'non-obvious' and 'useful' respectively. Article 27(2) of the TRIPS states that members may exclude from patentability 'inventions' which may be necessary in order to protect public order or morality or human/animal/plant life or the environment in their territory. Article 27 (3) of the agreement lays down that members shall provide for the protection of plant varieties either by patents or by an effective *sui-generis* system or by any combination thereof. Article 27(3) in particular is critical to India as this requires us to provide protection of plant varieties by conferring plant breeder's rights either by way of patents or through *sui-generis* plant variety protection legislations. Countries with strong R & D base in plant genetic engineering such as U.S.A. have robust Plant Patent Legislations. India is certainly not inclined to adopt patent protection regimes for its plant varieties. India is rather inclined to adopt a *sui-generis* legislation, which is non- 'patent', based. There are many reasons for this proclivity. India is one of the twelve mega-diversity countries of the world and a rich storehouse of land races of principal agricultural crops. India has a strong R & D base in conventional plant breeding methods. Its strength in plant genetic engineering is impressive but not an overwhelming factor by comparison. The first two strengths explain India's disinclination towards plant patent regimes or towards a *sui-generis* legislation which is 'patent' – driven. Today in India, differences of opinion is not as much on the desirability of plant variety protection as it is on the structure of the *sui-generis* legislation. Broadly one sees two schools of thought in India in regard of *sui-generies* plant variety protection. One school of thought favours the adoption of a UPOV model of plant varieties protection, while the second school advocates a non-UPOV framework for protection of breeder's rights which could also uphold rights of local communities conserving the germplasm which forms the foundations of protected plant varieties. The second school of thought is associated with the green movement in India (GRAIN, 1990 and Shiva, 1998).

Those favoring the UPOV framework do not form a homogenous group. As a matter of fact there are two categories of UPOV enthusiasts *viz*., those who advocate India's joining the 1978 version of UPOV and those who advocate the more rigorous 1991 version of UPOV. The former include the plant breeders of India, nurtured in the traditions of public-funded research while the latter include plant breeders who work in the environs of private (national or international) plant breeding research.

Plant patents – The essence and implications

The roots of plant patenting go back to the US Supreme Court ruling in the Diamond vs Chakrabarty case in 1980. Following this landmark ruling, human altered micro-organisms and living organisms became patentable subject matter in USA and elsewhere. Plant patents have become the order of the day in the United states of America and Europe. The criteria for award of plant patents are 'novelty', 'inventiveness' and 'utility'. Plant patents are stronger in degree of protection, more costly from the point of view of preparation of patent application (ranging from US $ 10,000 - $ 20,000) and even more costly to defend or enforce (approximately US $ 250,000) RAFI, 1995, p2). The scope of protection under plant regimes is enormous. A plant variety or multiple varieties of plants or processes or parts, seeds, genes, proteins can fall within the protection ambit of plant patents. RAFI *op.cit* (p 315) also cite specific instances where plant patents granted have been sweeping in their range of protection afforded. Of special relevance to commercial crops have been the two reported cases of patent granted, *viz*, one to M/s DNA Plant Technology of USA on all transgenic pepper plants (engineered by multiple transformation methods) and the other to M/s Escagenetics Corporation of USA on all transgenic Ethiopian varieties of *Coffea Arabica* engineered by *Agrobacterium* method.

It is clear that plant patents protect gene characteristics and traits besides transgenic techniques of gene implantation. The implications of the sweeping characteristics can be far-reaching. A patent on *Agrobacterium* method can extend the proprietor's rights over all agricultural plants liable to this method of gene implantation. The same holds for other techniques such as DNA mediated gene transformation, protoplasts mediated transformation method, micro or macro projectiles or electroporation techniques amongst other. On the other hand, by patenting a gene characteristic, the patent holder would have rights over all plants over which these characteristics are sought to be expressed either by way of conventional breeding or by molecular gene manipulation, or still, by transgenic techniques.

The economic outcome of plant patents would be higher rents by way of fees and royalties accruing from monopolistic control over plant variety generation and seed production. Other things remaining equal, a patent holder would naturally set his fee or royalty to cover for the increased cost of patent application and defense. In the event of a strong plant patent regime, transgenic or non transgenic varieties of plants cannot be traded between nations without the approval of the patent holder. To this extend, royalties and fees are realisable for protected varieties both within and outside the country.

The essence and implications of Plant Varieties Protection Regulations – The UPOV Convention

In considering *sui-generis* IPR systems of protection for plant varieties, WTO members belonging to developing countries have been inclined to adopt the UPOV model Plant Breeders Rights. India is not an exception to this tendency. The UPOV is an international association/union which draws its legitimacy from the World Intellectual Property Organization (WIPO). The UPOV, which was entered into by a handful of developed countries in 1961 had 19 members by 1990, mostly drawn from the

European Community. The central feature of the UPOV is the protection it affords to plant breeders who produce plant varieties that fulfil the criteria of Distinctiveness, Uniformity and Stability (DUS). The current version of the UPOV, namely UPOV 1991 had added an additional criteria of 'new' to DUS thus rendering DUS as NDUS. Contrary to the popular notion, the NDUS criteria of UPOV 1991 is not substantively different from the principles of 'novelty', 'inventiveness' and 'industrial application' (NII) which obtain for patents. The criteria of 'novelty' and 'inventiveness' in Patent Laws are covered by the criteria of 'new' and 'distinct' in UPOV 1991. Thus distinctness, the UPOV means a variety of plant which is 'clearly distinguishable from other varieties whose existence is a matter of common knowledge'. It is apparent that this term captures the attributes of 'novelty' and 'inventiveness' implicit in Patent Laws. Even in respect of 'uniformity' and 'stability' criteria the UPOV does not offer different recipes. True, by 'stability' the UPOV conveys that 'relevant characteristics of protected plant variety remain unchanged either for a specified period or after repeated propagation's or cycles of propagations'. It is also true that 'stability' is a difficult criteria for a plant breeder to fulfil. Attainment of 'stability' criterion is problematic for cross-pollinated plants and non-single homozygous lines of autogamous plant varieties. This, in turn, reduces the commercialization potential of the plant variety since inconsistency of genetic quality jeopardizes commercial application of the plant variety. The same holds true of the criterion of "uniformity". Therefore, the NDUS criteria of UPOV 1991 is homologous tot he NII criteria implicit in Patent Laws.

The UPOV has undergone two major amendments since its inception in 1961. The 1978 version of the UPOV is expected to expire or close by April, 1999 by which time UPOV 1991, would be in position. The main concern with regard to UPOV 1991 has been its stringent provisions including the additional attribute of 'new' to the DUS criteria. The scope of UPOV 1991 in terms of coverage is larger. While plant varieties of all taxa are covered by UPOV 1991 only plant varieties of nationally designated species were covered by UPOV 1961 and 1978. Further by laying down clearly that 'variety' represents a 'group of plants', or 'single' or 'several plants' or 'one' or 'several parts' of plants the UPOV 1991 has considerably enlarged the scope of coverage. Going by this definition even asexual and vegetatively propagated varieties are covered by UPOV 1991. The US PVPA legislation has been quick to adopt the UPOV 1991 formula. The amendments of 1994 to the US, PVPA broadens the term 'plant varieties' to include all materials harvested from the protected varieties. (RAFI op. cit, p2).

The other drastic feature of UPOV 1991 has been abridgement of the 'plant breeder's exemptions' and 'farmer's privileges' conferred by the earlier versions. Earlier versions of UPOV allowed farmers to re-use seeds generated from their farms for self-use, and allowed breeders to freely use protected varieties for further improvements. These concessions gave UPOV a 'less stringent' face in comparison to 'patent' laws. UPOV 1991 gives an option to National Governments to disallow the farmer's privileges of retaining or re-using seeds for self cultivation. UPOV 1991 also restricts the breeder's rights by enlarging the right of the breeder to close variations of his cultivar or 'essentially derived varieties'. In other words, the breeder of a cosmetically bred variety would have to buy genetic dependency rights from the derived variety prior to commercializing the derived version (GRAIN op. cit, p4.). Further the duration of protection have also been extended under UPOV 1991 to 20 years for crops and 25 years for trees and vines (GRAIN op. cit, p3). Thus in terms of these rigorous features, UPOV 1991 eliminates the arbitrage between plant varieties protection and patent regimes.

Plant patents vs UPOV: Where lies the difference?

