ETHNOBOTANICAL STUDIES OF BEER JHUNJHUNU CONSERVATION RESERVE OF JHUNJHUNU DISTRICT OF RAJASTHAN AND SCREENING OF SELECTED PLANT SPECIES FOR THEIR ANTIBACTERIAL ACTIVITY

''राजस्थान के झुन्झुनू जिले के बीड़ झुन्झुनू रक्षित वनखण्ड का मानवजातिविज्ञानिय अध्ययन तथा जीवाणुरोधी क्रियाओं के लिए चयनित पादपों का परीक्षण''

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by

Ms. Manju Chaudhary

Under the supervision of

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UNIVERSITY OF KOTA, KOTA

2018

CERTIFICATE

I feel great pleasure in certifying that the thesis entitled **'Ethnobotanical studies of Beer Jhunjhunu Conservation Reserve of Jhunjhunu district of Rajasthan and screening of selected plant species for their antibacterial activity'** by **Ms. Manju Chaudhary** under my guidance. She has completed the following requirements as per Ph.D. regulations of the University.

(a) Course work as per the university rules.

(b) Residential requirements of the university (200 days).

(c) Regularly submitted annual progress report.

(d) Presented her work in the departmental committee.

(e) Published/accepted minimum of one research paper in a referred research journal.

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ABSTRACT

Biodiversity is the term given to the variety of life on Earth. Loss of biodiversity may trigger large unpredictable change in an ecosystem. The creation of protected area network helps to reduce biodiversity loss and provides significant contributions to conservation efforts. Based on floristic diversity and existing threats to their conservation, State Government of Rajasthan declared Beer protected forest of district Jhunjhunu as conservation reserve. The present study area Beer Jhunjhunu Conservation Reserve harbors a rich array of floristic diversity with a large number of ethnomedicinal as well as rare, endemic and threatened plants. During the present study, a total of 453 plant taxa (including variety) belonging to 452 species under 289 genera and 79 families have been recorded from the area. Among these, 350 species were dicots and 101 belonging to monocots and only one species of gymnosperm was recorded. Herbs were the most dominant plant form in the study area followed by trees, climbers, shrubs and undershrubs. Poaceae was the most dominating family in the present study followed by Fabaceae and Asteraceae. 35 plant species have been recorded as rare, endemic and threatened in the area, which need effective conservation. In the present study, 120 plant species of ethnomedicinal uses and 64 species of ethnoveterinary uses were recorded which are being exploited by the local people in different ailments. The information recorded about different uses was obtained from local elderly people, shepherds, vaids and herbal healers. The present work also indicates various uses of plant species of material culture. Many plant species were used for construction of shelter, household articles, agriculture implements and musical instruments. The importance of medicinal plants lies in their biological active principles, which are the real healers in the process of medication. In the present investigation, two common ethnomedicinal plant species *Aristolochia bracteolata* Lam. and *Ruellia patula* Jacq. which were widely used by the rural and local people to treat various ailments have been selected for further study. TLC and PTLC were carried out to isolate the principal compounds that were present in extracts of plant parts of *A. bracteolata* and *R. patula*. The phytochemical screening of different extracts of plant parts indicated that these plants are rich in flavonoids and sterols. The present study further extended to assess the antibacterial activity and to determine the zone of inhibition of various extracts on some bacterial strains using agar well method. The antibacterial activities of extracts were tested against two Gram positive, *Staphylococcus aureus*, *Streptomyces griseus* and two gram negative, *Escherechia coli*, *Pseudomonas aeruginosa* human pathogenic bacteria. Zone of inhibition of extracts were compared with standard antibiotic drug streptomycin. The results showed significant antibacterial activity. The present study justified the ethnomedicinal use of both plant species to treat various infectious diseases caused by the microbes. However, further studies are needed to better evaluate the potential effectiveness of the crude extracts as the antimicrobial agents. The present results will form the basis for selection of both plant species for further investigation in the potential discovery of new natural bioactive compounds.

CANDIDATE'S DECLARATION

I, hereby, certify that the work, which is being presented in the thesis, entitled **'Ethnobotanical Studies of Beer Jhunjhunu Conservation Reserve of Jhunjhunu District of Rajasthan and Screening of Selected Plant Species for their antibacterial activity'** is in partial fulfillment of the requirement for the award of the degree of Doctor of Philosophy, carried under the supervision of **Dr. S.K. Shringi** and submitted to the University of Kota, Kota represents my ideas in my own words and where others ideas or words have been included I have adequately cited and referenced the original sources. The work presented in this thesis has not been submitted elsewhere for the award of any other degree or diploma from any institutions. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will cause for disciplinary action by the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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This is to certify that the above statement made by **Ms. Manju Chaudhary** (Enrollment No. 2013/000109) is correct to the best of my knowledge.

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If I have seen further……
It is by standing upon
The shoulders of giants

- Isaac Newton

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Manju Chaudhary

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LIST OF ABBREVIATIONS

IUCN	International Union for Conservation of Nature and Natural Resources
UNEP	United Nations Environment Programme
WWF	World Wide Fund for Nature
EX	Extinct
EW	Extinct in Wild
CR	Critically Rare
EN	Endangered
VU	Vulnerable
NT	Near Threatened
LC	Least Concern
NE	Not Evaluated
R	Rare
WHO	World Health Organization
CITES	The Convention on International Trade in Endangered Species
CVD	Cardiovascular Disease
TLC	Thin Layer Chromatography
PTLC	Preparative Thin Layer Chromatography
DMSO	Dimethyl Sulfoxide
MTCC	Microbial Type Culture Collection
NA	No Activity
AI	Activity Index
MIC	Minimum Inhibitory Concentration
ZOI	Zone of Inhibition
Rf	Retardation Factor
IR	Infra Red
UV	Ultra Violet
mg/g dw	Milligram/ Gram Dry Weight

CHAPTER-1
GENERAL INTRODUCION

"Biodiversity starts in the distant past and it points toward the future"

Frans Lanting

The term "Biodiversity" is the short form of biological diversity used to convey the total number, variety and variability of living organisms in a given area, whether is it on land, in rivers and fresh water bodies and sea or the whole surface of the earth. Biological diversity means the variety of life and its processes, including the variety of living organisms, the genetic differences among them and the communities and ecosystem in which they occur (Keystone, 1991).

The diversity of life forms, so numerous that we have yet to identify most of them is the greatest wonder of this planet. According to the United Nations Environment Programme, biodiversity typically measures variation at the genetic, the species and the ecosystem level. Terrestrial biodiversity tends to be greater near the equator (Gaston, 2000), which seems to be the result of the warm climate and high primary productivity. Biodiversity is not distributed evenly on Earth, and is richest in tropics. These tropical forest ecosystems cover less than 10 percent of earth's surface, and contain about 90 per cent of the world's species (Young, 2003). Marine biodiversity tends to be highest along coasts in the Western Pacific, where sea surface temperature is highest and in the mid- latitudinal band in all oceans. Biodiversity generally tends to cluster in hotspots (Myers *et al*, 2000) and has been increasing through time, but will be likely to slow in the future (Robosky, 2009).

India has a total geographical area of about 329 million hectares with a coastline of over 7500 km. The ecological or ecosystem diversity of the country is enormous, ranging from sea level to the highest mountainous ranges in the world; hot and arid conditions in the northwest to cold arid conditions in the trans-Himalayan region; tropical wet evergreen forests in Northeast India and the Western Ghats; mangroves of Sundarbans and fresh water aquatic to marine ecosystems (Sharma and Singh, 2000).

India has 12 biogeographical provinces, 5 biomes and 3 bioregion domains (Cox and Moore, 1993). The country supports a diverse array of habitats or ecosystems such as forests, grassla-nds, wetlands, coastal, marine and desert and each with rich and unique floristic diversity. These biological attributes are further enhanced by the geographical location of the country at the confluence of three major global biogeographic realms, viz. Indomalesian, Eurasian and Afro-tropical, thus allowing the intermingling of floristic elements from these regions as well and making it one of the 17 megadiversity countries in the world, recognised by the World Conservation Monitoring Centre in 2000. The floral biodiversity in India is majorly concentrated in the 4 biodiversity hotspots, namely Eastern Himalayas, Western Ghats (and Sri Lanka), Northeast India and Andaman Islands (Indo-Burma) and Nicobar Island (Sundaland), out of 34 biodiversity hotspots recognized in the world. These floristically significant areas exhibit exceptional concentration of endemic species and also experiencing loss of habitat with higher occurrence of threatened plant species (Arisdason and Lakshminarasimhan, 2017).

India is a country of vast biodiversity. Vegetation ranges from the wet evergreen forest of the Western Ghats and north-eastern hills to the dry deciduous forest of Central India and the thorny forest of the Thar Desert. About 61.5% of flora in India is endemic. There are about 300 endemic species in the Himalayas and the Khasi Hills of north-eastern India and 2000 in the Deccan peninsula in the south. The richest area from the biodiversity point of view lies in the Silent Valley of Kerala in the Western Ghats and north-eastern hills of Assam and Meghalaya.

Though the geographical area cover of the country represents about 2.4% of the world's total landmass, it harbors a total of 47,513 plant species (Singh and Dash, 2014) out of about 0.4% million hitherto known in the world, representing as much as 11.4% of world flora. About 28% of plants that occur in India are endemic to the country. Table 1.1 represents a comparative account of species in major groups of plants, including virus, bacteria, algae, fungi and lichens recorded from India and the world. The table also provides approximate number of species considered endemic to India. Recent estimate accounts a total of 18043 species of angiosperms in the country (Fig. 1.1).

Table 1.1: Total number of plant species (including virus, bacteria, algae, fungi and lichens) and their status in World and India

S. No.	Type	Number of known species World	India	Percentage of occurrence in India	Number of Endemic Species	Number of Threatened Species
I	**Flowering Plants**					
1.	Gymnosperms	1021	74	7.35%	8	7
2.	Angiosperms	268600	18043	6.72%	ca.4036	1700
II	**Non- flowering plants**					
1.	Bryophytes	16236	2523	15.54%	629	ca. 80
2.	Pteridophytes	12000	1267	10.57%	47	414
III	**Others**					
1.	Virus and bacteria	11813	986	8.77%	Not known	Not known
2.	Algae	40000	7284	8.21%	1924	Not known
3.	Fungi	98998	14883	15.09%	ca.4100	ca.580
4.	Lichens	17000	2401	14.12%	ca.520	Not known
Total		**465668**	**47513**	**-**	**11273**	**2781**

Source: Chapman, 2009; Singh and Dash, 2014.

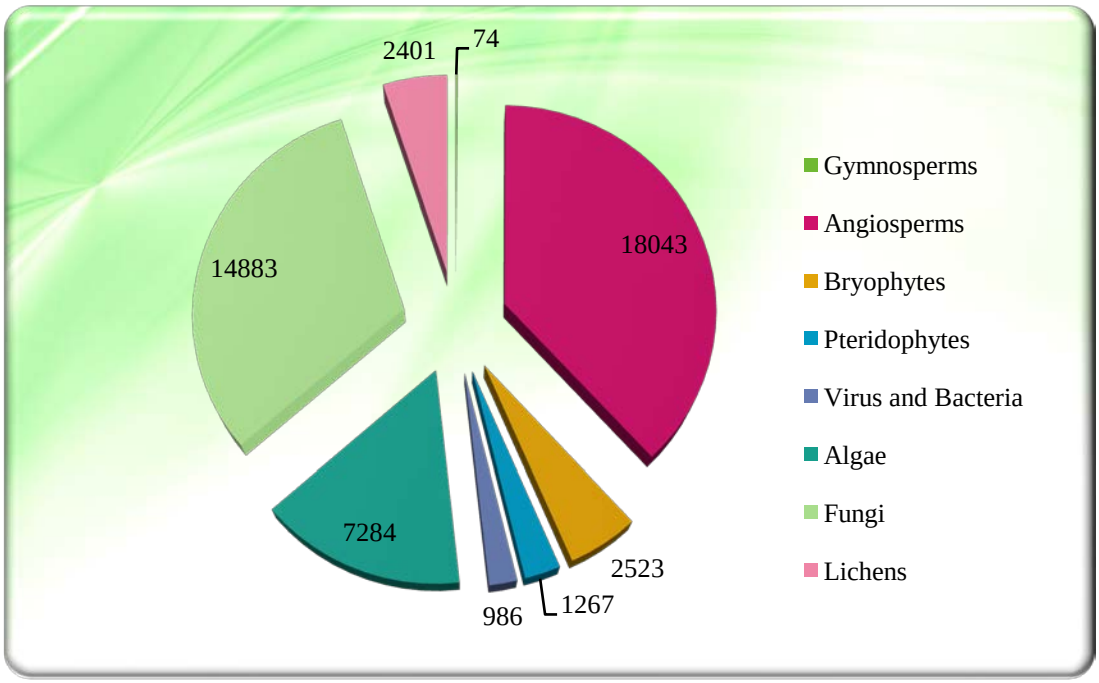


Figure 1.1: Status of Plant Species (including Virus, Bacteria, Algae, Fungi and Lichens) in India.

India has rich and varied vegetation with a wide range of climatic conditions. India can be divided into eight distinct floristic regions viz., the Western Himalayas, the Eastern Himalayas, Assam, the Indus plain, the Gangetic plain, the Deccan, Malabar and the Andaman (Research, Reference and Training Division, 2010, BSI, Kolkata).It has one of the five world heritage sites, 18 biosphere reserves and 26 Ramsar wetlands. Amongst the protected areas, India has 103 National parks, 537 sanctuaries, 67 Conservation reserves and 25 community reserves covering an area of 1.61 lakh sq km or 4.89 per cent coverage of country.