Today the real difference between the Patent Act and the UPOV is that the latter provides IPRs only over plant varieties while the former provides rights over plant varieties, traits and genes encoding the traits and characteristics (Dan Leskein & Michael Flitner, 1997). Though the 'plant variety' is defined by characteristics which express a given genotype or a group of genotypes, the manifestation of a variety is physical that is, in terms of plant (s), plant part or parts. Plant variety rights do not extend to genes. This produces certain, strange paradoxes and complexities in plant variety protection. To take an example, let us assume that a new plant variety has qualified for protection under a UPOV modeled legislation. Subsequently a 'new', 'add-on' characteristic has been transgenically introduced in this variety for, say disease-resistance, by another researcher. In such a situation, the variety while retaining the essential genetic structure of the previous variety has an 'add-on' gene induced by the transgenic expression. The 'essentially derived' clause of UPOV 1991 could cause the Plant Breeder's Right to extend to the changed variety despite the transgenic change. This is due to fact that 'variety' is the object of protection in UPOV based PBRs. In such a situation plant patent claims by the second researcher could only be over the 'processed or isolated DNA' sequence or the 'gene' introduced or still over the techniques of transgenic expression. For once let us assume that National Governments provide for 'double protection' provisions in their laws (as allowed for by UPOV 1991). This will enable a plant breeder to seek PBRs under UPOV based legislation's while also permitting him to seek protection under plant patents legislations. In such an eventuality there could be, in the above example, two acceptable 'patent' claims by the two parties. In practice, double protection may result in needless confusion. This is the reason for many countries including USA to separate PVPA in scope from Plant Patents Act by just confining the protection scope of the former to sexually produced varieties.

Economic implications

Plant patents and Plant Varieties Protection systems based on the UPOV model have certain major economic implication. These arise from

- Investment behaviour in plant breeding industries on account of differences in technologies of plant breeding and tightening IPR regimes implicit in Plant Varieties Protection Legislations.

- The macro-economic implications of Plant Patent and Plant Varieties Protection on the seed industry.

It is a well known fact that conventional plant breeding methods are dilatory and time consuming. It requires 7 to 8 generations of repeated breeding to reduce heterozygosity of new genotypes. As Vossen (1985, p 84) observes *Arabica* coffee subject to three to four cycles of breeding still display heterozygosity and it is not until 20 to 25 years (spanning 4 to 5 generations) that one arrives at true breeding varieties. This time lag is even more pronounced for the *Arabusta* coffee variety (inter-specific hybrid of *Arabica* and *Robusta* coffee) where segregation of unfavorable characteristics could still occur even after several generation of back crossing and selfing (Vossen *op. cit*, p 89). Another interesting example is the one cited by Robert Evenson (1991) about the long gestation period in regard to rice varieties in India. According to Robert Evenson, India released 306 rice varieties for planting during the period 1965-1986 after performing 20,000 crosses over a period of over 15 years since 1950 (Evenson, p 173). It must be understood that this long process of back crossing is preceded by an equally considerable time spent on location in identification of individuals plants with requisite traits. The speed or pace at which plant varieties qualify for being released for planting have economic implications on investment behavior in seed/plant breeding which include plant genetic engineering and transgenic techniques could obviate the long gestation period associated with pre-release preparations encountered conventional breeding (Chrispeels, *op. cit*, p 261). It is a different matter than biosafety concerns may delay releases of these varieties.

The time lag in release of plant varieties fulfilling the criteria of novelty, distinctness, uniformity and stability (or alternatively the requirements of novelty, inventiveness and commercial application) raise fundamental issue from the view point of capital investment. As Figure 1 brings out the time lag in varietal release is potentially least in the case of transgenic and non-sexually produced varieties (Damodaran, 1998) while for traditional or classical methods the time lag can be greater. Interestingly Figure 1 brings out fact that UPOV 1991 could causes maximum time lag compared to its predecessor version, namely UPOV 1978. This is due to the fact that the minimum genetic distance concept implicit in UPOV 1991 precludes 'close cousin' varieties from acquiring protection rights, unless the techniques of genetic distance determination by themselves are inadequate. The smooth curve 'C' representing the UPOV 1978 stands in marked contrast to the time compressed jumping steps of curves 'B' and 'A' which stand for UPOV 1991 and Plant Patents Acts respectively.

In the above situation, assuming that 'X' and 'Y' represent the time factor for variety release for cereals and horticulture crops respectively and supposing further that possible values of 'X' range from 1 to r years and of 'Y' from 1 to 25 years in the traditional plant breeding scheme of things, a discrete probability distribution function would present the following picture:

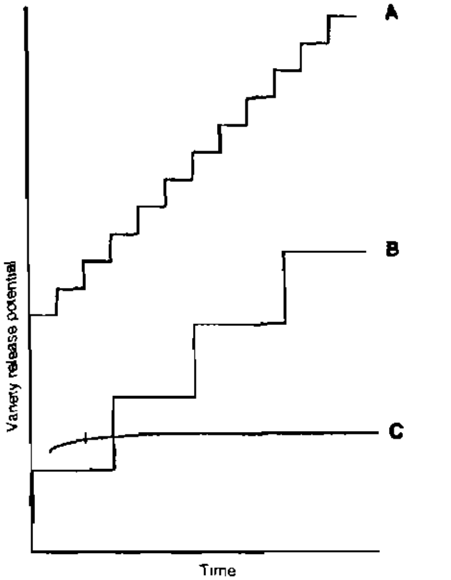


Figure I. Plant variety release patterns over time

$$P(X \leq xi) = F(x) \quad [1]$$

$$P(Y \leq yi) = F(y) \quad [2]$$

Where $xi = 1,2 \ldots\ldots 5$ [3]

and

$yi = 1,2 \ldots\ldots 25$ [4]

Then for cereal crops the events of varietal release would follow the following pattern:

$$0 < x < X_1 = 0 \quad [5]$$

$$X_1 \leq x < X_2 = f(x_1) \quad [6]$$

$$X_2 \leq x < X_3 = f(x_2) \quad [7]$$

$$X_3 \leq x < X_4 = f(x_3) \quad [8]$$

$$X_4 \leq x < X_4 = f(x_4) \quad [9]$$

Where $\sum_{i=1}^{5} F(x_1) = 1$ [10]

In reality, in a UPOV 1978 situation where techniques of 'identification' do not sharpen genetic distances, the varietal release event could occur between the 30th and 40th month which means the period covering $f(x_3)$ and $f(x_4)$. The following would then be the situation.

$$0 \leq f(x_3) + f(x_4) \leq 1 \quad [11]$$

However, in a UPOV 1991 regime where genetic distance is sharply brought out [11] above would change to the following:

$$0 < F(x_3) + F(x_4) + F(x_5) + F(x_6) \leq 1 \quad [12]$$

or

$$\sum_{ii=3}^{6} F(x_{ii}) \leq 1 \quad [13]$$

The situation for the horticulture crops would be similar. For UPOV 1978 the position would be:

$$\sum_{i=16}^{20} F(yi) \leq 1 \quad [14]$$

And in the event of UPOV 1991 obtaining, the probability of the event of varietal release of horticulture crops will be:

$$\sum_{ii=20}^{30} F(yii) \leq 1 \quad [15]$$

In view of the above patterns of varietal release, UPOV 1978 would facilitate capital investment to some extent as the release of plant varieties is periodically more frequent. Even under the plant patent regimes, investment could bring about short-term returns, though the volume of investments will have to be larger on account of capital intensity of advanced plant genetic engineering technologies. By comparison, UPOV 1991 regime is least conducive to capital investments as plant variety releases can be painfully slow under this regime. Therefore sustenance of conventional plant breeding under UPOV 1991 regimes, can only be ensured by infusion of low discount capital.

Paradoxically it is the reduced availability of low discount public funds for plant breeding that has induced countries like India to go in for Plant Varieties Protection Legislations modeled on UPOV lines. The implicit assumption in undertaking this step is that private funds for R & D in plant breeding will 'crowd in', if protection plant varieties rights are accorded. But the reality is that is liberalized deregulated developing economies, private investments have 'crowded in', in short return promising avenues (Damodaran, 1998). In other words, private investment funds for R & D are not likely to be channellised into medium to long return yielding areas.

Let r_a, r_b & r_c be the discount rates relevant for regimes A, B & C in Figure I. Then the relative rates of discount will be

$$r_l > r_b < r_c \qquad [1]$$

and relative present worth will be

$$p_a < p_b > p_c \qquad [2]$$

consequently classical plant breeding activities will suffer for want of funds in the UPOV 1991. In other words, UPOV 1991 modeled legislation will not necessarily hold attraction for private sector investors in R & D projects involving classical plant breeding as compared to say, UPOV 1978 or the Plant Patent regimes. Rather private investments would be catalysed better by *sui-generis* plant protection legislations which partake of plant patent elements and focus in the main on hybrids and genetically engineered varieties.

Given the linkages between plant breeding and the seed industry these perverse investment behavior trends can produce major economic consequences. The Seed Laws in various countries, both advanced and developing, are getting to be progressively oriented towards restricting market circulation to varieties that are conferred with plant breeder or patent rights. The UPOV guidelines on DUS are used world wide not only as the basis for establishing varietal distinctiveness and descriptions but also for seed certification purposes. The DUS guidelines are employed for recognizing and registering not only the 'basic' seeds used for multiplication of 'pedigree' seeds but also for certification of the pedigree seeds themselves (Kelly, Fenwick, A *et. al.*, 1998, p 80-81). Evenson *op.cit* explains how absence of IPR rights will reduce Marginal Variable Costs (MVC) of seed multiplication. Tougher controls by certification of seeds could ensure that seed supply is kept in a 'constricted mode' and MVC of seed multiplication are raised. This in turn, will produce its own supply – demand dynamics as Figure 2 depicts (Damodaran, 1998).

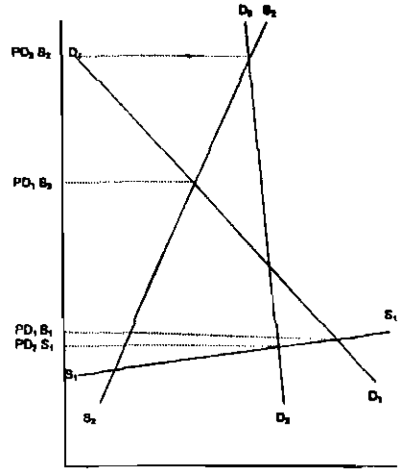


Figure 2. Supply-demand dynamics for seeds in different IPR regimes

Figure 2 brings out the implication of IPR regimes in terms of the supply curves for seeds. As Figure II brings out that in a situation of 'liberal' plant varieties protection laws (which do not provide for genetic distance) and equally liberal 'seed laws' which permit non-registered varieties (including land races) to be sold in open markets, the macro-supply curve of seeds will be elastic (S1). When these regimes shift towards 'genetic dependency' PBR regimes and tighter seeds laws that prohibit marketing of non-registered varieties, the supply curve will tend to be relatively inelastic (S2). Analogously, demand curves could shift from D1 (wherein demand for protected varieties will be elastic on account of availability of land races and non-protected variety will be inelastic on account of ban on sale of land races and other non-protected varieties). In the D1-S1 situation, supply constraints and demand flexibility could induce low price regimes while in D2 –S2 the reverse situation would occur. D2 – S2 situation is not desirable for countries like India for other reasons as well. The experience of transitional economies of East Europe which had remodeled their Seed Laws in conformity with European Community Seed Laws has been sad. Farmers of the East European bloc cultivating and conserving land races have been adversely affected by new seed laws which by prohibiting contributed to the erosion of land races in these countries. It is thus clear that agro-biodiversity can be adversely affected by the uniformity criteria of DUS which brings about resultant changes in demand and supply position of seeds.

The *sui-generis* option : The UPOV illusipn

As mentioned at the outset, India has embarked on the path of *sui-generis* plant varieties protection. Indeed there is a strong body of opinion which advocates the UPOV 1978 model for India's *sui-generis* legislation. UPOV 1978 is widely viewed as advantageous to India in terms of its provisions relating to 'breeders exemptions' and 'farmers privileges'. India's compulsion to adopt UPOV 1978 in understandable for the additional reason that Indian breeders have developed a large number of new cereals and non-cereal varieties. It is natural for the country's plant breeder to seek recognition by way of securing plant breeders rights outside the country. The UPOV with its national treatment provisions offers scope for Indian plant varieties getting protection. Currently the Department of Agricultural Research, Government of India, has initiated measures for putting in place a DUS system for protection of plant varieties. However, it is also a fact that conventional techniques of determining essentially derived status such as morphometric methods, fail on account of environmental factors in establishing 'derivative distance'. Molecular markers while being useful in identifying varietal distinctions also display different properties and can prove to be costly. The faster 'Random Amplified Polymorphic DNA' (RAPD) techniques can be particularly useful for DNA analysis for individual seeds or in other words for identification of variations within cultivar. However, results from RAPD can be notoriously unreliable unless many samples of alleles are available for analysis (Henry, 1997, p 76-77). This enhanced data samples requirements in turn enhances costs of 'identification'. In addition, there are problems and paradoxes in the choice of varietal distinguishing techniques. Morphometric methods, the most widely used technique is inadequate for determining genetic dependency. The range of variations available in morphological characteristics may limit scope for determining distinctiveness of new cultivars (Kelly & Fenwick, A *et. al.*, 1998, p 84-86). An unfortunate result could be that morphometric method may mask the inadequacy of genetic distance. (It is conceded here that genetic distances may vary from variety to variety). On the other hand, the advanced first and second generation techniques of molecular markers may overstate genetic distance (also see Dan Leskin *et. al.*, 1997, p 20). Given the economic reality described in Fig. 1, adoption of morphometrical methods in India may help capital investments in classical plant breeding for two reasons (1) that these techniques are by themselves less costly and (2) by compressing 'genetic distance' morphometric methods may induce faster release of plant varieties per unit of time thus promoting flow of medium to high discount private capital for plant breeding operations. However, viewed from the perspective of the Convention on Bio-diversity and India's commitment to biodiversity conservation, morphometric techniques may also be inimical to countries like India since cosmetic breeds derived from our landraces would in larger numbers, qualify for protection and registration both within India. Therefore choice of DUS determination techniques would need to be carefully done. Indeed it could be even considered whether DUS criteria is necessary, as TRIPS does not obligate DUS in *sui-generis* legislation (Dan Leskein *et. al.*, p 6.)

The other aspect is the much-touted attraction of UPOV 1978 for *sui-generis* plant variety protection legislation and the widely held belief that developing countries such as India have a soft UPOV option by acceding to this version while it is true, that the UPOV 1991 allows developing countries to adhere to UPOV 1978, it is also a fact that once a developing country joins UPOV 1978, it will be sucked into the vortex of the UPOV process. It is interesting to note that Article 31 of UPOV 1991while allowing a non-member of UPOV 1991, that it shall follow the latest act by which is bound (say, UPOV 1978), also gives UPOV 1991 members the freedom to be bound by UPOV 1991 in their relationship with UPOV 1978 members (IUPOV, 1991, p 44). The implications of *Article* 31 will be clear if read with *Article* 14 of UPOV 1991. As per Article 14 prior authorization of the breeder is required prior to for exports and imports of the protected plant variety (IUPOV, *op. cit*, p 20-21). Thus in case, a breeder from a UPOV 1991 country, authorizes exports of his protected plant variety to a researcher in a non UPOV 1991 country, who in turn generates an essentially derived variety, irrespective of whether the importing, country is a member of UPOV 1991 or not. This is because the principle of prior authorization for exports of the protected variety based on UPOV 1991 principles allows him to exercise the genetic dependency clause on exported material. Article 31 further fortifies his position in this regard. In other words UPOV 1978 and UPOV 1991 are not compartmentalized regimes. Since UPOV 1991 is a developed countries club, it is bound to predominate in the long-run over its preceding versions.

To sum up, the economic logic of plant patents and plant varieties protection creates its in-built complexities and paradoxes. While it is important to honour our commitment to the TRIPS and frame a *sui-generis* legislation for protection of plant varieties in India, it is equally significant to ensure that we maintain our basic position of non-agreement to the principle of plant patenting. While the UPOV may offer an attractive plant variety protection regime, the arbitrage between the UPOV and the plant patent systems in terms of degree of protection is disappearing with current versions of the UPOV having reduced the traditional flexibility of 'farmers privileges' and 'breeder exemption'. There is no reason to suppose that the UPOV will follow a two tract course of soft and hard options. The reality of trade in protected plant varieties envisaged under UPOV 1991 is a – symmetrical and provides enough safeguards to ensure its predominance vis-a-viz UPOV 1978 or UPOV 1961. All the same the UPOV 1991 is a mixed bag. In an environment of advanced techniques of DUS determination, UPOV 1991 could expose 'cosmetic breeding' and thus be helpful for agro-biodivesity conservation by countries like India. An ideal *sui-generis* legislation in the Indian context should be a dynamic legislation which in the short-run protects farmers privileges, breeders rights and community rights over land races and in the medium and long-term catalyses private investments in R & D in plant breeding. A dynamic legislation of this type prepares India for the reality of tightened Plant Patent and UPOV regimes without compromising on our biological wealth. Crafting a *sui-generis* legislation of this kind is not an easy task.