Conservation International identified 17 mega-diverse countries in 1998. Many of them are located in, or partially in, tropical or subtropical regions. These mega-diverse countries harbor the majority of Earth's species and high numbers of endemic species. Around the world, 35 areas qualify as hotspots. They represent just 2.3 per cent of Earth's land surface, but they support more than half of the world's plant species as endemics and nearly 43 per cent of bird, mammal reptile and amphibian species as endemics.

In India, which has a treasure of natural forests, grasslands and wildlife in the past, the people have a respect to preserve them so far. Profuse references regarding love for wild animals, growth of trees and abundance of forest cover exist in the Indian mythological scriptures like Upanishads, Vedas and Mahabharat etc. The ancient scriptures are full of saying and justifying the need of survival and preservation of all life forms.

India is a country with strong traditions and diverse natural resources. Plants are now recognized as an important component of natural resources throughout the world. Plants are an integral part of nature. Since ancient times, plants are the essential part of human life. They are used for various purposes of food, fodder, medicines, dyes, clothing, narcotics, gums and dyes etc. They are subjected to the same risk and the same degree of protection, as the other natural resources. Out of over 27000 species of plants, more than 25 % taxa are under various degrees of continuous threat (Barthlott *et al*., 2000). It gained momentum during the 2nd half of the 20th century and over exploitation of the taxa of economical, medicinal and

ornamental significance in trade started significantly. Therefore, there is an urgent need to regulate the trade of plants and animal species through an effective agency (Goel and Mitru, 2000).

The exact number of species available on the earth is still not known, however, Wilson (1988) estimated that the total number of identified species is about 1.4 million. It was evaluated that around 7500 species of organisms are getting to be wiped out every year (Chatterjee, 1995) and a large portion of them vanish ever before known to the scientific world (Myres *et al*., 2000; Pimm and Raven, 2000). There are many causes for the loss of species but the most important is the habitat loss and fragmentation. Floristic inventories and studies are important to comprehend the present diversity status and biodiversity conservation (Jayakumar, 2011).

The earth and its diversity are dynamic and ever changing with species extinction a natural phenomenon. Newly evolved species replaced them at the same rate, thus maintaining equilibrium. In the past such extinction events took place over hundreds of thousands to millions of years. But the present rate of species extinction is of great concern to biologists because it is about 400 to 1000 times faster than that recorded in the geological past. Hundreds of species and myriad populations are being driven to extinction every year (Ehrlich, 1995).The world is currently undergoing a very rapid loss of biodiversity comparable with the great mass extinction events that was previously occurred only five or six times in the Earth's history (Barnosky *et al*.,2011).

During the present time, the rapid destruction of natural ecosystem is the most serious threat for the survival of plants and other natural resources (Nayar, 1995). Many activities of human societies are responsible for the degradation of the environment. Our use of natural resources has grown dramatically, particularly since the mid-20th century, so that we are endangering the key environmental systems that we rely upon (WWF, 2016). Threats to the species are principally due to a decline in the areas and quality of their habitats.

Loss of biodiversity may trigger large unpredictable change in an ecosystem. It is mainly due to habitat destruction, over exploitation of biological resources, pollution and introduction of exotic plants and animals. There are other reasons also for significant depletion of biodiversity. Prominent among them are the expansion of agriculture and industries, urbanization, road construction and large scale developmental projects. Excessive and uncontrolled biotic interferences also resulted in depletion of biodiversity. It has been estimated that 140 species of plants, animals and microbes are lost every day from earth (Agarwal, 1996). Rapid destruction of forest is the main cause for loss of biodiversity on land.

The world conservation strategy (IUCN, UNEP and WWF, 1980) defines conservation as "the management of human use of biodiversity so that it may yield the greatest sustainable benefit to present generation while maintaining its potential to meet the needs and aspirations of future generations." The above definition invokes two complementary components "Conservation and Sustainability". The creation of protected area network helps to reduce biodiversity loss and provides significant contributions to global conservation efforts.

Protected Areas Network in India

Protected areas of India cover 1, 60,901 sq km, roughly 4.89% of the total surface area. India has 103 national parks, 537 wild life sanctuaries, 67 conservation reserves and 26 community reserves comprising 160901.77 sq km area (Table 1.2).

Table 1.2: Protected Areas of India (as on Jan. 2017)

Protected Areas	**No.**	**Total Area (Km)**	**Coverage % of country**
National Parks	103	40500.13	1.23
Wildlife Sanctuaries	537	118005.23	3.59
Conservation reserves	67	2349.38	0.07
Community reserves	26	46.93	.001
Total	733	160901.77	4.89

Geographical Area of India (http:// knowindia.gov.in) = 3287263 km2
Forest cover of India (FSI, 2015) = 7, 01,673 km2
Percentage are under forest cover = 21.34% of Geographical Area of India

In addition to this, 18 biosphere reserves have established in India which promotes solution reconciling the conservation of biodiversity with its sustainable use. India's first national park was established in 1930 as Halley National park, presently known as Corbett National Park which is famous for richness and diversity of wild life.

Despite being a desert state, Rajasthan has good network of protected areas. It is also noted for its national parks and sanctuaries. There are 5 national parks, 25 wild-life sanctuaries and 10 conservation reserves in Rajasthan (Table 1.3-1.5; Map 1.1).

Table1. 3: List of National Parks of Rajasthan

S. No.	Name	Area (Sq. km)	Date of Established	District
1.	Darrah (Mukundra hills)	265.8	2003	Kota
2.	Desert	3,162.00	1980	Barmer & Jaisalmer
3.	Keoladev Ghana	28.73	1981	Bharatpur
4.	Ranthambore	392.00	1980	Sawai Madhopur
5.	Sariska	273.80	1992	Alwar

Table 1.4: List of Wildlife Sancuaries of Rajasthan

S. No.	Name of Protected Areas	Year of Establishment	Area (Sq Km)	District(S)
1.	Bandh Baratha	1982	199.50	Bharatpur
2.	Bassi	1988	138.69	Chittaurgarh
3.	Bhensrodgarh	1983	229.14	Chittaurgarh
4.	Darrah	1955	80.75	Kota
5.	Jaisamand	1955	52.00	Rajsamand
6.	Jamwa Ramgarh	1982	300.00	Jaipur
7.	Jawahar Sagar	1975	153.41	Kota
8.	Kailadevi	1983	676.38	Sawai Madhopur
9.	Kesarbagh	1955	14.76	Dholpur

S. No.	Name of Protected Areas	Year of Establishment	Area (Sq Km)	District(S)
10.	Kumbhalgarh	1971	608.58	Udaipur, Pali
11.	Mount Abu	1960	112.98	Sirohi
12.	Nahargarh	1980	50.00	Jaipur
13.	National Chambal	1979	274.75	Kota
14.	Phulwari ki Nai	1983	692.68	Udaipur, Pali
15.	Ramgarh Vishdhari	1982	252.79	Bundi
16.	Ramsagar	1955	34.40	Dholpur
17.	Sajjangarh	1987	5.19	Udaipur
18.	Sariska	1955	219	Alwar
19.	Sawaimadhopur	1955	131.30	Sawai Madhopur
20.	Sawai Man Singh	1984	103.25	Sawai Madhopur
21.	Shergarh	1983	98.71	Kota
22.	Sitamata	1979	422.94	Chittaurgarh, Udaipur
23.	Tal Chapper	1971	7.19	Churu
24.	Todgarh	1983	495.27	Ajmer, Rajasamand, Pali
25.	Van Vihar	1955	25.60	Dholpur

Source: National Wildlife Database Cell

Conservation reserves are the protected areas completely owned by the Government and declared by the State Governments for the purpose of protecting landscapes, flora, fauna and their habitat. The major aim of conservation reserves are protection of existing forests and restoration of the degraded forests in ecological sensitive areas.

Table 1.5: List of Conservation Reserves in Rajasthan

S. No.	Name	District	Area
1	Bisalpur Reserve	Tonk	48.31
2	Jod Beed Goadwala, Bikaner	Bikaner	56.46
3	Sundha Mata	Jolore, Sirohi	117.49
4	Gudha Vishnoiyan	Jodhpur	2.31
5	Shakambhari	Sikar, Jhunjhunu	131
6	Gogelao	Nagaur	3.58
7	Beer Jhunjhunu	Jhunjhunu	10.47
8	Rotu	Nagaur	0.73
9	Ummed Ganj Bird	Kota	2.78
10	Jawai Bandh	Pali	19.38

'We come on this earth as a guest of plants' is a monumental ancient aphorism. Since time immemorial nature's own supreme creation, Man, has completely been dependent on plants and as civilization developed, he has learnt to exploit natural resources and to make use of every bit of it. In fact from the start of life to the last breath, almost every aspect of human life is deeply associated with plants.

The science of ethnobotany was codified by explanation of the term by John William Harshberger (1896) who defined it as the 'study of plants used by primitive and aboriginal people' and later published it in Botanical Gazette. Ethnobotany knowledge can provide a wealth of information regarding both past and present relationship between plants and the traditional societies. Investigations into traditional use and management of local flora have demonstrated the existence of local knowledge of not only about the physical and chemical properties of many plant species but also the phenological and ecological features in case of domesticated species. One of the most prominent contributions of ethnobotany to the society is natural medicine. In addition, ethnobotany also contributed many beneficial things such as food, shelter, fibre, dyes, fodder and non-timber forest products (NTFPs).

Though the term Ethnobotany is of recent origin, the concept is not new to our country which has a very ancient history of civilization. The contribution of our

country towards the field of ethnobotany is outstanding. India being a megadiversity centre in all respects is the most diverse area known for varied human races that inhabit diverse geographic, floristic and climatic regions. Thus medicinal knowledge of each and every community differs a lot, which enriched the field of ethnobotany.

Plants containing medicinal and other beneficial properties have been known and used in some form or the other since time immemorial in the traditional system of medicines (Jain and Saklani, 1991). During the last few decades there has been an increasing interest in the study of medicinal plants and their traditional use in different parts of the world. Documenting the indigenous knowledge through ethnobotanical studies is important for the conservation and utilization of biological resources.

The most ancient records on the medicinal usages of plants of our country are available in the form of Vedas (*Rigveda, Atharva Veda* etc.) Samhitas(*Sushruth samhitha, Charak samhitha, Kashyap samhitha* etc.) and Epics such as *Ramayana* and *Mahabharatha*. *Rigveda*, which is the most ancient available record dating to 5000 BC, reveals the medicinal properties and usage of several plants, description of various diseases and the mode of application of drugs with examples. *Atharva Veda* Which is another classical work describes about 2000 plants having medicinal properties. The *Charak* and the *Sushruta Samhita*s were written between 700-200 BC, and contain accounts of the findings of medicinal plants (Pandey and Verma, 2005).

Among the Indian systems of medicine, *Ayurveda* is the most ancient and prevalent system in the country, uses about 700 species of plants. Other systems like, *Siddha* uses over 500 species, *Unani* 400 species and *Tibetan* or *Emchi* system about 300 species. The folklore system plays an important role in meeting the health care needs of the rural community in India and uses more number of plants than in the Indian systems of medicine (Sasidharan and Muraleedharan, 2000).

Herbal medicine is among the most respected of ancient natural therapies and has stood the test of time despite the introduction of modern medical science. The idea that certain plants had healing potential was known long before human being discovered the existence of pathogens. Despite the tremendous progress in medicine,

infectious diseases caused by bacteria, fungi, viruses and parasites continue to pose a threatening challenge to public health (Cos *et al*., 2006). Antimicrobial resistance is one of the biggest problems to face global public health at the beginning of the third millenium. Since the introduction of Penicillin in the 1940s, antimicrobial drugs have played a major role in effectively controlling infectitious diseases, especially those caused by bacteria. Soon after the introduction of antimicrobial drugs, however, some bacterial pathogens became resistant to many of these drugs.

Many infectious diseases have been known to be treated with herbal remedies throughout the history of mankind. It has been well known since ancient times that plants and spices have antimicrobial activity. Natural products, either as pure or as standardized plant extract, provide unlimited opportunities for new drug leads because of the unmatched availability of chemical diversity.

Herbs are compatible with the chemistry of human body, which has adopted over thousands of years to assimilate them. Medicinal plants provide meaningful inputs for drugs. Moreover herbal drugs are believed to be comparatively safer and economical than modern medicine. The WHO has estimated that 80% of the world population relies on traditional plant medicine. Since ages through trial and error, people have learned and practiced the medicinal usage of plants growing in their close vicinity for treating various ailments. The medicinal plants are the backbone of the traditional medicinal system. 3300 million people in the under developed countries utilize medicinal plants on a regular basis (Dobriyal and Narayana, 1998). Demands for herbal health products are growing even these are proving costlier than the corresponding inexpensive synthetic ones (Reddy *et al*., 2011; Kotia *et al*., 2015).

India is a vast repository of medicinal plants that are used in traditional medicinal treatments (Chopra *et al*., 1956). There are about 45,000 plant species in India and among them several thousands have been claimed to possess medicinal properties and are being used in various human cultures around the world for medicinal purposes. Primarily based on plants, many system of therapy have been developed (Prakash *et al*., 2012). In India medicinal plants offer low cost and safe healthcare solutions. There are needs to collect and combine all the available

information regarding medicinal plants development in the country in order to obtain a comprehensive overview which will provide the necessary insight for coordinated and effective action. Many of today's drugs have been derived from plant sources. Scientists and pharmacologists are urgently looking for new drug sources and are increasingly turning their eyes to traditional medicine. The discovery of many natural and synthetic drugs is a remarkable progress in the field of medicine which has been made by the advancement in science and technology (Preethi *et al*., 2010). Medicinal plants provide meaningful inputs for drugs. Moreover herbal drugs are believed to be comparatively safer, economical and more user friendly than modern medicine. Treatment with herbs can therefore, provide a gentle and safe alternative of complement to modern drugs and other orthodox treatments.

As a result of the indiscriminate use of antimicrobial drugs in the treatment of infectious disease, microorganisms have developed resistance to many antibiotics (Cowan, 1999). There is need to develop alternative antimicrobial drugs. One approach is to screen local medicinal plants which represent a rich source of novel antimicrobial agents. Therefore, the present work has been planned to explore the ethnobotanical study of Beer Jhunjhunu Conservation Reserve and investigate the isolation of active compounds and antimicrobial properties of selected medicinal plants.

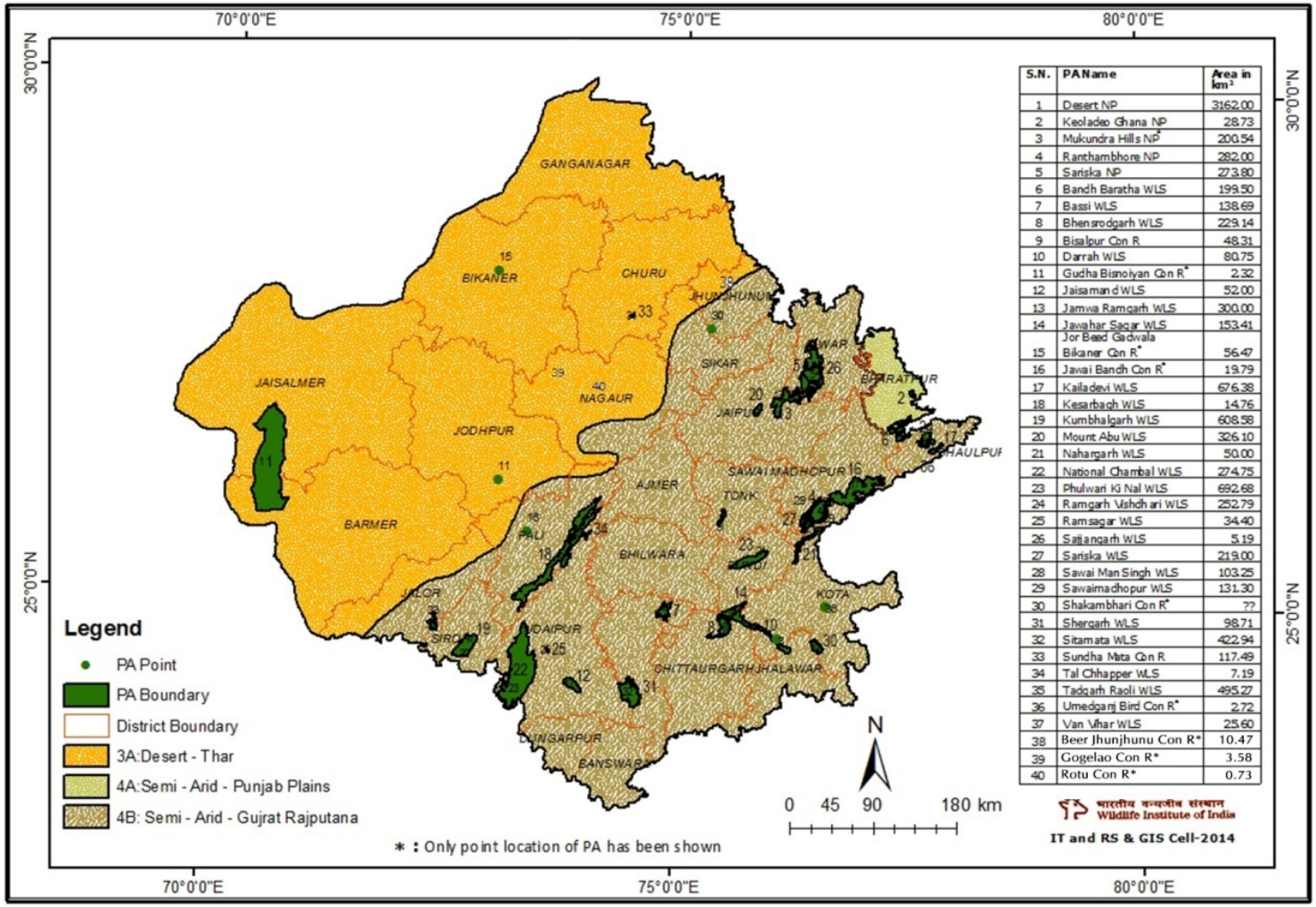
In the present study, two ethnomedicinal plant species *i.e*. *Aristolochia bracteolata* Lamk. of the family Aristolochiaceae and *Ruellia patula* Jacq. belonging to the family Acanthaceae has been selected for their antibacterial activity and phytochemical study of different plant extracts and isolation of active fractions from the plants showing best antimicrobial activity against selected pathogens.

Objectives of the Proposed Study

The study will be carried out with following objectives:

1. Exploration of phytodiversity, collection and identification of flora of Beer Jhunjhunu Conservation Reserve of Jhunjhunu district from 2013 to 2016 in different seasons.
2. Preparation of herbarium and documentation of flora of Beer Jhunjhunu Conservation Reserve according to Bentham and Hooker's system of classification (Genera Plantarum, Vol. I, II and III, 1862-1883).
3. To enumerate the ethno-medicinal, ethno-veterinical and miscellaneous uses of plants (including religious, rituals and ceremonies).
4. To identify the rare, threatened and endemic taxa of the present study area.
5. To evaluate existing threats to plants and identify sustainable conservation measures in the study area.
6. Photography of the plants and activities related to the ethnobotany in the study area.
7. To select some medicinal plant species on the level of usage for further studies to confirm the therapeutic properties.
8. Phyto-chemical analysis of the selected medicinal plants.
9. Screening of phytochemicals of selected medicinal plant species for their antibacterial properties.
10. To educate and encourage the rural people to conserve the protected forest area so as to promote its sustained utilization. Encouragement and protection of traditional knowledge about the sustainable uses of plant biodiversity.

Map-1.1: Showing Wildlife Protected Areas in Rajasthan



S.N.	PAName	Area in km²
1	Desert NP	3162.00
2	Keoladeo Ghana NP	28.73
3	Mukundra Hills NP	200.54
4	Ranthambhore NP	282.00
5	Sariska NP	273.80
6	Bandh Baratha WLS	199.50
7	Bassi WLS	138.69
8	Bhensrodgarh WLS	229.14
9	Bisalpur Con R	48.31
10	Darrah WLS	80.75
11	Gudha Bisnoiyan Con R*	2.32
12	Jaisamand WLS	52.00
13	Jamwa Ramgarh WLS	300.00
14	Jawahar Sagar WLS	153.41
15	Jor Beed Gadwala Bikaner Con R*	56.47
16	Jawai Bandh Con R*	19.79
17	Kailadevi WLS	676.38
18	Kesarbagh WLS	14.76
19	Kumbhalgarh WLS	608.58
20	Mount Abu WLS	326.10
21	Nahargarh WLS	50.00
22	National Chambal WLS	274.75
23	Phulwari Ki Nal WLS	692.68
24	Ramgarh Vishdhari WLS	252.79
25	Ramsagar WLS	34.40
26	Satiangarh WLS	5.19
27	Sariska WLS	219.00
28	Sawai Man Singh WLS	103.25
29	Sawaimadhopur WLS	131.30
30	Shakambhari Con R*	??
31	Shergarh WLS	98.71
32	Sitamata WLS	422.94
33	Sundha Mata Con R	117.49
34	Tal Chhapper WLS	7.19
35	Tadgarh Raoli WLS	495.27
36	Umedganj Bird Con R*	2.72
37	Van Vihar WLS	25.60
38	Beer Jhunjhunu Con R*	10.47
39	Gogelao Con R*	3.58
40	Rotu Con R*	0.73

CHAPTER-2
REVIEW OF LITERATURE

Floristic Diversity

The state of Rajasthan invited the attention of many researchers due to its challenging nature. Mr. and Mrs. G.L. Allen (1852) published a book "The view and flowers from Rajputana", botanically not significant. Major Vicari, according to Hooker and Thomson (1855), published a list of some desert plants, mostly from the erstwhile province of Sind (now in Pakistan).

George King (1869, 1870) published famine plants of Marwar and also cited the local names of the plants. Subsequently King (1879) published "The sketch of the Flora of Rajputana" which is first scientific account of the flora of this region. Blatter and Hallberg (1918-21) published the "Flora of Indian Desert" in the journal of Bombay Natural History Society. Rao (1941) published a list of some plants of the desert areas including those of Rajasthan and Sind. Sarup (1951) listed plants of Jodhpur and its neighbourhood. Sankhla (1951) also enumerated plants of north- west Rajasthan together with their life forms. Similar lists of the plants were later compiled for Jaisalmer and Bikaner by Sarup (1957, 1958). Bhandari (1961-65) also reported more than 50 species of plants for the first time with critical notes in series of paper.

Puri *et al*. (1964) published "Flora of Rajasthan - west of Aravallis", where the identification of plants and short descriptions of the species have been provided. Bhandari (1978) in "Flora of the Indian Desert" enumerated 682 species belong to 352 genera and 87 families of flowering plants from the western part of Rajasthan. Similarly flora of North- East Rajasthan has been worked out by Sharma and Tiagi (1979). These authors have recorded 627 species grouped into 343 genera belonging to 95 families of angiosperm.

A large number of publications dealing with the floral composition of Desert of Rajasthan have been published during last few decades. These have been reviewed by Raizada and Sharma (1962), Bhandari and Sharma (1977a), Bhandari and Singh (1964), Pandey *et al*. (1985), Bharucha and Mehr Homji (1965), Guha

Bakshi (1969), Maheshwari (1963), Chopra and Hada (1960), Maheshwari and Singh (1974), Pal and Meena (1999); Gena (2006) etc.

The reports on the flora of Central Aravalli region are also available. Sharma (1958) enumerated trees and shrubs of Ajmer. Gena and Sharma (1988) described the vegetation of different habitat of Rajasthan.

Tiagi and Aery (2007) published the Flora of Rajasthan (South and South-East Rajasthan) and included systematic and up to date representation of 1378 plant species (including cultivated and ornamental) belonging to 126 families. Meena and Yadav (2011) published 'The Flora of South Central Rajasthan' and included 686 species belonging to 416 genera and 117 families.Other notable contribution for taxonomic accounts of desert flora are Joshi (1958, 1961), Puri *et al*. (1964), Kanodia and Gupta (1969), Bhandari and Sharma (1977 a).

The flora of Rajasthan has been published by Shetty and Singh (1987; 1991; 1993) in the form of three volumes. They have included 1911 species, 780 genera and 159 families in which one species was Gymnosperm.

At the district level, flora of many districts such as Ganganagar (Dhillon and Bajwa, 1969); Jaipur (Sharma, 1974); Bhilwara (Parmar and Singh, 1982); Banswara (Singh, 1983); Tonk (Shetty and Pandey, 1983); Pali (Pandey and Shetty, 1984); Alwar (Parmar,1987); Churu (Singh *et al*., 1997) and Nagaur (Sharma and Aggarwal, 2008) etc. have also documented. Sharma (2002) made a contribution on vegetation of Hadoti region in "The Flora of Rajasthan" and included 1187 species, 628 genera and 139 families.

The floristic contribution from eastern Rajasthan was negligible till 1950. Since then, however many contributions come out in the form of the check lists of the plant of certain areas in their vicinity viz. various areas from the Shekhawati region, e.g. on and around Pilani (Bakshi, 1954; Joshi, 1958; Mulay and Ratnam, 1950; Nair and Nathawat, 1956; Nair and Joshi, 1957; Ratnam and Joshi, 1952), Chirawa (Nair, 1956), Lohargal (Ratnam,1951; Nair and Malhotra, 1961), Harshnath hills (Nair and Nathawat, 1957), Jhunjhunu, Mandrella and neighbourhood (Nair,

1961), Ajit Sagar and Khetri (Nair and Kanodia,1959; Nair *et al*.,1961). Joshi and Sharma (1964, 1966) listed grasses and sedges from Jhunjhunu and adjacent localities. Similarly a revisionary study on flora of Jhunjhunu district has been worked out by Kulhari (1988). Contributors from the Pilani School preserved their collection at Birla college herbarium, which too unfortunately is not in a good condition in these days, some duplicates of the Nair and his associates (Nair, 1956; Nair and Malhotra, 1961) are being the exception

Rajasthan has extraordinary diversity and high endemism of floral species. Some rare, endemic and threatened plants in different eco-regions have been published by several workers (Sahni, 1970; Jain and Sastry, 1980; Sharma 1983; Pandey *et al*., 1983; Meena and Yadav 2006). Similarly an observation on rare and threatened species of Thar Desert was made by Kasera and Mohammed (2007). In 2008, Arid Zone Circle Jodhpur of BSI region of Rajasthan published a list of rare taxa of western region of Rajasthan. Pandey *et al*. (2012) have also published depleting 65 taxa with their present status and conservation in Rajasthan. Joshi and Shringi (2014) recorded 37 plant species as rare and threatened in Jawahar Sagar Sanctuary area in Kota (Rajasthan).