References

Chowdhry, N. K. and Agarwal, J. C. 1994. Dunkel Proposals *Vol. II*. The Final Act 1994. Significance for India and the World Trade". Shipra Publications, New Delhi.

Chrispeels., Maarten & Sadava, David. E., Jones & Bartlett. 1994. Plant Genes and Agriculture, Publishers, Boston.

Clifford, M. N., and Wilson, K. C. (eds.) 1985. Coffee : Botany. Biochemistry and Production of Beans and Beverage. Croom Helm, London & Sydney.

Damodaran, A. 1997. "Dis-engaging for Sustainable Development : on the Art of the Possible in India". In *The challenge of the Balance: Environmental Economics in India*. Proceedings of National Environment and Economics Meeting, edited by Anil Agarwal, Centre for Science & Environment, New Delhi, p. 81-88 & 371.

Damodaran, A. 1988. "Economics of Plant Patents and Plant Variety Protection : *Sui-generis* options for India". Indian Institute of Plantation Management, Bangalore, Working paper No. 9823.

Dan Leskein and Michael Filtner. 1997. Intellectual Property Rights and Plant Genetic Resources : Options for a *Sui-generis system*. Issues in Genetic Resources, No. 6, IPGRI, June.

GRAIN. 1990. Disclosures – UPOV Sells Out, No. 2, December

Henry, R. J. 1997. Practical applications of plant molecular biology, Chapman & Hall, London.

International Union for the Protection of New Varieties of Plants (IUPOV) 1991. Diplomatic Conference for the Revision of the International Convention of the International Convention for the Protection of New Varieties of Plants, Geneva, DC/91/138, March, 19.

Kelly, Fenwick, A & George, Raymond, A. T. (eds.) (1998). Encyclopaedia of Seed Production of World Crops, John Wiley & Sons, Chichester, England.

Marciode Miranda Santos and Richard, C. Lewontin. 1997. "Genetics, Plant Breeding and Patents : Conceptual Contradictions and Practical Problems in Protecting Biological innovations". Plant Genet. Res. Newsl. No. 112, pp. 1-8.

RAFI. 1995. 'Utility Plant Patents : A review of the US Experience (1985 – July, 1995), In: Rafi Communique, July/August 1995, Ontario, Canada, pp. 1-10.

Robert E. Evenson. 1991. "Genetic Resource : Assessing Economic Value" In Vincent, J. Crawfor, E. Hochn, J. (eds.) Valuing Environmental Benefits in Developing Economies. Proceeding of Seminar Series held February – May 1990 at Michigan State University, Special Report No. 29.

United Nations Environment Programme. 1992. "Convention on Biological Diversity", Environmental Law and Institutions programme Activity Centre, June.

Vananda Shiva and Tom Crompton. 1998. "Monopoly and Mono-culture – Trends in Indian Seed Industry", EPW. September 26, pp. A-137 to 151.

Vossen, Van Der, H. A. M. 1985. "Coffee Selection and Breeding", In: Clifford, M. N. & Wilson, K. C. (eds.) 1985 : Coffee Botany, Biochemistry and Production of Beans and Beverage, Croom Helm, London & Sydney, pp. 48-96.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 334 -340, 1999

Spices development programmes with a futuristic outlook

KOSHY JOHN

Spices Board
Cochin - 682 025, Kerala.

Abstract

India is a major exporter of various spices and plays a prominent role in the world market. The role of Spices Board on the development of spices is elaborated.

Introduction

Indian Spices are almost as ancient as history itself, and are valued on account of their fragrance, ingredients of incense, embalming preservatives, perfumes, cosmetics and medicines. They turn insipid food palatable. India is one of the world's largest producers of spices, and also has the distinction of being the largest consumer. The country has emerged as a major supplier of various spices and dominant player in the world market. Spices Board has been acting a facilitator and coordinator between the planting/exporting community and the Government for formulating long term policies and innovative schemes for attaining excellence in quality production and exports of spices.

Production of spices

Spices Board under the Ministry of Commerce is concerned with production of (small) cardamom cultivated in Kerala, Karnataka and Tamil Nadu and (large) cardamom in Sikkim and Darjeeling districts of West Bengal. The production of other major export oriented spices like pepper, chilli, ginger, turmeric, coriander, cumin, fennel, fenugreek, celery, garlic, etc. are vested with Ministry of Agriculture. Centrally sponsored schemes are operated by the State Governments which are monitored by the Directorate of Cocoa, Arecanut and Spices Development placed in Calicut. Nevertheless, post harvest development programme of important export oriented spices giving impetus to quality standards are cared by the Spices Board too. (Table 1).

Table 1. Export target for spices for 1998-99

Item	Quantity	Value
Black pepper	35,000	64800.00
Cardamom (Small)	500	1800.00
Cardamom (Large)	2,000	1400.00
Chilli	55,000	19200.00
Ginger	30,000	9000.00
Turmeric	28,000	8400.00
Coriander	15,000	3300.00
Cumin	10,000	5500.00
Celery	3,800	800.00
Fennel	12,000	4200.00
Fenugreek	7,000	1000.00
Other seeds	5,000	1300.00
Garlic	8,000	1600.00
Other spices	25,000	750.00
Curry powder	6,000	3600.00
Mint oil	3,000	109000.00
Spice oleoresins and other oils	2,750	27500.00
Total	**248,050**	**171800.00**

(Quantity in M. T. and value in Rs. lakhs)

Exports of spices

Spices Board looks after export promotion of different spices grown in the country. Spices industry kept up its record of scaling new heights, during 1997-98. An export value of Rs. 1352.15 crores was earned out of a quantity of 2,18,750 tonnes exported. As usual, black pepper remained as the star performer, followed by spice oil, oleoresins and chillies.

Cardamom development

Small cardamom (*Elettaria cardamomum* Maton) is a plantation crop grown in Kerala, Karnataka and Tamil Nadu. In 1997-98, the total area under cultivation in India is estimated at 72,444 ha. with a total output of 7,400 m.t. from an yielding area of 52,912 ha. In all these states cardamom cultivation is dominated by the small growers. The highest average yield of 180 kg/ha was obtained in Tamil Nadu, followed by Kerala (172 kg/ha.) and Karnataka (103 kg/ha.). Traditionally, cardamom has been an export oriented crop, and since the mid eighties, there has been a steady decline in India's export and today India accounts for only about 4 percent of the world export of cardamom. The deterioration in the competitive position of India in the world market has been attributed to the lower price of Gautemalan cardamom, the main supplier at present in the world market.

Large cardamom (*Amomum subulatum*) is the main cash crop in Sikkim and also in the adjoining Darjeeling district in West Bengal. This is cultivated in a total area of 26,358 ha with a production of 5265 m.t. during 1997-98 from an yielding area of 22,312 ha. only. Small growers dominate in large cardamom cultivation as well. The productivity in Sikkim is 233kg/ha. and in West Bengal it is 260 kg/ha.

Large Cardamom exports have picked up in recent years indicating 1450 m.t. during 1997-98 with export value realization higher than small cardamom.

Recurring climatic vagaries especially drought and delay in the onset of South West and North East monsoons in small cardamom growing areas and incessant rains in large cardamom growing areas, deforestation and resultant changes in the ecology of the growing areas, crop loss due to pest and disease incidences, old and senile plantations with low productivity, non exploitation of the irrigation potential, wide fluctuations in prices, sometimes leading to uneconomic levels, are the production problems generally for small and large cardamom.

With a view to increasing the production and productivity of cardamom (small & large), the Spices Board initiated extension services, cardamom award scheme, supplying quality planting materials through departmental nurseries and through certified nursery schemes, replanting scheme and water harvesting and irrigation scheme, as promotional measures and implemented.

These schemes have yielded augmenting effects, in respect of both small and large cardamoms as experienced in 7th and 8th plan periods and hence will be continued during IX plan period.

The demand for cardamom in the domestic market has grown sharply in the recent years consuming almost the entire production. The total demand for cardamom (small) in the country within different segments *viz.*, house hold uses, industrial uses, institutional uses etc. is expected to be around 9500 m. t. by 2000 A.D registering an over all compounded growth rate of six percent per annum. Measures proposed for increasing domestic cardamom consumption and the important areas are as follows.

Promoting inter-regional spread of food habits, introducing cardamom in ready to use consumer packets, opening sales depots/auction centres in the major cardamom consumption centres in North India, promoting sophisticated cardamom based mouth freshner products, targeting the high growth high consumption segments for direct supply from the producing areas, promoting use of cardamom powder in sprinklers, opening exclusive spice corners in the major shopping complexes which are frequently visited by the foreigners and promoting festival packets.

No one doubts that adoption of scientific cultivation will help reduce cost of production and enhance marketability within the country and abroad. The development porgrammes now being implemented by the Spices Board are for productivity increase resulting in further increase in production from the existing area. The increase in production will be absorbed if the present trend in consumption continues.

Post-harvest spices development programmes

As the mandate for production of spices other than cardamom is vested with the Union Ministry of Agriculture and concerned State Agriculture/Horticulture Departments, Board concentrates its activities on post harvest improvement for production of quality spices for exports. It also supplements the efforts of State Governments by intervening in critical areas of production of specific varieties of spices having export potential.

Schemes for developing infrastructure facilities for production of white pepper; supply of bamboo mats for improving drying quality of pepper; supply of polythene sheets for improving drying quality of chilli, seed spices, turmeric; construction of drying yards for ginger, turmeric, chilli, seed spices, pepper; providing warehousing for storage of spices under hygienic conditions and popularizing ASTRA driers for cardamom curing and supplying sieves for enabling grading export quality cardamom, are operated on this line.

Technical programmes

With a view to make available quality spices for exports, Board is regularly conducting training programmes for growers, officers of State Agriculture/Horticulture departments, traders, representatives of NGOs, workers of export processing units on food hygiene and plantation workers on scientific pre and post harvest practices of spices. Quality requirements of importing countries related to crops like pepper, cardamom, ginger, turmeric, chillies, seed spices, vanilla etc. are imparted through trainings. The training programmes relevant to the crops and specific needs are conducted in almost all spices growing states including North Eastern States. Quality training programmes particularly have been progressing stead-fastly since 1991. Farmers exchange programmes are also regularly taking place to transfer the knowledge on recent innovation in farming practices and processing of spices.

Vanilla development

Vanilla is emerging as a valuable spice crop in the country which has got potential in the export market. Because of the efforts of the Spices Board since 1989-90, its cultivation has taken roots in Karnataka, Tamil Nadu, Kerala and Andamans. Quality cured beans are being produced in small and large vanillaries. To encourage the vanilla growers, schemes on vanilla cultivation by area expansion, production of vanilla rooted cuttings in the farmers field by opening certified nurseries, setting up of vanilla processing units and awarding progressive vanilla growers are operated by the Spices Board.

Collaborative programmes on identified spices

Spices Board has identified some more export demanding crops requiring collaborative programmes with the State Governments/Agricultural Universities/NGOs.

Paprikas, garcinia and kokum, tamarind, saffron and herbal spices are now focussed to be developed with R & D efforts.

Spices development in north-eastern states

The Spices Board has got a baseline survey of the north eastern states carried out through the Regional Research Laboratory, Jorhat for assessing the status of spices production in the region for formulating viable future plans. There has been directions from the Government of India to provide 10% of the budget provision for development and export of spices in the north eastern states. Accordingly, Spices Board has drawn up various programmes for implementation in the north eastern states from 1997-98 onwards. The programmes identified for implementation during the IX plan and proposed to Government of India for approval are : production of organic pepper, drying yard for chillies, supplying ginger driers, varietal improvement of bird eye chilli, warehouse cum cold storage, setting up of spice powdering/curry powder units, re-imbursement of cost of transportation of spices for exporting needs, setting up of spice complex and training of officers.

Research directions

Research efforts in cardamom have given rise to evolving high yielding varieties like ICRI-1, ICRI-2, and ICRI-3 from the Indian Cardamom Research Institute under the Spices Board and some more are in the pipeline to come up soon. One of the progressive farmers came up with a variety called 'Njallani Green Gold' a few years back which has been found to yield very good results in certain locations, and is still in demand. There are progressive farmers who are producing about 2000 kg/ha. where as the national productivity is below 200 kg/ha. Another option is to go for minimum use of pesticides and fungicides with total discarding of banned chemicals for pest and disease management in spice crops. Biological means of options like use of botanicals, biocontrol methods etc. are now available to the farming community. Research is required to be focussed to look at the consumers food safety concerns or the extrinsic quality parameters like macro cleanliness, microbial load, mycotoxins particularly aflatoxin and pesticide residues particularly of the organo chlorine group. There must be pests and disease resistant varieties primarily with an objective of reducing use of pesticides. An integrated pest and disease management strategy aimed at maximizing bio-inputs and minimizing chemical pesticides is necessary. Further, evolving scientific post harvest practices, product developments, process upgradation and value addition will hold the keys.

Marketing directions

The export promotional schemes of the

Board are categorized based on eligibility to registered exporters, registered manufacturer exporters, exporters whose brands are registered with the Board and spice house/logo exporters. Indian spice logo spells Indianess and quality control capability and maintained a high level of hygiene and sanitation to their products. The latest in the Board's campaign for quality upgradation is the introduction of the spice house certificate. This certificate is issued to those processors/exporters who have a genuine commitment to quality, and whose long-term objective is sustained export growth.

The strategy of the Board in export promotion is centred around quality improvement of spices products exported from India. Quality is the key to success of Indian spices. On promotional role, Board is implementing a number of schemes to assist the exporter community which include promotion of Indian brands abroad, technology transfer and infrastructure upgradation, trade promotion, product and end use development. It also acts as a guide and plays the role of a mediator between the exporters and the Government, exporters and importers, exporters and international associations.

Organic spices

Productivity pressure has been driving the farmers to seek disastrous chemical enhancement, despite its pollution and erosion side effects. Nevertheless, environmental knowledge has created a large demand for organic food abroad. People have understood the health and environmental risks of chemicals in farming and have opted out. The revolution in eating habits is now all set to generate demand for organic spices from India. Organic farming presents itself as a high-value niche market which will eventually grow to cover larger sections of the society. Indian spice farmers must tap this market. There are at present foreign certifying agencies accredited from International Federation of Organic Agriculture Movement (IFOAM) functioning in India for certification of spices produced genuinely following organic farming practices. No doubt, the market and knowledge are looking after the spread of organic agriculture in India. The Spices Board has taken lead in publishing a document on production of organic spices containing therein concepts, principles, basic standards, production guidelines of important export oriented spices, documentation, inspection and certification. This document remains approved by the National Standards Committee constituted by the IFOAM members in India. Subsequently, Spices Board has arranged a training conducted by the faculty trained by the IFOAM for equipping organic spices inspection in the country, and 19 officers drawn from various sectors could be trained in a batch. Two schemes related to organic farming presently operated by the Board are awarding the organic spices farmers and pilot scheme for subsidizing certification fee for promoting exports of organic spices.

Future of cardamom depends on Increasing the present level of spices production, taking up market oriented R & D programmes, focussing on post-harvest technology, full integration of the industry both forward and backward, improving macro and micro cleanliness in spices with environment friendly processing and eco-labelling and packing, value addition and development of new products, development of new end uses, development of organic spices, proper technology transfer and quality of India spices.

Conclusion

The thrust area for intervention in spices is productivity by the appropriate authority. It has been established that Indian farmer can achieve high levels of productivity in many a crop. With this strength and existing vibrant trade, India shall remain as the largest producer of spices, largest consumer of spices and largest exporter of spices. Production has to be market driven. Exporters need to establish clear backward linkages with farmers for value added products. Arising the need to develop organically grown spices with certification to cater to niche markets is to be taken note of. Technology is available but needed proper transfer by working together of different agencies in the field of development, research and marketing. The potential is there and the missing linkages need to be strengthened to convert this into performance in the future scenario of spices development.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 341 -344, 1999

Garlic development in India - Role of NHRDF

LALLAN SINGH & K. J. SRIVASTAVA

National Horticultural Research and Development Foundation Nasik - 422 001, Maharashtra.

Abstract

Garlic varieties and the role of NHRDF in the development of garlic are highlighted.