Thus the perusal of literature revealed that a lot of work has been done on the exploration of floristic diversity of different places of Rajasthan but references for taxonomic description about district Jhunjhunu are less documented and understood. There is an urgent need to document and monitor the area for floristic diversity and so it becomes imperative to observe the conservation status of threatened plant species in the area. Therefore, the present study was undertaken to record the floristic composition of Beer Jhunjhunu Conservation Reserve of Rajasthan.

Ethnobotany

Ethnobotany is the science simply defined as “the study of interrelationship between plants and people. The term ethnobotany denotes the comprehensive approach towards the knowledge of the ethnic people on various life forms. The term “Ethnobotany” was first given by Harshberger (1896) to the studies dealing with plants used by primitive and aboriginal people. Shultes (1962) defined it as the

study of the relationship between the people of a primitive society and plants. Jain (1987a, b) elaborated it as the total natural and traditional relationship and interaction between man and his surrounding plant wealth. The relationship between plants and human cultures is not limited to the use of plants for food, clothing and shelter, but also includes their use for religious ceremonies, ornamentation and health care. Ethnobotany in wider context denotes the entire realm of useful relationship between plants and man, a view held by Arora (1997).

Present ethnobotany links diverse disciplines such as anthropology, sociology, taxonomy, phytochemistry, archaeology, ecology, agriculture, linguistics and medicines. Today ethnobotany has become an important and crucial area of research and development in resource management, sustainable utilization and conservation of biodiversity and socioeconomic development. Now the botanists, anthropologists, social-scientists, the practitioners of indigeneous medicines all over the world are engaged in the study of man-plant interactions in natural environment. The focus of ethnobotany is on how plants have been or are used, managed and perceived in human societies. It includes plants used for food, fodder, fuel, medicine, intoxication, cosmetics, dyeing, for building, tools, clothing, rituals, agricultural and social life implements etc. (Baghel, 2002; Sharma, 2006; Jain and Jain, 2012). In last three decades, it has been considerably expanded both in its concept and scope. Beginning with the study of plants used by tribals for food, medicine and shelter, now it includes studies like conservational practices of tribals, ethnopharmacology, ethnofarmacognosy, ethnomusicology and ethnogynaecology etc.

In many countries like USA, England, France, India and several Latin American and African countries, a lot of work has been done on ethnobotany in the past few years. Faulks (1958) monumental work *An Introduction to Ethnobotany* includes all the relevant information associated with the science of ethnobotany. The ethnobotanical studies with interdisciplinary approach were under taken during the latter half of the 20^{th} century. Conklin (1961, 62) conducted his studies on shifting cultivation and folk taxonomy. Fransworth (1966) worked on the morning glory hallucinogenic plants. Alland (1966, 70) worked on the cultural, biological and anthropological aspects of several plants. Duke (1970) worked on the ethnobotany

of Choco Indians with special reference to the utilization of *Papaver* and also published an *Ethnobotanical Dictionary of Dariene, USA*. Ford's (1978) publication on the nature and status of ethnobotany is a compilation of several papers on the anthropological and ethnobotanical information is of great significance.

Weiner (1970, 71) contributed to the knowledge of medicinal plants in Fiji and Tonga. Osborn (1968) documented the medicinal and other useful plants in Egypt. Hsu (1972) published an illustrative account of Chinese's herbal medicine of Taiwan. Hodge (1974) documented the Vasabi native condiment plant of Japan. Keng (1974) studied the economic plants in ancient north China. Danuta (1980) studied the traditional medicines of Afganistan. Manadhar (1980, 1986) documented some lesser known medicinal plants and food plants of Nepal. Rahman and Yusuf (1996) worked on diversity, ecology and ethnobotany of the Zingiberaceae of Bangladesh. Kariuki and Njoroge (2011) worked on ethnobotanical and antimicrobial studies of some plants used in Kenya for management of respiratory tract infection.

Kabir *et al*. (2014) conducted a survey of medicinal plants used by the Deb-Berma Clan of the Tripura tribe of Moulvibazar district, Bangladesh. Singab *et al*. (2014) from Cairo (Egypt) has described medicinal plants with potential anti-diabetic activity and their assessment. Dolatkhahi *et al*. (2014) studied the ethno medicinal plants used in Arjan- Parishan protected area in Fars Province of Iran. Limenih *et al*. (2015) studied traditional medicinal plants of Amhara region of North Ethiopia and similar studies were carried out by Oran and Dawud (2015) in Jordan. Ritter *et al*. (2015) performed biblio-metric analysis on ethnobotanical research for Brazil tribes. Koleva *et al*. (2015) studied ethnomedicinal plants of Bulgaria and Niduche *et al*. (2015) studied about the plants of Nigeria, which are useful in human fertility.Hong *et al*. (2015) worked on ethnobotanical study on medicinal plants used by Maonan people in China.

India has vast ethnobotanical knowledge from ancient time. *Ayurveda*, *Rigveda, Charak Samhita, Sushrut Samhita* etc. are the old Indian literature having wonderful knowledge of plants as medicines. A large portion of this country was

covered with forests which yielded a number of medicinal plants. These plants were initiated extensively in Ayurvedic system of medicine since many centuries. Kirtikar and Basu (1935) have stated "The ancient Hindus should be given the credit for cultivating what is now called Ethnobotany."

Ammal (1954) popularized ethnobotanical research in India. In early sixties, she initiated researches on ethnobotany in BSI. She studied subsistence food plants of certain tribes of Southern India. Jain (1964), who initiated the ethnobotanical research in well organized way, started from such studies on the tribals of Central India. He devised methodology for ethnobotany particularly in the Indian context. The publications from this group in the early sixties triggered the ethnobotanical activity in many other centres, particularly among botanists, anthropologists and medical practitioners etc. During the last four decades similar work has been initiated at various centres such as National Botanical Research Institute at Lucknow, National Bureau of Plant Genetic Resources (NBPGR) at Delhi, Central Council of Research in Unani medicines, Central Council of Research in Ayurveda and Siddha (CCRAS) and in some other institutes. This awakening resulted in bringing out volumes like "Glimpses of Indian Ethnobotany (Jain 1981); "A Manual of Ethnobotany" (Jain 1987a); "Dictionary of Indian Folk Medicine and Ethnobotany" (Jain 1991) and "Ethnobiology in Human Welfare" (Jain 1996). Jain *et al*. (1984) published Bibliography of Ethnobotany which contains about 2000 references covering almost all the major publication on ethnobotany.

A large number of publications have been made from India covering various lines of research such as ethnobotany of specific tribes, of certain regions, of particular plant groups or diseases and on many other miscellaneous interdisciplinary approaches without employing suitable quantitative indices (Jain and Borthakur, 1980; Pushpangadan, 1995; Singh and Pandey, 1998; Jain (2004); Jain and Patole, 2001; Katewa *et al*., 2001; Patil and Patil, 2006; Sajem and Gosai, 2006; Rao and Pullaiah, 2007). Salahuddin *et al*. (2013); Mittal and Batra (2014); Kumar *et al*. (2015); Dutta (2015); Vijigiri and Bembrekar (2015) are few other notable workers who published on different aspects of the ethnobotany. Currently many other workers also focus on ethnomedicinal plants like Chandrakumar *et al*.

(2015); Gritto *et al*. (2015) Chowdhury and Karmakar (2015); Patharaj and Kannan (2015); Sen *et al*. (2015); Singh and Singh (2015) etc.

Ethnobotanical studies of selected tribes have been made especially on Koku tribes (Kamble and Pradhan, 1980); Abujhmara tribe of Bastar (Maheshwari and Dwivedi, 1985); Mikir tribe of Assam (Jain and Borthakur, 1980); Bhil tribe of Rajasthan (Joshi, 1982); Saharia tribes of Madhya Pradesh (Anis *et al*., 2000); Gujjar tribes of Uttar Pradesh (Khanna and Kumar,2000); Kokani tribes of Maharashtra (Sachin and Bapat, 2010) and Konda Reddis of Khammam district of Andhra Pradesh (Reddy and Raju, 2008).

Ethnobotany of specific geographical region were also carried out in central India (Jain, 1994); Meghalaya (Kumar *et al*., 1980); Assam (Hajra and Baishya, 1981); Maharashtra (Kulkarni and Kumbhojkar,1993); Madhaya Pradesh (Pandey *et al*., 1991) ; Rajasthan (Joshi,1993); Eastern Ghats (Ramarao and Henry,1996) and Kolli hills of Tamilnadu (Dwarkan and Ansari,1996). These studies compiled the information regarding the traditional plant resources of particular geographical provinces.

The documentation of traditional knowledge especially on the medicinal uses of plants has provided many drugs of the modern day. A few prescriptions were gathered from different sets of people by different regions of India for specific purposes such as diabetes (Khan and Singh,1996); snake-bite(Hemambara Reddy *et al*., 1996); antidotes (Thangadurai, 1998); skin diseases (Maruthi *et al*., 2000); rheumatism (Naidu *et al*., 2008); urinary disorders (Reddy *et al*., 2009); oral complaints (Punjani,1998; Mohanty,2003); bone fracture (Suneetha *et al*.,2011) and jaundice (Annalakshmi *et al*.,2012; Deb *et al*.,2016).

The earliest record on the documentation of the traditional botanical knowledge of the plants from Rajasthan is from King (1869), who record on the wild plants used as famine food. Vyas and Gupta (1962) listed some medicinal plants occurring in Alwar. Chopra *et al*. (1960) referred to some of medicinal plants of Indian Arid Zone. Bhandari (1974) gave a detailed account of famine foods of Marwar. Dixit and Mishra

(1976) listed some less known medicinal plants of Ajmer forest division. Singh and Shetty (1977) surveyed the natural resources of Rajasthan desert. Sen and Bansal (1979) gave an account of food plant resources. Singh and Pandey (1982) enumerated fibre yielding plants of Rajasthan. Khan (1984) discussed the anticancer plants of Banswara district. Sebastian and Bhandari (1984) gave an ethnobotanical profile of the Indian desert plants used in veterinary medicines by the Bhils.

A floristic survey of ethnomedicinal plants occurring in the tribal area of Rajasthan was conducted by Katewa *et al*. (2004) to assess the potentiality of plant resources for modern treatments and recorded uses of 61 plant species. Jain *et al*. (2005) carried out a study in Sitamata Wildlife sanctuary in Rajasthan and documented the medicinal utility of herbs belonging to 243 genera. Kumar and Chauhan (2006) carried out an ethnomedicinal survey in Keoladeo National Park and documented a considerable number of medicinal plants. For the treatment of animal and insect bite, 23 plant species were recorded as household remedies by Shekhawat and Batra (2006) from Bundi district. Choudhary *et al*. (2008) have made a review on ethno-botanical studies in Rajasthan. Ethnomedicinal uses of *Acacia jacquemontii*, a tree of Thar Desert was given by Chaudhary *et al*. (2009). Sariska and Siliserh regions from Alwar district were also surveyed by Jain *et al*. (2009) for ethnobotanical study. Sharma and Khandelwal (2010) described traditional uses of 36 plant species used by the tribals in Dang region in Rajasthan as cooling agents during summer. Upadhyay *et al*. (2010) conducted ethnobotanical study in eastern Rajasthan and reported the use of 213 plant species for treating various ailments. Other reports on ethnomedicinal plants of Rajasthan include Katewa and Guria (1997), Katewa and Sharma (1998), Meena *et al*. (2013), Seema and Kumar (2004), Sharma and Kumar (2006, 2011), Meena and Yadav (2007, 2010 a), Katewa (2009), Meena (2011), Meena and Kumar (2012). Kapoor and Arora (2014) studied ethnomedicinal plants of Jaisalmer district of Rajasthan used in herbal and folk remedies. Meena *et al*. (2014) enumerated ethnomedicinal plants used by tribals in Pratapgarh, Rajasthan. Hada and Katewa (2015) studied ethnomedicine aspects of some medicinal plants of Bundi district of Rajasthan.

The role of ethnoveterinary medicine in livestock development is beyond dispute. Many countries have documented ethnoveterinary practices with special emphasis on use of medicinal plants. Ethnoveterinary medicine is particularly important in developing countries where conventional remedies for animal health care are inaccessible or simply unaffordable to poor farmers (Mc Gaw *et al*., 2007). According to the World Health Organization (WHO), at least 80% of the people in developing countries depend largely on traditional practices for controlling and treating various diseases affecting both humans and their animals (Alves and Rosa, 2005; Shen *et al*., 2010).

In India, animal treatment like *Hasty Ayurveda*, *Aswa Ayurveda*, *Ghora Nidana* and other *Nidanas* was mostly confined to Ayurveda (Paul and Paul, 2006). Issar (1981) reported few medicinal plants from Uttarakhand Himalayas for the treatment of animals. Pal (1981) enumerated 25 plant species used in the treatment of cattle and birds among the tribals of Eastern India. Sebastian (1984) reported 27 plant species used as veterinary medicines, galactogogues and fodder in the forest area of Rajasthan. Geetha *et al*. (1996) enumerated 26 plant species used by *Kolli Malyalis* of Koli hills for curing various diseases of their livestock. Reddy *et al*. (1997) collected 17 interesting crude drugs used by the tribals of Cuddapah hills in Andhra Pradesh for the treatment of ephemeral fevers and anthrax in cattle.

The status and prospectus of plants used in Indian ethno-veterinary medicine is very well documented by Jain (2000, 2003). 37 plant species belonging to 25 families used for the treatment of domestic animals about folk herbal veterinary medicines of southern Rajasthan has been discussed by Takhar and Chaudhary (2004). The use of traditional herbal medicines from Shekhawati region of Rajasthan has been studied by Katewa and Galav (2004). Various botanists studied animal healthcare practices by livestock owners at Pushkar animal fair of Rajasthan (Galav *et al*., 2010). Yadav *et al*. (2015) documented ethnoveterinary practices of tribals of Banswara district of Rajasthan.

Many ethnobotanists have listed edible plants along with medicinal plants. Jain (1964) reported wild food plants of Bastar area. Pal and Banerjee (1971)

enumerated 22 food plants used by the tribals of Andhra Pradesh and Orissa. Negi (1988) listed 50 lesser known wild edible plants of Uttar Pradesh hills. Bhandari (1974) and Sebastian and Bhandari (1990) during their survey on the food plants of Rajasthan desert, identified the leaves of *Cassia tora*, bark of *Acacia leucophloea*, seeds of *Achyranthes aspera* and grains of *Echinochloa colonum*, *E. crusgalli* and *Eragrostis tenella* as famine food. Joshi and Awasthi (1991) document the life support plant species used in famine by the tribals of Aravallis.

Singh and Pandey (1982); Dubey *et al*. (2001) and Rana *et al*. (2016) described the religious use of plants in Rajasthan, Bundelkhand (Madhya Pradesh) and Banswara district of Rajasthan, respectively. Sharma (2002) studied the ethno–medic–religious plants of Hadoti Plateau (S. E. Rajasthan). Choudhary *et al*. (2008) studied the use of plants in material culture of tribals and rural communities of Rajsamand district of Rajasthan. Folk proverbs regarding to plants have also recorded by several workers (Bhil, 1954; Joshi, 1978; Kachhawa, 1995; Pareek and Trivedi, 2014).

Phytochemical Analysis

Throughout the ages, human have relied on nature for their basic needs, for the production of food, shelter, clothing, fodder, fertilizers, flavors and fragrances and medicines. Plants have formed the basis of sophisticated traditional medicine systems that have been in existence for thousands of years and continue to provide mankind with new remedies. Over the centuries traditional medicine system has developed an enormous wealth of information on the use and efficacy of herbal medicine, passed down from generation to generation and has survived until the present day.

Herbs are compatible with the chemistry of human, which has adopted over thousands of years to assimilate them (Gopa *et al*., 2013). Using plants as medicines to cure many diseases predates written human history. Many of the herbs and spices used by human being to season food also produce useful medicinal compounds (Lai and Roy, 2004). The use of herbs and spices in cuisine developed in past as a response to threat many pathogens responsible for various diseases. Studies show

that in tropical climates where pathogens are the most abundant, recipes are the most highly spiced. Further, the spices with the most potent antimicrobial activity tend to be selected (Solecki, 1975). In all cultures vegetables are spiced less than meat, presumably because they are more resistant to spoilage (Judith, 2000). Many of the common weeds that populate human settlements, such as nettle, dandelion and chickweed, also have medicinal properties (Susan and Barbara, 2007).

The study of herbs dates back over 5,000 years to the Sumerians, who created clay tablets with lists of hundreds of medicinal plants such as Myrrh and Opium. In 1500 B.C., the Ancient Egyptians wrote the Ebers Papyrus, which contains information on over 850 plant medicines, including Garlic, Juniper, Cannabis, Castor bean, Aloe, and Mandrake (Barry and Baek, 2009).

In India, ayurveda system of medicines has been using many herbs such as turmeric possibly since 1900 BC (Irvine, 2002). Sanskrit writings since1500 B.C., such as the Rig Veda, are some of the earliest available documents detailing the medical knowledge that formed the basis of the Ayurveda system (Barry and Baek, 2009). Many other herbs and minerals used in Ayurveda were later described by ancient Indian herbalists such as Charaka and Sushruta during the 1st millennium BC. The Sushruta Samhita attributed to Sushruta in the 6th century B.C. describes 700 medicinal plants, 64 preparations from mineral sources, and 57 preparations based on animal sources (Minta, 2000).

All plants synthesize chemical compounds as part of their normal metabolic activities. These phytochemicals are divided into primary metabolites such as sugars and fats, which are found in all plants; and secondary metabolites such as alkaloid and steroids which are found in a smaller range of plants, serving a more specific function (Meskin *et al*., 2002). Some secondary metabolites are toxins used to deter predation and others are pheromones used to attract insects for pollination. It is these secondary metabolites and pigments that can have therapeutic actions in human race and which can be refined to produce drugs e.g. Quinine from the Cinchona, Morphine and Codeine from the Poppy, and Digoxin from the Foxglove (Meskin *et al*., 2002).

Furthermore, the indigenous knowledge on the use of lesser-known medicinal plants is also rapidly declining. Continuous erosion in the traditional knowledge of many valuable plants for medicine in the past and the renewal interest currently, the need existed to review the valuable knowledge with the expectation of developing the medicinal plants sector (Kala *et al*., 2006). The medicinal value of the plants is due to their specific constituent combination of metabolites present in them. Changes in the proportion of secondary metabolites are often required for the improvement of therapeutic values of medicinal plants. The biosynthetic pathways for the metabolically active chemical compounds in the medicinal plants are usually complex but important. Genetic manipulation can help increase or decrease the content of specific compounds in medicinal plants.

Various secondary metabolites produced by some medicinal plants are involved in plant defense responses and facilitate plant adaptation to their environment by enhancing their general fitness and well-being. These compounds are also sources of pharmaceuticals, pesticides, flavoring agents, fragrances, and food additives. Different plants produce diverse products and their production is often related to a particular developmental stage, and is profoundly affected by seasonal variations. Cell cultures are attractive alternatives to whole plants for production of high value secondary metabolites due to consistency in quality and quantity of the desired product (Rao and Ravishankar, 2002). Plants synthesize a bewildering variety of phytochemicals but most are derivatives of a few biochemical motifs (Karen and Kutchan, 2009).

Polyphenols (also known as phenolics) are compounds contain phenol rings. The anthocyanins that give purple color to the grapes, the isoflavones, the phytoestrogens from soy and the tannins that give tea its astringency are phenolics.
Nature has long been an important source of medicinal agents. An impressive number of modern drugs have been isolated or derived from natural sources, based on Thai medicinal plants for cancer treatment, 289 plants are used in traditional medicine (Cragg and Newman, 2001). Plants have formed a basis for traditional medicine systems that have been used for thousands of years in countries with ancient civilizations such as China (Chang and But, 1986), India (Kapoor, 1990) and

Thailand (Subchareon, 1998). The use of plants in traditional medicine systems has been extensively documented (Iwu, 1993).

Plant-based systems continue to play an essential role in healthcare and it has been estimated by the WHO that approximately 80% of the world's inhabitants rely mainly on traditional medicine for their primary healthcare (Farnsworth *et al*., 1985). Plant products also play an important role in the healthcare systems of the remaining 20% of the population who reside mainly in developed countries. Analysis of data on prescriptions dispensed from community pharmacies in the United States from 1959 to 1980 indicates that about 25% contained plant extracts or active principles derived from higher plants. Furthermore, at least 119 chemical substances derived from 90 plant species can be considered as important drugs currently in use in one or more countries (Farnsworth *et al*., 1985). About 74% of these 119 drugs were discovered as a result of chemical studies directed at isolation of the active substances from plants used in traditional medicine (Cragg *et al*., 1997). Ethnopharmacological or traditional use of plants often results in the discovery of new biologically active molecules (Houghton, 1995). However, it is important that the investigators understand the principles of folk medicine or mode of action of folk herbs (Nakanishi, 1999).

The use of herbal medicines is growing in developed countries, presently 25% of the UK population use herbal medicine (Zhou and Wu, 2006). About 40% of compounds used in pharmaceutical industry are directly or indirectly derived from plants (Rout *et al*., 2000) because the chemical synthesis of such compounds is either not possible and/or economically not viable. Therefore a large number of plant species (especially medicinal) are under threat of extinction because of their over exploitation (Chen *et al*., 2016; Getachew and Mehamed., 2016).

Plants produce a large number of compounds that are important part in defense and adaptation to the environment. Gupta *et al*.(2016) suggested that these compounds includes terpenes, steroids, phenolics and alkaloids, that has good amount of biocompatibilities and have important potential application in the chemical-pharmaceutical industries as pharmaceuticals, agrochemicals, flavors,

fragrances, colors, biopesticides, and food additives. However the plant raw materials that are the sources of some of these valuable compounds are becoming scared. During a particular growth or developmental stage or under specific conditions the production of a metabolite is often restricted to a concrete species or genus which might be affected due to various biotic and abiotic stresses.

For thousands of years nature has been a source of medicinal agents and a large number of modern drugs have been isolated from these sources and are used in traditional medicine (Cragg and Newman 2001). The study of biologically active compounds from natural sources has always been of great interest to scientists looking for new sources of useful drugs for treating infectious diseases of bacteria, fungi, viruses, and parasites. Infectious diseases cause many harmful diseases which cause a major threat to public health, though human beings have discovered new era medicines. Their impact is particularly great in developing countries because of the relative unavailability of medicines and the emergence of widespread drug resistance.

Herbal medicines are the valuable and reality available resources for primary health care and complementary health care system. Unfortunately many species of plants containing substances of medicinal value have yet to be discovered; though large numbers of plants are constantly being screened for their antimicrobial effects. Nair *et al.,* (2009) reported the promising role of medicinal plants as they are potential sources of various bioactivities.

Plants have the ability to synthesize a wide variety of active phyto-constituents that are used to perform important biological functions, and to defend against attack from predators such as insects, fungi and herbivorous mammals. Nevertheless more than 12,000 such compounds have been isolated so far; a number estimated to be below 10 parts of the whole (Lai and Roy, 2004). Phytochemicals in plants arbitrate their effect on the human health by different modes identical to those already well known for the chemical compounds in myths medicinal preparations; thus herbal medicines do not vary greatly from conventional drugs in terms of how they work. This enables herbal preparations to have useful as well as cost effective pharmacology, but also gives them the same potential as conventional

pharmaceutical drugs to cause harmful side effects. A medicinal plant is a plant of which every potential plant part can be used as drugs (Sofowora, 1982). Herbal drug constitutes only those traditional medicines that primarily use medicinal plant preparations for therapy (Samy and Gopalakrishnakone, 2008)..

In India around 20,000 medicinal plant species have been recorded (Dev, 1997; Kamboj, 2000) of which 500 plants with medicinal use are mentioned and approximately more than 800 plants have been used in indigenous Ayurvedic systems of medicine. Thus Indian subcontinent is a vast repository of medicinal plants that are used in Indian traditional medical system (Chopra *et al.,* 1956), which also forms a rich source of knowledge (Nadkarni, 1982). Various prevailing indigenous systems such as *Siddha, Ayurveda*, *Unani* and Allopathy use several plant species to prepare drugs and treat different ailments (Rabe and Staden, 1997).

Antibacterial Activity

Since past 20 years Antibacterial potency of different plant parts like leaves, seeds and fruits have been reported. The ability of medicinal plants to produce antimicrobial substances could be used not only as a defense agent but also as pharmaceutical bioactive natural compounds. Though much is known about the chemistry and the antimicrobial action of some active phyto-constituents, very few reports are available on the probable way of action. Sashidhar *et al*. (2002) reported the biological mechanism to know the exact role of these compounds.

Against various microbial infections antibiotics provide the main basis for the therapy. Excessive use of antibiotics has created various microorganisms as multidrug resistance (Perez *et al.,* 1990). So there is a need of formulation of new antimicrobial agents. Since ancient times natural products have been used in folklore preparations all over the world and predate the introduction of antibiotics and other modern drugs. Owing to their popular use as remedies for many infectious diseases, searches for plants containing oxidative stress and antimicrobial protecting substances are frequent (Betoni *et al.,* 2009). Many studies focus on determining the antimicrobial activity of plant extracts, found in folk medicine (Ngwendson *et al*., 2005), essential oils (Alma *et al*., 2003; Maria *et al*., 2008) or isolated compounds such as alkaloids (Klausmeyer

et al., 2004; Vanessa *et al*., 2008), sesquiterpene lactones (Lin *et al*., 2003), triterpenes (Katerere *et al*., 2003) or naphthoquinones (Machado *et al*., 2003), flavonoids (Sohn *et al*.,2004), diterpenes (Siegfried *et al*., 2006).

Thus, plant-based therapeutic agents continue to have scientific, social, and commercial significance and appear to be gathering a momentum in health relevant areas. A study of the process by which the traditional or more recent plant-based molecular drugs or the new breed of herbal drugs came to be used in present-day medicine reveals that, in over 70% of the cases, the starting point has been some reference to the use of that plant as an indigenous cure in a folklore or traditional system of medicine of one culture or other.

However, due to syngerstics harmful effects the total dependence on synthetics is finished and people are diverting to the natural counterparts with hope of safety, security and permanent cure. The utilization of natural plant products with therapeutic properties is as ancient as human civilization and, for a long time, plant and animal products were the main sources of drugs (De Pasquale, 1984).