Introduction

Garlic is one of the important bulb crops grown and used as a spice or a condiment throughout India. Garlic has higher nutritive value than other bulb crops. (Table 1). Garlic contains about 0.1 % volatile oil. The chief constituents of the oil are diallyl disulphide (60%) which possess the true garlic odour, diallyl trisulphide (20%), allyl propyl disulphide (6%), a small quantity of diethyl disulphide and probably diallyl polysulphide.

As per FAO estimates the world area of garlic is 9,83,000 ha and production is 1,03,81,000 tonnes. China, Korea, India, Spain, Egypt and USA are the major garlic growing countries. China ranks first in area and production (5,57,000 ha and 76,74,000 tonnes). India though ranks second in area (86,000 ha) its position is third in production (3,50,000 tonnes).

The world garlic area, production and productivity trends during the past decade show that since 1986 they have improved by about 138.59, 309,18 and 71.62% respectively. In India area, production and productivity of garlic have improved by about 48.28, 69.90 and 14.19%, respectively. Madhya Pradesh, ranks first in Indian states accounting for more than 35% of area and 38% of production with average yield of 4.58 t/ha. The other major garlic producing states are Gujarat, Rajasthan, Orissa, Uttar Pradesh and Maharashtra. In India per hectare yields are highest in Punjab (12.44 t/ha) followed by Haryana (12.00 t/ha) and Maharashtra (6.72 t/ha).

The production and productivity of garlic in India are very low compared to many other countries. Unawareness of the farmers about improved varieties, climate, soil and agro-techniques, diseases and pests damaging the crop and their control measures as well as post harvest management are though main reasons, inadequate market support is also responsible for limiting the production and productivity indirectly.

National Horticultural Research and Development Foundation (NHRDF) through its consistent research programmes on varietal improvement, has evolved 6 new varieties of garlic and standardized techniques in production and post-harvest technology. Popularization of these improved varieties and improved package of practices on garlic production and post-harvest technology is being done under Central Sector Scheme of the Govt. of India.

The present paper aims to brief about the improved varieties of garlic, techniques on production and post-harvest technology as is being done under Central Sector Scheme.

Varieties

Not much work had been done on garlic improvement earlier. Only after establishment of the then Associated Agricultural Development Foundation, work on development of varieties was initiated by different state Agricultural Universities and Institutes. Major work on garlic varieties is being taken up at National Horticultural Research and Development Foundation (formerly Associated Agricultural Development Foundation); HAU, Hissar; MPKV, Rahuri and PAU, Ludhiana. The varieties developed are Godavari and Sweta at Rahuri; HG-1 and HG-6 at HAU, Hissar; Pusa Sel-10 at IARI, New Delhi; LCG-1 at PAU, Ludhiana; ARU-52 at VPKA, Almora and Agrifound White (G-41), Yamuna Safed-1 (G-1), Yamuna Safed -2 (G-50), G-282, G-323 and Agrifound Parvati by NHRDF. These varieties are mostly small bulbed and have more number (20-30) of smaller cloves except G-282 and Agrifound Parvati which have bigger bulbs with bigger cloves and cloves are fewer in number. The varieties Agrifound White, Yamuna Safed and Yamuna Safed-2 have been notified by Govt. of India. Variety G-282 has been recommended for release based on the results of multilocational trials.

Role of NHRDF in garlic development

The production and productivity of garlic can be increased if improved varieties are used by the farmers and improved production and post-harvest technologies, are followed. Also since adequate quantities of planting material of improved varieties are not available, there is need to produce and distribute breeder, foundation and certified seeds, before improvement could be expected. Farmers need to be educated with improved production and post-harvest technologies. Demonstration, minikit programmes, field days, distribution of technical literatures etc. are the extension tools with the help of which technologies are passed on researchers to the farmers. Keeping the above views, the Govt. of India considered massive developmental programme for VIII Five year plan. The NHRDF was identified as one of the agency for the implementation of integrated programme on development of garlic under Central Sector Scheme through Directorate of Arecanut, and Spices Development, Calicut.

To fulfill the objectives, the NHRDF has taken up the task of replacement of the traditional garlic varieties with improved varieties developed by NHRDF in the important states of garlic growing viz. Madhya Pradesh, Gujarat, Maharashtra, Orissa, Bihar, Uttar Pradesh, Haryana, Rajasthan, Punjab, Karnakata, Himachal Pradesh and Tamil Nadu, since 1993-94 through production and supply of breeder, foundation and certified seeds, conducting demonstrations and minikits and arranging training to the farmers.

It is evident from the data (Table 2.) that during the period of last 5 years (1993-94 to 1997 - 98), the NHRDF has produced 12,120.0 q seeds of improved varieties of garlic which includes 896.9 q breeder, 5393.0 q foundation and 5830.7 q certified seeds of garlic. Though this programme, about 962 ha area has been covered, 10495 minikits and 7773 demonstrations have also been arranged benefiting 18,750 farmers.

By the development of improved high yielding varieties, researches on development of improved technology and its transfer to the farmers field through demonstrations, minikits, trainings and distribution of quality seeds by NHRDF, the production of garlic in India which was 0.21 million tonnes during 1986 has increased to 0.38 million tonnes during 1996 showing an increase of 69.90%. A similar trend in increase of area (48.28%) and productivity (14.19%) has also been observed. The bigger sized varieties developed by NHRDF viz. G-282 and Agrifound Parvati popularized by NHRDF which is suitable for export have also added to the increased export of the country which was 2092 MT during 1993-94 and during 1995-96, 3640

Table 1. Composition of garlic

Particular	Freshly peeled garlic cloves	Dehydrated garlic powder
Moisture (%)	62.80	5.20
Protien (%)	6.30	17.50
Fat (%)	0.10	0.60
Mineral matter(%)	1.00	3.20
Fibre (%)	0.80	1.90
Carbohydrates (%)	29.00	71.40
Calcium (%)	0.03	0.10
Phosphorous (%)	0.30	0.42
Potassium (%)	-	0.70
Iron (%)	0.001	0.004
Niacin (%)	-	0.70
Sodium (%)	-	0.01
Vitamin A (IU)	-	175.00
Nicotinic acid(mg/100g)	0.40	-
Vitamin C (mg/100g)	13.00	12.00
Vitamin B (mg/100g)	-	0.68
Vitamin B2 (mg/100g)	-	0.08

Source : Vegetable Crops in India by T.K. Bose & M.G. Som (Ed.)

Table 2. Details of garlic development programme undertaken by NHRDF during 1993-94 to 1997-98 under Central Sector Scheme of the Govt. of India.

Year	Quantity of seed produced				No. of minikits arranged	No. of demos. arranged	No. of farmers/ families benefited	Coverage of area (ha)
	Breeder	Foundation	Certified	Total				
1993-94	33.0	216.0	-	249.0	-	30	50	5.0
1994-95	125.0	380.0	585.0	1090.0	195	621	815	31.05
1995-96	151.23	508.3	2886.85	3546.38	3687	3020	6474	236.384
1996-97	487.7	3688.7	1058.87	5235.27	1613	2102	4206	474.38
1997-98	100.0	600.0	1300.0	2000.0	5000	2000	7205	215.00
Total	896.93	5393.0	5830.72	12120.65	10495	7773	18750	961.814

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants 345 -350, 1999

Flavours and fragrances in national economy-today and tommorrow

D.P. SINGH

Fragrance & Flavour Development Centre, Industrial Estate,
G.T. Road, Makrand Nagar, Kannauj-209 726.

Abstract

Flavour and fragrance industry in the country too is moving upward as all over the world. Though a large number of plants possess aroma, only about 65 of these plants have large and consistent demand in the trade and hence grown in different parts of the country and abroad. Major essential oil yielding plants available in the country, list of important imported essential oils as well as importnat indigenously produced aroma chemicals are given.

Introduction

During the last 50 years dramatic changes have taken place in various sectors four national economy. The Government has made massive investment in infrastructure, education, agriculture, heavy industry as also in chemicals and petrochemical industry. Private sector has also contributed its might in all such areas. During this period chemical industry alone has developed leaps and bound in various areas covering fine chemicals, petrochemicals, chemicals based on natural products. The turn over of chemical industry, as of today, in our country is worth Rs. 80,000 crores. This is only next to steel and textile. Chemical industry is also contributing a fair amount to national exechequer in terms of excise/custom duty & sales tax. There have been substantial changes in life style of every Indian over this period. Average income has gone up suggesting increasing use of consumer goods, such as detergents, cosmetics and toiletries as also confectioneries, beverages, soft drinks & pharmaceutical, which has resulted increased usage of sensuous fragrances and tasty flavours.