Some of the compounds with pharmacological specificity and bio-efficacy are inevitable and being used even today, do not possess any synthetic substitutes (Balandrin and Klocke, 1988). Medicinal plants are the local heritage with global importance. Tribal men methodically collected information on herbs of their area and developed well-defined herbal pharmacopoeias. One of the aspects of medicinal plants is production of bioactive compounds, which are also used as drugs and dietary supplements (nutraceuticals) to cure or prevent various diseases (Raskin *et al*., 2002)

Nature has been a resource of therapeutic agents for thousands of years and a large number of modern medicines have been isolated from natural resources; much of this isolation was based on the uses of these agents in traditional medicine (Cragg and Newman, 2001). The study of biologically active compounds from natural sources has for eternity been of great interest to scientists looking for novel sources of useful drugs for treating infectious diseases. Infectious diseases caused by fungi,

bacteria, viruses and parasites remain a major threat to public health, regardless of incredible progress in individual medicine. Their impact is predominantly great in developing countries because of the relative unavailability of medicines and the appearance of prevalent medicine resistance. Bacteria cause serious infections in humans as well as other animals.

In recent time, plant-derived substances have become of immense interest due to their versatile applications (Baris *et al*., 2006). Medicinal flora are the richest bio-resource of drugs of traditional systems of medicine, food supplements, nutraceuticals, folk medicines, modern medicines, pharmaceutical intermediates and chemical entities for synthetic drugs (Hammer *et al*., 1999). It has been anticipated that 14-28 % of higher plant species are used medicinally and that 74 % of pharmacologically active plant derived phyto-constituents were discovered after following up on ethno medicinal use of the plants. A number of attractive reviews have been found with the use of a combination of natural products to treat diseases, most notably the synergistic property and polypharmacological function of plant extracts (Gibbons, 2003).

There is need to develop alternative antimicrobial drugs. One such approach is to screen local medicinal plants which represent a rich source of novel antimicrobial agents. In the present study two ethnomedicinal plant species *i.e*. *Aristolochia bracteolata* Lamk. and *Ruellia patula* Jacq., which are commonly used by the tribals and rural people of Jhunjhunu district have been selected for their antimicrobial activity of different plant extracts and isolation of active fractions from the plants showing best antimicrobial activity against selected pathogens.

Ayurveda, with its base in medicinal plants, is recognized as one of the major systems of alternative and complementary medicine. In Ayurveda, Kitamari-*Aristolochia bracteolata* is mentioned for its bitter, diuretic, emenogogue, abortifacient, anti-fertility, anthelmintic, anti-inflammatory and anti-bilious properties and is found to be useful in vitiated conditions of *kapha* and *vata*, intestinal worms,edema,skin diseases and indigestion(Wealth of India,2002). The plant is used in traditional medicine as a gastric stimulant and in the treatment of

lung inflammation, dysentery, skin diseases, eczema, scorpion sting, snake bites, syphilis, gonorrhoea, allergic disorder, leprosy, jaundice, malaria, fever and worms (Kirtikar and Basu, 1935; Burkill, 1985; Alagesaboopathi, 2009; Roy *et al*., 2009; Ratna Manjula *et al*., 2011). The phytochemical screening revealed the presence of alkaloids, triterpenoids, steroids, sterols, flavonoids, tannins, phenolic compounds and cardio glycosides (Periyasamy *et al*., 2010; Kalpana Devi *et al*., 2011; Devesh and Alka, 2014).

Ruellia patula (syn *Dipteracanthus patulus*) is an Ayurvedic medicinal plant and have ethnomedicinal importance. It is widely used in the folk medicine for the treatment of wounds, bone fracture, gonorrhoea, syphilis, eye-sore, renal infection, cough, scalds, toothache, stomachache and kidney stones (Kirtikar and Basu, 1980; Murugesa Mudaliar, 1988; Muthumani *et al*., 2009). The Kani tribes of Kilamalai, India used this plant as a remedy for the bite of special species of spider known as ‘Tiger spider’ (Raja and Prakash, 2007).

CHAPTER-3
STUDY AREA

Rajasthan is one of the largest states situated in the north western part of India covering an area of 3, 42,274 sq. km among 29 states (Map 3.1). Rajasthan can be segregated in several specific regions. Shekhawati is one such significant region. The region fully or partly covers three districts, viz. Churu, Jhunjhunu and Sikar. Jhunjhunu district, a part of Shekhawati region is covering 5,928 sq. km total geographical area. The district is irregular hexagon in shape in the northeastern part of the state and lies between 27° 38′ and 28° 31′ North latitude and 75° 02′ and 76° 06′ East longitude (Map 3.2).

Although Jhunjhunu district is mostly restricted to the east of Aravalli, the mountain range has substantiated presence in the south eastern part of the district. Consequently, the physiographic features of the district can be divided into three main units:

- The hilly south eastern part,
- The undulating south western part with small isolated hills,
- The plain desert like northern part.

Although the Aravalli hills are restricted to a small area in the district, but it has immense influence on the life of the people here. In the east it forms the border with Haryana. It is bounded by Sikar district towards South and West and Churu district towards North. South eastern part of the district is dominated by off-shoots of Aravalli range of hills running in the SW-NE direction. The district is poor in forest resources as the total area under forest including hills is reported to be 39680 hectares which is 6.65% of total geographical area of the district. Most of the forested area is found in moderate to severely degraded state. Based on the floristic wealth and existing threats to their conservation, certain forest areas have been prioritized and brought under long term conservation programme. In this context State Government declared 1047.48 hectare area of Beer protected forest of district Jhunjhunu as conservation reserve.

History

Beer Jhunjhunu Conservation Reserve was used as grassland before independence. It was transferred by the Revenue Department to the Forest Department vide Government order dated 2 May 1959. The said land being forest land over which the State Government had proprietary rights, Government of Rajasthan published a notification being No.7 (371) R.V/64 Jaipur dated 9 January 1969, declaring the said lands as the "protected forest" under section 29(1) of the Rajasthan Forest Act, 1953. Before 1969, management of Beer Jhunjhunu was conducted by Gram Panchayat Pratappura. This forest was protected and cutting and felling of trees was strictly not allowed. Sometimes, a water tank and a temple or 'Math' was also build inside the forest. The open space served as the catchment for the 'Johdas' or the water tank. Cattle could freely graze in the open area and a cattle ramp was built as a part of the 'Johda' facilitating access of drinking water to the cattle. This unique ecosystem with a water body in the harsh climate of Shekhawati also functioned as a recreation space for the people of the town. Due to rich biodiversity and existing threats to its conservation, state government declared it as Conservation Reserve under the Gazette Notification No. P3 (47), Forest 2008 dated 9 March, 2012.

Location Dimensions

Beer Jhunjhunu Conservation Reserve of Rajasthan is located between 28°09′ to 28°10′ North latitude and 75°25′to 75°27′ East longitude. It is situated about 3 km from Jhunjhunu city and known as 'lungs of city'. It is almost plain area but towards boundaries some sand-dunes with little slopes are present. Bounderies of conservation reserve are:

- East - Boundary to village Charanwas
- West - Agriculture land Jhunjhunu city
- North - Boundary of village Desusar
- South - Boundary of village Samaspur

There are no internal boundaries in the Beer Jhunjhunu Conservation Reserve. The State Highway- 8 divides this region in North and South segments (Plate 3.1).

Division of Study Area

To collect maximum plant species to cover up floristic diversity, 15 collection sites were fixed on the basis of plant biodiversity. The sites are represented in Map 3.3 For the sake of convenience the study area has been divided into four compartments according to management plan of Beer Conservation Reserve Jhunjhunu.

Compartment No. 1

The area of this compartment is 148.35 hectare. It is surrounded by Jhunjhunu city in the West and a road goes to Soti village in the East. In the South, Jhunjhunu Pilani highway is situated and bounded by village in the North. Terrain is almost plain in this compartment. *Acacia nilotica*, *Salvadora oleoides*, *Zizyphus nummularia*, *Zizyphus xylopyrus* and *Acacia senegal* are commonly found in this area.

Baba Khetanath Ashram (also known as Vilakshan Avadhoot Ashram) and a beautiful pond are situated in this compartment (Plate 3.2). It is lush green patch of the area. Lord Shiva's temple and Guru Goraknath ka Dhoona are very ancient and worships by Nath community and local people settlement around the Ashram. Many sacred plants are grown in this ashram *viz. Mangifora indica, Ficus benghalensis, F. religiosa*, *Aegle marmelos, Ocimum sanctum* and *Prosopis cineraria* are found in this area. Besides these, it comprises *Salvadora oleoides*, *Acacia nilotica*, *Cassia fistula*, *Pongamia pinnata*, *Dalbergia sissoo* and *Cannabis sativa*. The western part of this compartment has facing severe problem of pollution. City sewage of Jhunjhunu is channelized in this region. As a consequence native flora has replaced by *Prosopis juliflora* and troublesome weeds such as *Parthenium hesterophorus*, *Verbesina encelioides, Lantana camara* and *Ageratum conyzoides*.

The pond situated behind the ashram was built in ancient times to store and conserve water and drinking water in the past years. It is age old structure and show

that it is carefully developed, maintained and sustained over the ages. These traditional water storage systems remained environmentally viable and sustainable until it was subjected to large scale abuses as in the recent times. However there are numerous other water bodies such as 'Johad' and 'Nadda' in the Beer region, but it is very beautiful and unique in architecture. Now it is filled with polluted water and facing threat for its conservation. The government in conjunction with Forest Department and the local people must make all round efforts to revive this beautiful heritage.

In the south-east of this compartment a large banyan tree is existed. Besides it Police check post is situated. A wetland behind the ashram is a feeding point of migratory birds and attracts the tourists. The noticeable point of this compartment rich in biodiversity are:

(a) Khetanath Ashram
(b) Goshiyon ka Nadda
(c) Maliyon ki Johdi (Plate 3.3a)

Compartment No.2

It is the largest compartment and comprises an area of 360.68 hectare. It is surrounded by village Desusar in the East, Soti village road in the West, Jhunhunu Pilani State Highway in the South and by boundaries of village Soti and Desusar in the North. It covers the eastern part of the conservation reserve and includes five collection centers. These are:

(a) Kumhara ki Johdi
(b) Leelbadi
(c) Phalda ki Johdi
(d) Nahra ki Johdi (Plate 3.3b)
(e) Soti village boundary

Maximum collection centre were made near the earthen pond known as 'Johdi' where rainwater is collected and supports rich vegetation. *Salvadora oleoides, Ailanthus excelsa, Capparis decidua* and *Ephedra foliata* were observed in this compartment. The area is almost plain with sandy soil.

Compartment No.3.

This compartment covers southern east part of the conservation reserve. It makes eastern and southern boundaries of village Pratappura and Samaspur respectively. The area of this compartment is 270.98 hectare and four collection centers were fixed for plant collection. These are:

(a) Bamna ki Johdi (Plate 3.3c)

(b) Dunadda

(c) Gadran ki Johdi (Plate 3.3d)

(d) Morchhala

Gadran ki Johdi site of the Beer Conservation Reserve Jhunjhunu is rich in plant diversity.. *Sarcostemma viminale, Enicostemma hyssopifolium, Indigofera caerulea, Abutilon fruticosum, Cocculus pendulus, C. hirsutus, Telosma pallida, Leptadenia reticulata, Ephedra foliata* were collected from this site.

Morchhala site is known for the occurrence of threatened plant *Ceropegia bulbosa*, locally known as *Khadula*.

4. Compartment No. 4

This study site covers the 179.32 hectare with 6753 m perimeter. It makes southern west boundary of the conservation reserve. In the west, it is surrounded by Jhunjhunu city. Three collection sites were selected for plant collection. These are:-

(a) Near Forest Chowki

(b) Patharla

(c) Khadan (Plate 3.3e)

A new plant species *Solanum elaeagnifolium* was observed at Patharla. The later is famous for huge *Salvadora oleoides* tree and Lord Hanuman temple.

At Khadan, the surface soil developed a hard crust and form hard impermeable kankar pan.

Peganum harmala, *Fagonia cretica*, *Lepidagathis trinervis*, *Solanum elaeagnifolium*, *Indigofera tinctoria*, *Solanum indicum* were observed in this compartment.

Climate – The climate of this area is generally dry except in the monsoon. It is affected by the surrounding topography and the air masses travelling over the region, which lead to a greater local variation in weather phenomenon. The climate of this area is characterized by four distinct seasons as given below:

(1) Summer season from March to June,

(2) The monsoon season from July to the end of September,

(3) The post monsoon period from October to the middle of November,

(4) The winter season from the middle of November to end of February.

Rainfall Pattern

Rainy season generally starts after reaching the monsoon in this area in the month of June. August is known as most rainy month of the season. During this period, the mean monthly average rainfall varies between 300 -400 mm. One or two winter showers are also experienced during the month of January and February which are very much welcomed for their great importance. The south-west monsoon advanced into the area in the later half of June and as much as 95%of the annual rainfall was received from June to September. The amount of annual rainfall in a particular area has complete impact on its vegetation. In this manner the annual rainfall determines the type of vegetation. Hence, the forest vegetation of the conservation reserve is mixed xeromorphic woodland type.

Temperature

Winters are quite cool and summers are very hot in this area. January is the coldest month when the minimum temperature drops up to 4^0C and the May and June are the hottest months, when maximum temperature reaches up to 47^0C.

Wind

Winds are strongest in May and June and lightest in November. During the cold weather period winds are generally light and variable. In the hot season and

during the monsoon, winds generally blow from the south-west and west. Hot winds, locally called "*Loo*" are common during summer. The nights are pleasant. Dust storms are also very common in the area.

Humidity

The air is generally very dry in the area except monsoon seasons. Relative humidity is often less than 30% during summer months, but gradually increases upto 80% by monsoon and then decreases from October onwards.