Till recently, fragrance and flavours were considered, in developing economy like ours, as luxury items, since the emphasis had been for the provision of essential items like food, shelter and clothing. Things have, however, changed and as of now, it is difficult to imagine the use of toilet soap, detergent, cosmetics without a dose of fragrance or for that matter the use soft drinks without a few drops of flavour. Right from morning to evening, we use fragrance or flavour in one form or other-while in the morning we use flavour in the form of tooth paste, in the evening a fragrance in our mosquito repellent.

The dimensions of fragrance, flavour and essential oils on global level in value terms are estimated to be of the order of 12 billion US$ (Rs. 54000 crores) out of which, India's share is also now appreciable and is of the order of Rs. 2000 crores and what is important is that, it is growing at a rate faster than the one witnessed in the developed countries.

In the forties and earlier, the fragrance industry in our country was hovering around the traditional "attars" which were in production right from 13th century in a small town of U.P, 'Kannauj'. The techniques and formulae of such fragrance have percolated down from father to son for many generation. 'Attars' are natural perfumes, made entirely from the natural raw materials like flowers-rose, jasmine, bela, champaka, keora, marigold and spices like cardamom, clove, nutmeg, saffron etc. These natural materials are distilled over sandalwood oil. 'Attars' found ready acceptance as body perfumes in our country as also in some Muslim countries especially Saudia Arabia as they are free from alcohol. People of different classes had fascination for such products and the industry based on natural raw materials continue to survive and flourish for many centuries.

Raw materials

Essential oils, their isolates, aroma chemicals, oleoresins are the ingredients for flavours and fragrance industry. India is blessed with a wide variety of soils and climatic conditions which supports the enormous plant wealth. Of the 45000 native species found in this country, some 1300 species are known to contain aromas. Though, such a large number of plants possess these aromas, only about 65 of these plants have large and consistent demand in the trade and are accordingly grown in different parts of our country and also abroad. India, however produces limited items of commercial value both from its rich natural vegetation and cultivation. There is a great scope for commercial cultivation of several aromatic crops in India and there is always a demand for new and specific aroma chemicals in market for development of new & exotic flavours & fragrance. Commercially important major essential oil plants available in our country and important essential oils, which are being imported into our country are given in Tables 1 & 2.

There are over 250 aroma chemicals, which are being produced internally. A list of important indigenously produced aroma chemicals is given in Table 3. Apart from this, important aroma chemicals, which are being imported for creation fragrance & flavour is given in Table 4.

Table 1. Commercially important major essential oils

Agarwood	Lavender
Basil	Lemon grass
Bergamot mint	Mayurpankhi
Bitter fennel	Mentha arvensis
Costus	*Mentha piperita*
Cedarwood	*Mentha spicata*
Celery	Nagarmotha
Citronella Java	Patchouli
Chammomile	Plamarosa
Cinnamon	Pine
Davana	Rosemary
Dill	Rose
Eucalyptus citridora	Sandalwood
Geranium	Tuberose
Jatamansi	Tagetes
Jasmine	Vetiver
Keora	Valerian
Kapur kachri	

Table 2. Essential oils imported to India

Bergamot	Lemon
Clove leaf oil	Lime
Geranium	Orange
Lavender	Patchouli

Flavour & fragrance industry

There are more than 500 units in our country producing and marketing fragrances for use in toilet, laundry soaps, detergents, floor cleaners, cosmetics and toiletries including skin/hair care products and *agarbattis*. The consumption of fragrances is also increasing in proportion to the growth in such consumer products.

Similarly, the growth in flavour industry is also closely aligned with the growth of industry, such as soft drinks, beverages, biscuits, confectionery, ice creams and other essential products, mouth fresheners, chewing tobacco and pan masala. The expansion food industry in the areas of processed foods products, snacks and fast food has created new openings for our flavour industry. There are now, over 450 units engaged in flavour manufacture with an impressive turn over.

Table 3. Major aroma chemicals produced in India

Amyl acetate	Camphor
Alpha amyl cinnamic aldehyde	Citral
Aurantiol	di-Phenyl oxide
Aldehyde C-14	di-Phenyl methane
Aldehyde C-16	Ethyl vanillin
Aldehyde C-8	Eugenol
Aldehyde C-10	Iso-eugenol
Aldehyde C-11	Eucalyptol
Aldehyde C-12 Lauric	Ethyl acetate
Aldehyde C-12 MNA	Ethyl butyrate
Acetophenone	Ethyl phenyl acetate
Anisic aldehyde	Geraniol & its esters
Anethole	Green acetate
Amyl salicylate	Geranyl nitrile
Amyl iso valerinate	Hydroxy citronellal
Amyl butyrate	Hexyl cinnamic aldehyde
Benzyl alcohol	Indole
Benzyl acetate	Ionones (Alpha, Beta, methyl, 100%)
Benzyl salicylate	Iso-borneol & its esters
Benzyl formate	Linalool & its esters
Benzyl butyrate	Limonene
Benzyl propionate	Methyl anthranillate
Benzyl iso valerinate	Methyl salicylate
Benzyl dehyde	Methyl benzoate
Iso-butyl phenyl acetate	Methyl phenyl acetate
Benzyl benzoate	Musk ambrette
Citronellol & its esters	Musk ketone
Citronellal	Musk xylol
Citral demethyl acetal	Methyl beta napthy ketone
Carvone	Menthol
Cinnamic aldehyde	Methyl abietate
Cinnamic alcohol	Nerol

Ortho-tertiary butyl cyclohexyl acetate	Rhodinol
Para-tertiary butyl cyclohexyls acetate	Sandella
Phenyl ethyl alcohol, its esters & ethers	Skatole styrallyl acetate
Pinene (Alpha & Beta)	Terpineol
Para-cresol	Terpenyl acetate
Iso-propyl myristate	Vanillin
Rose oxide	Vetiverol
Rose crystal	Vetiveryl acetate

Table 4. Major aroma chemicals imported to India

Ambrettolide	Isoral-diene
Anbrox	Jasmone Cis
Aldehyde mandarine	Linalool (synthetic)
Brahmanol-F	Linally accetate
Benzyl iso eugenol	Lilial
Bacdanil	Lyral
Cedral	Lime oxide
Cedryl acetate	Limetol
Cotronellol	Linalool oxide
Cfetone V	Mayol
Cyclogalbanate	Musk moskene
Cyclamen aldehyde	Musk tibetene
Cis-3-hexenol & its esters.	Methyl heptine carbonate
Decalactone gamma	Muguet alcohol
Di-methly benzyl carbinyl acetate	Musk DTI
Damascone (Alpha, Beta and ISO)	Myrodyde
Evernyl	Nerolidol
Exaltolide	Nonadienal
Frambinone	Sandolore
Fixolide	Stemone
Farnesol	Sandela
Florazon	Tripal
Galaxolide	Timberol
Hedione	Vertofix
ISO E Super	Veloutone
Iralia	

Globalization

This strong base of essential oils, isolates and aroma chemicals has made India a global player in fragrance & flavour industry.

Realizing such a market, multinationals are also stepping in the territory of Indian flavour and fragrance industry offering quality products. The indigenous manufactures have to update their technology and knowledge to continue to survive under this globalization of market.

Research & Development

To strengthen our R & D base, there are over forty institutions under CSIR/ ICAR umbrella and Universities working for the develoment of agro-technology & processing of essential oil bearing crops. It is the result of their untiring efforts that improved varieties and processing techniques for essential oils like mints, basil, celery seed, davana, geranium, lavender and vetiver are available to the industry. We are now able to add new techniques of genetics, tissue culture, solvent extraction as also new ways of isolation, separation and structure determination techniques. These developements have led to the idea of structure-odour relationship. Based on this, one can carry out total synthesis of fragrance and flavours for different applicaitons.

With a view to augment such developmental and extension efforts, Govt. of India with the assistance of UNDP has set up in 1991 a Fragrance & Flavour Development Centre at Kannauj. This centre is providing a link between R & D institutions on one hand and farmers and entrepreneurs on the other. Modern processing techniques on pilot plant scale, steam distillation, solvent extraction, reaction, fractionation, freezing upto-40°C and hydrogenation have been established in the centre to help entrepreneurs in minimizing their risk factors while entering in trade and industry. State of the art analytical and blending techniques are being provided by the centre to the enterpreneurs to learn the art of fragrance and flavour creation.