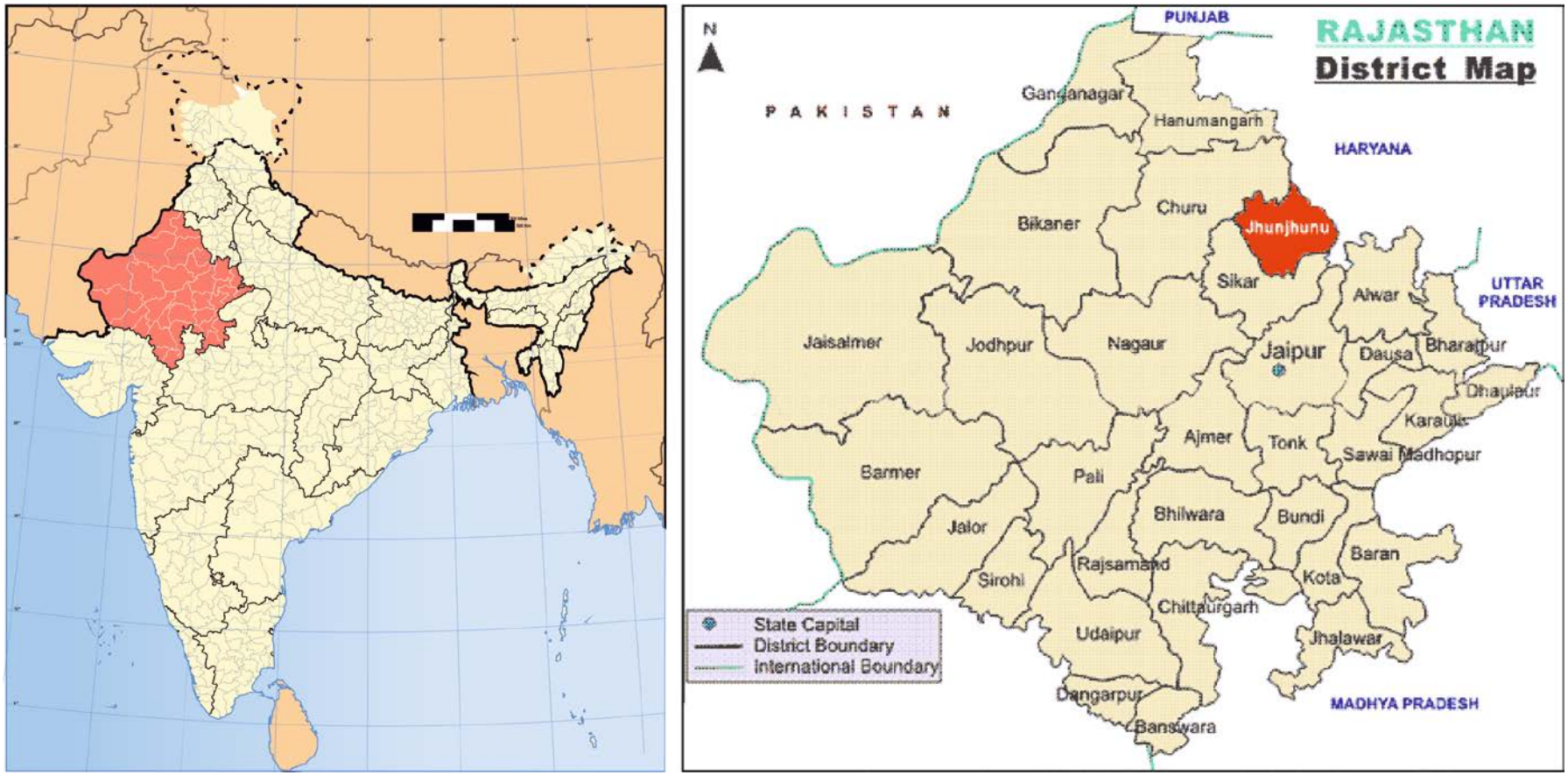
Soil

The soils are coarse textured light brown sandy to loamy fine sand, very deep, non-calcareous and well drained. The soils are deficient in nitrogen and organic carbon but have medium level of phosphorus and potash. Soil pH is 8.7 (Table 3.1).

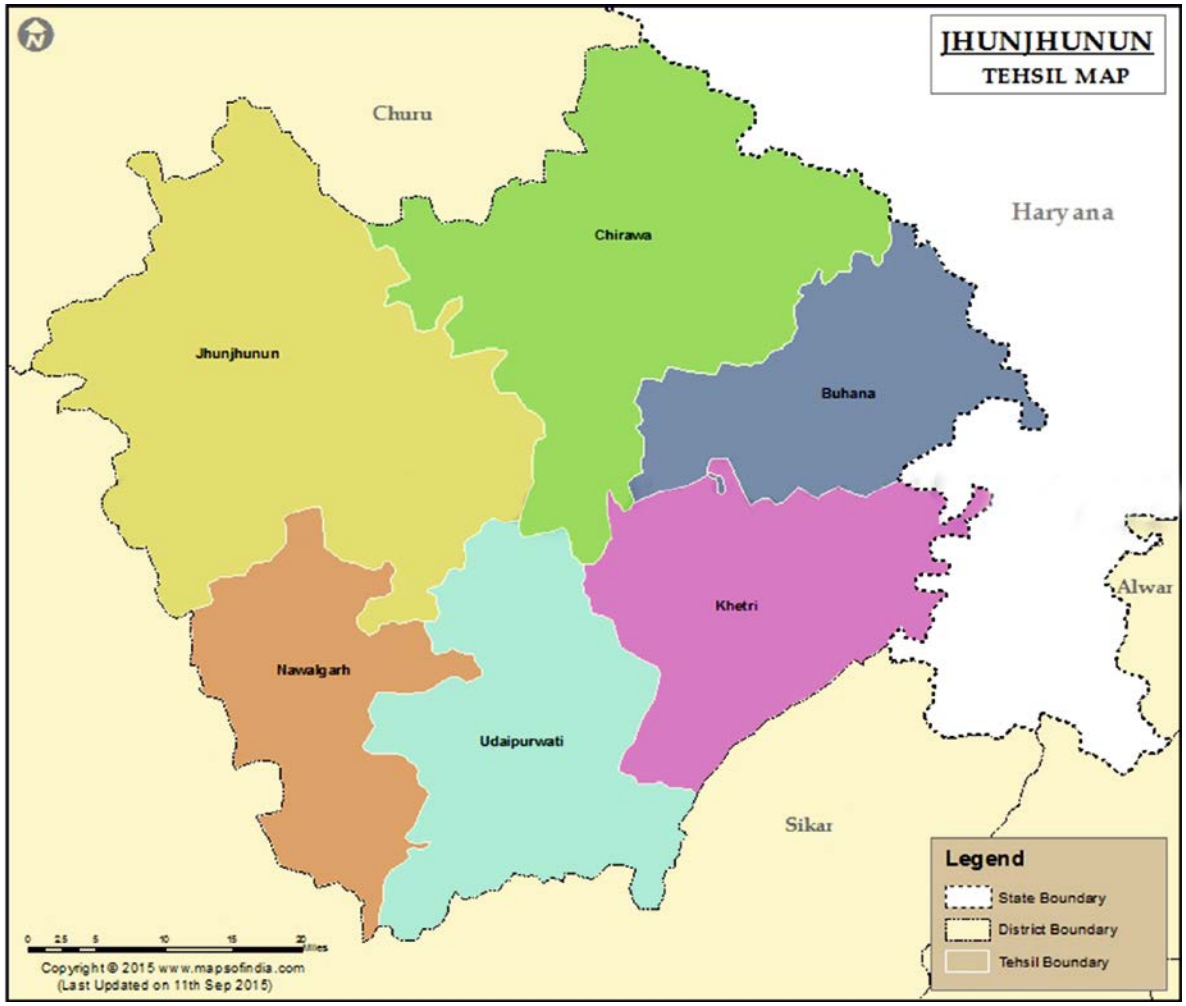
Table-3.1: Physico-chemical Properties of Soils in study area

Habitat	**Soil texture**	**Collection sites**
Waterlogged	Clay-loam	Near Ashram
Dry sandy	Sandy soil	Throughout Beer
Dry beds of ponds and puddles	Silty-clay-loam	Near Johdi
Hard pan soil	Calcareous	Patharla
Near cultivated land	Silty-clay-loam	Near agriculture lands of adjoining villages

Map-3.1: Key Map showing Location of Jhunjhunu District in Rajasthan and India



Map-3.2: Map of Jhunjhunu District



Map-3.3: Location of Compartments and Study Sites of Beer Jhunjhunu Conservation Reserve

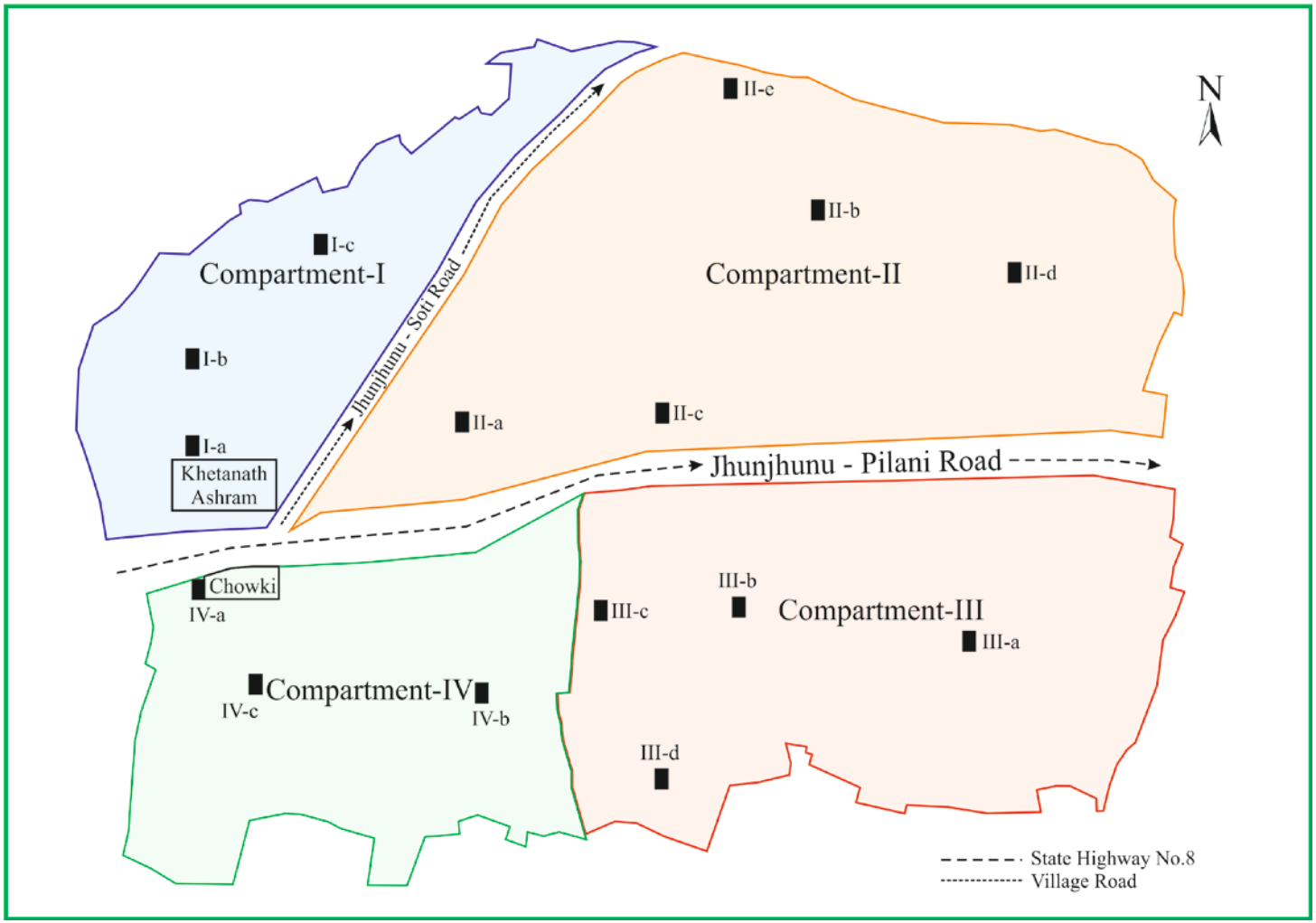


PLATE 3.1: A VIEW OF BEER JHUNJHUNU CONSERVATION RESERVE

Overhead view of Beer Jhunjhunu Conservation Reserve

State highway no. 8 dividing the Beer Jhunjhunu Conservation Reserve

Forest Chowki

PLATE 3.2: FASCINATING SCENES OF BABA KHETANATH ASHRAM

Baba Khetanath Ashram

Vegetation at Baba Khetanath Ashram

Fascinating pond near Baba Khetanath Ashram

PLATE 3.3: STUDY SITES OF BEER JHUNJHUNU

(a) A view of Maliyon ki Johdi

(b) A view of Nahran ki Johdi

(c) Bamna ki Johdi

(d) Gadran ki Johdi

(e) Khadan behind Forest Chowki at Patharla

CHAPTER-4

FLORISTIC DIVERSITY STUDIES

INTRODUCTION

Biodiversity comprises the whole life on earth. It refers to variety within the living world. The term 'biodiversity' is indeed commonly used to describe the number, variety and variability of living organisms. Floristic diversity comprises of variety of plant species distributed within a particular area. It denotes the natural flora of the area and quite essential for the stability, composition and proper regulation of ecosystem. The study of floristic diversity has attained importance as the world biodiversity in its present status has threatened in its existence. Plant diversity may be considered as backbone of biodiversity. It is important from medicinal, economical, ecological and environmental point of view. The plant diversity also provides the essential ecological services of maintaining our atmosphere, creating and maintaining soils, sustaining hydrological cycles and controlling world climate patterns. Besides, plant diversity has great impact on our social structure.