The future

As a country, we need to concentrate on few essential oil crops and offer the essential oils isolates and products derived from them to the work market. We have to sustain the price level with standards of quality. Considering our vast trained human resources and climatic diversity, there is a room to co-exist for different players and operators in fragrance and flavour industry, the future of all of us is definitely very bright.

Coming years will witness, the Indian fragrance and flavour industry making strong impact in the world market on account of our strength of essential oils, resinoids and aroma chemicals base. There is a need to initiate and work for the production of citrus oils and for flavour & fragrance which are safe for consumers if we have to complete for the global market.

Biodiversity, Conservation & Utilization of
Spices, Medicinal & Aromatic Plants 351, 1999

PANEL DISCUSSION

Panel I : Biodiversity of Spices, Medicinal & Aromatic Plants and Intellcctual Property Right.

Moderator : Dr. P. Natesh
Co-moderator : Dr. P. Pushpangadan
Members : Prof. A. Damodaran
: Dr. K.C. Dalal
: Dr. S. Kumar

Following are the important decisions arrived at during the panel discussion.

1 India has a rich biodiversity of spices, medicinal and aromatic plants. Concrete action has to be taken to conserve and protect this diversity from biopiracy.
2 To safeguard the endemic biodiversity, need for preparing inventory, documentation, molecular characterization and registration of the germplasm were emphasized.
3 Protection of traditional knowledge on medicinal and aromatic plants should be given high priority.
4 Effective agrotechnologies in spices, medicinal and aromatic plants have to be standardized for increasing their production and productivity.
5 Local people should be taken into confidence for conservation of traditional knowledge and encouragement should be given for homestead cultivation and conservation of medicinal plants.
6 Role of taxonomists to protect the plant wealth was highlighted.
7 The importance of involvement of Botanical Survey of India in surveying and collecting the genetic wealth of the country was highlighted.
8 *Panchayat* level biodiversity documentation is essential to protect the local biowealth; involvement of NGOs and voluntary organization is also stressed.
9 Breeder's excemption and Farmer's rights should be protected under the emerging scenario of Intellectual Property Rights.
10 Documentation of indigenous knowledge on traditional medicines has to be carried out on a priority basis as well as the evaluation of effectiveness of common indigenous medical practices is important.
11 Integration of traditional and modern medicines should be encouraged.
12 Systematic screening of indigenous plant wealth for their biological activity should be given importance.

Panel II : Futurology of Spices, Medicinal and Aromatic Plants - An action plan

Moderator : Dr. C.K. George

Members : Dr. K.V. Peter

: Dr. D.P. Singh

Mr. Koshy John

Prof. A. Damodaran

The major recommendations of the panel are:

1 To retain India's supremacy in spices production and to meet the competition from other producing countries, production technology is to be tuned to leap higher productivity. Improved varieties in spices should be given high priority so also organic spices. 'Clean Spices' will have a high premium in the years to come.

2 Medicinal and aromatic plants should be shortlisted based on domestic need and export potential. Plants whose roots and barks are extracted for medicinal use should be given higher priority in conservation.

3 Geographic Indications/Appellations Act of the Convention of Biological Diversity should be made effective to protect the biowealth of our spices, medicinal and aromatic plants from biopiracy.

4 Developmental schemes for spices and medicinal plants need to be strengthened

5 Technological capabilities for value addition of spices, medicinal and aromatic plants are to be strengthened.

Biodiversity, Conservation & Utilization of Spices, Medicinal & Aromatic Plants 353, 1999

PLENARY SESSION

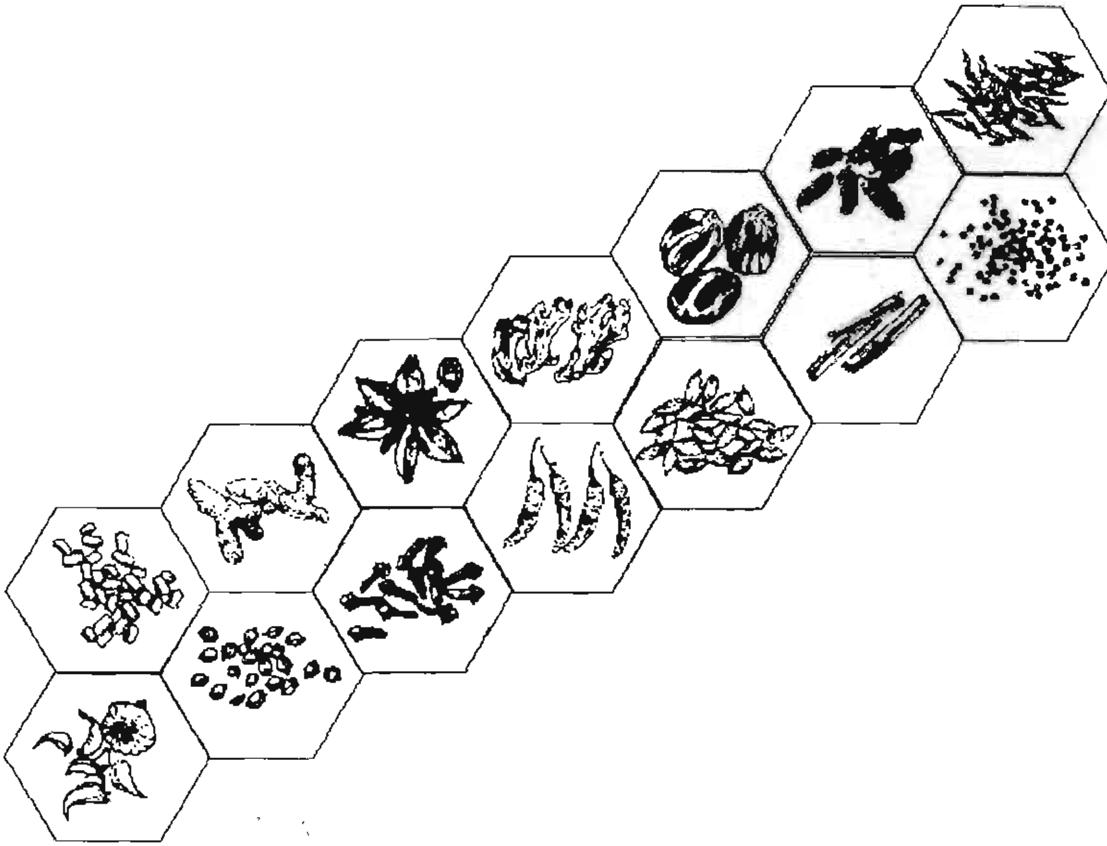
The pleanary session was chaired by Dr. R.N. Pal, AD (PC), ICAR, New Delhi and co-chaired by Dr. D.V. Peter, Director, IISR, Calicut.

Following were the major discussion taken during the session.

1. India has a rich biodiversity of spices, medicinal and aromatic plants. It is essential to collect, conserve, characterise, document and register the germplasm of these plants for the benefit of mankind.
2. Resource mapping of available germplasm of MAPs in the country is to be done.
3. Conservation of spices, medicinal and aromatic plants assumes further significance due to the severe genetic erotion caused by over exploitation and destruction of natural ecosystem.
4. *In situ* conservation of spices, medicinal and aromatic plants alongwith other mode of conservation have to be strengthened for sustainable utilisation. Threatened and endangered species should be immediately identified and conserved using *ex situ, in situ, in vitro* means.
5. Indegenous and traditional knowledge should be documented by all concerned organisations on a nation wide basis. A coordination / link up of different organisations working in the field is of utmost in importance.
6. Efforts may be made to encourage farmers to cultivate medicinal and aromatic plants in large scale besides training rural people and women in proper use and identification of medicinal plants.
7. Utmost care may be taken to maintain the quality of the products of spices, medicinal and aromatic plants. Post harvest technology and product development should be strengthened by efficient and innovative technologies.
8. Bioprospecting for useful biomolecules in our medicinal and aromatic plants should be pursued with increased vigour.
9. Systematic studies are required to identify active compounds in the herbs and their preparation. Standardisation of the quality of the herbal drugs is very important.
10. Trained taxonomists / field botanists are essential for conservation of spices, medicinal and aromatic plant wealth.

AUTHOR INDEX

ISBN 81 - 86872 10 - 8



Indian Institute of Spices Research ,
P B No. 1701
Marikunnu Post
Calicut - 673 012
Kerala , India
Phone: 0495 371410
cable: Rersearch, Calicut
Telex : 0804 250 NRCS IN
Fax : 0091-495-370294
Email : iisrclt@mt3.bsnl.net.t .