Protected areas (PAs) such as Biosphere Reserves, National Parks, Wildlife Sanctuaries and Conservation Reserves are the most suitable places on ths earth for conservation of biodiversity. These areas also have significant role in scientific, educational and cultural activities. Beer Jhunjhunu Conservation Reserve of Jhunjhunu district of Rajasthan is such an area which was recognised as protected forest in 1969 and then declared as conservation reserve by the State Government on 9 March, 2012 for the purpose of protecting landscapes, flora and fauna and their habitat. The region harbours a rich array of flora and fauna manifested by diverse habitat conditions. Besides, floral and faunal wealth, the study area has important ancient places such as Baba Khetanath Ashram and a beautiful pond situated behind it.

Present study area has a rich floristic diversity and contributed many economic plants. However, the region is subjected to enormous anthropogenic pressure such as over exploitation of timber as well as non-timber forest products especially wild medicinal plant, unchecked livestock grazing, alien species invasion

and deforestation. Some parts of the conservation reserve which are heavily used by human-beings for pilgrimage and live stock grazing, a few species have witnessed rapid decline during recent decades. There is an urgent need to conserve the rich biodiversity of Beer Conservation Reserve, Jhunjhunu before the treasure is lost. There is an immediate need for the *in-situ* and *ex-situ* conservation of this area.

A holistic understanding on the current status of Beer Jhunjhunu Conservation Reserve of Rajasthan is an essential prerequisite for assessing their ecological role, productive potential and conservation values. Beer Jhunjhunu, as a whole has remained unexplored botanically and for which floristic data of this area is still incomplete. The study of flora of this area was not carried out before in detail and the present work is the first of its kind. To achieve the objectives of the present work, a systematic survey of the study area has been undertaken to explore the phytodiversity.

MATERIAL AND METHODS

Extensive surveys of the study area were conducted between 2013 - 2016 to prepare a list of plant species occurring in different seasons. Field work was carried out in all seasons of the year with more frequency during rainy reason, so that none of the herbaceous ephemeral flora appearing in that season escapes. All the collected specimens were numbered serially. A field note book was maintained for field notes related to habit and habitat of the plant.

Floristic Survey

Collection of Plants

Apart from the general study of the vegetation during excursion, plant specimens, at least four in the number for a species were collected. For collection fertile material i.e. material that includes flowers or fruits had selected as these were very useful for the identification of the species. Vasculum, laminated jute bags with zip locks or cotton bags were used for carrying the plants. Finally plants were pressed by using plant press, old newspapers, blotting papers etc.

Locality, local name, color of flowers and other important characters were observed from the different sites of the study area.

Herbarium Preparation

A herbarium is a collection of plants that usually dried, pressed, preserved on sheets and arranged according to any accepted system of classification for future reference and study. Herbarium is a great fileting system for information about plants. All the efforts were made to make a healthy specimen on herbarium sheet so that easy floristic study can be performed. The collected plant material was laid inside a folded newspaper sheet, taking care that there was no overlap among plant parts. Plant specimens were then pressed by means of a plant press.

Mounting

All plants were dried and pressed using frequent changes of blotters till got completely dried. Corrugated sheets were placed between blotters for aeration purpose.

Before mounting, plant specimens were poisoned by immersing them solution of corrosive sublimate (15gm $Hgcl_2$ in one liter of rectified spirit). After poisoning, these specimens were mounted on herbarium sheets of 16.5" x 11.5" size. Well pressed specimens were selected and pasted on the sheet with help of glue or diluted fevicol to which some corrosive sublimate were added.

Mounted specimens are labelled with all essential data such as date and place found, description of the plant and special habitat conditions.

Preservation and Storage of Plants

The specimens were again put in dryers and pressed till it gets completely dried. Properly dried, pressed and identified specimems were kept in herbarium cabinets. Naphthaline balls packed in perforated cellophane bags were kept in herbarium cabinets as insect repellents.

Identification of Plants

Identification of plant specimens was made with the help of "Flora of The Indian Desert" (Bhandari, 1990); "Flora of Delhi' (Maheshwari, 1963); 'Flora of

Rajasthan' (Shetty and Singh, 1987, 91, 93); "Flora of Rajasthan" (Sharma, 2002) and 'Flora of Rajasthan – East and South-east Rajasthan (Tiagi and Aery, 2007). Identification of specimens were also confirmed and authenticated at Herbarium by comparing them with herbarium specimens of Herbarium, Department of Botany, University of Rajasthan, Jaipur and Botanical Survey of India (BSI) Jodhpur and other sources.

Presentation of Data

Enumeration of Floristic Diversity

The data of this study have been restricted to the seed plants only. The arrangement of families is done according to the Bentham and Hooker's classification and with the help of relevant flora while the enumeration of genera and species in the families is in alphabetical order (Table 4.1).

During the observation of floristic composition in the present study, some rare, endemic and threatened plants have also been recorded which are enumerated in alphabetical order with local name, family, habit, conservation status, major threats and present status in the study area (Table 4.2). The threatened status of the plant was determined according to IUCN Red List Category Straties and Criteria (1994-2007) and also with the help of using available Red Data book and standard publications (Walter and Gillet, 1998; Rao *et al*., 2003; ENVIS centre on floral diversity, BSI Kolkata, 2016). Rarity of species was determined by field study, visual estimation, literature and herbaria and from discussions with the traditional healers, tribals and the old aged citizens. The categories at extinction risk include: Extinct (EX), Extinct in the Wild (EW), Critically endangered (CR), Endangered (EN), Vulnerable (VU), Rare (R), Near threatened (NT), Least concern (LC) and Not evaluated (NE).

Table 4.1: Enumeration of Floristic Diversity in Beer Jhunjhunu Conservation Reserve

ENUMERATION OF FLORISTIC DIVERSITY						
S. NO.	**BOTANICAL NAME**	**COMMON NAME**	**HABIT**	**HABITAT**	**FLOWERING FRUITING**	**SPECIES NO. AND SPECIFIC LOCATION**
DICOTYLEDON						
1. FAMILY- RANUNCULACEAE						
1	*Ranunculus muricatus* L.	Jal-dhania	Herb	Marshy places	Feb.- May	CM-1316 : 2d
2. FAMILY- ANNONACEAE						
2	*Polyalthia longifolia* Sonn.	Ashok	Tree	Ornamental	Feb.- Aug.	CM-1296 : 4a
3. FAMILY – MENISPERMACEAE						
3	*Cissampelos pareira L.*	Patha	Climber	Open forest	July - Oct.	CM-1512 : 2d,3a
4	*Cocculus hirsutus* (L.)Diels.	Pilwani	Climber	On hedges and bushes	Sept. - April	CM-1520 : 1b,2a,3a,3b,3c
5	*Cocculus pendulus* (Forst.) Diels.	Pilwani	Climber	On hedges and bushes	Oct. - Jan.	CM-120 : 2a,3a,3b,3c
6	*Tinospora cordifolia* (Willd.) Miers.	Giloy	Climber	Common climber	March - June	CM-924 : 2a,2c
4. FAMILY – PAPAVERACEAE						
7	*Argemone mexicana* L.	Satyanasi	Herb	Along roadside, wastelands	Nov. - May	CM-1448 : 1a,1b,4a
8	*Argemone ochroleuca* Sweet	Satyanashi	Herb	Along roadside, wastelands	March-July	CM-48 : 1a,1b,4a
5. FAMILY – FUMARIACEAE						
9	*Fumaria indica* (Haussk.) Pugsley	Pith papro	Herb	Winter weed	Dec. - April	CM-672 : 2d,2e
6. FAMILY – BRASSICACEAE						
10	*Coronopus didymus* (L.) Smith	Pitpapda	Herb	Winter weed	Jan. - April	CM-1088 : 2d,2e

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11	*Farsetia hamiltonii* Royle	Hiran-chhabo, Kag-pilang	Herb	Sandy soil	Throughout year	CM-212 : 2d,3a
12	*Lepidium sativum* L.	Chandrasur	Herb	Winter weed	Jan. - March	CM-272 : 2d,2e
13	*Sisymbrium irio* L.	Aslio	Herb	Weed of shady places	Jan. - Feb.	CM-396 : 2e
7. FAMILY – CAPPARACEAE						
14	*Capparis decidua* (Forsk.) Edgew.	Ker	Tree	Common in forest	Mar. - April	CM-1036 : 2b,2c,3a,3b,3c,4a,4b
15	*Cleome gynandra* L.	Safed hulhul	Herb	Common weed of rainy season	Oct. - Nov.	CM-1064 : 1c,2a,2b
16	*Cleome viscosa* L.	Pili hulhul, Singali	Herb	Open forest and wasteland	July - Oct.	CM-1516 : 2a,2b
8. FAMILY – VIOLACEAE						
17	*Viola cinerea* (Boiss) Beck.		Herb	Hard soil	Sept. - Nov.	CM-1396 : 3b,4b
9. FAMILY – POLYGALACEAE						
18	*Polygala arvensis* Willd.	Jhojhru	Herb	Common in grasses	Aug. - Oct.	CM-348 : 3b,3c
19	*Polygala erioptera* DC.	Jhojhru	Herb	Hard and sandy areas	Aug. - Oct.	CM-804 : 3b,3c
10. FAMILY – CARYOPHYLLACEAE						
20	*Polycarpaea corymbosa* (L.) Lamk.	Jhutanio khad	Herb	Common weed of dry,sandy area	Sept. - Dec.	CM-1748 : 2c,3c
21	*Silene conoidea* L.	Choli-phulya	Herb	Winter weed	June - Sept.	CM-1796 : 2d,2e
22	*Spergula arvensis sensu* Bhandari	Muchmachia	Herb	Winter weed	Nov. - March	CM-1356 : 2d,2e

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23	*Spergularia rubra* (L.)J.Presl & C.Presl	Sandwort	Herb	Near moist places	Jan. - March	CM-1808 : 2e
24	*Stellaria media* (L.) Vill.	Buch-bucha	Herb	Winter weed	Jan. - April	CM-912 : 2e
11. FAMILY – PORTULACACEAE						
25	*Portulaca oleracea* L.	Lunkia	Herb	Common weed	Aug. - Dec.	CM-808 : 2a,2c
26	*Portulaca pilosa* L.	Lunkia	Herb	Common weed	Aug. - Dec.	CM-1304 : 1c,,2c3a
27	*Portulaca quadrifida* L.	Lunkia	Herb	Common in hard soil	Aug. - Dec.	CM-1756 : 3a,3c
12. FAMILY – TAMARICACEAE						
28	*Tamarix aphylla* (L.) Karst.	Farash	Tree	Open forest	Nov. - Feb.	CM-1816 : 1b
13. FAMILY – ELATINACEAE						
29	*Bergia ammannioides* Roxb.	Jal bhangra	Herb	Near ponds	Aug. - Nov.	CM-1016 : 1a,2a,2c
30	*Bergia suffruticosa* (Del.) Fenzl.	Kharbooji, kankerio	Shrub	Marshy places	Oct. - Dec.	CM-1468 : 1a,2c
14. FAMILY – MALVACEAE						
31	*Abutilon bidentatum* Hochst.	Kanghi	Undershrub	Wasteland	Oct. - Nov.	CM-460 : 3a,1b
32	*Abutilon fruticosum* Guill. & Perr.	Imarti	Undershrub	Rare in the locality	Sept. - Jan.	CM-956 : 3c
33	*Abutilon indicum* (L.) Sweet	Kanghi	Undershrub	Wasteland, along roadside	Oct. - Nov.	CM-1408 : 2a,2c,3a,3c
34	*Hibiscus ovalifolius* (Forsk.) Vahl	Dokala	Shrub	Hard soil	Aug. - Nov.	CM-232 : 3b,3c,3d
35	*Hibiscus rosa-sinesis* L.	Gudhal	Shrub	Ornamental	Throughout year	CM-688 : 1a,4a

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36	*Malvastrum coromandelianum* (L.)Garcke	Kharinti. Bhajiti	Herb	Dry wasteland	Aug. - Jan.	CM-1684 :3b,3c
37	*Sida cordata* (Burm. f.) Borss.	Aadiobal	Herb	Shady places in moist area	Throughout year	CM-392 : 1b,2c,2d,3a,4c
38	*Sida cordifolia* L.	Bal, Kharinti	Undershrub	Open forest and wasteland	Sept. - Dec.	CM-892 : 1c,2c,3c
39	*Sida ovata* Forsk.	Bal	Undershrub	Open forest	Oct. - Jan.	CM-1344 : 2d,3a,3b
15. FAMILY – BOMBACACEAE						
40	*Bombax ceiba* L.	Semal	Tree	Planted in the forest	Feb. - March	CM-1024 :1b
16. FAMILY – STERCULIACEAE						
41	*Melhania futteyporensis* Munro ex Mast.	Adbau khapat	Shrub	Open forest	Aug. - Nov.	CM-1240 : 2d
42	*Waltheria indica* L.	Pilo fulaju	Herb	Wastelands	Sept. - Feb.	CM-1848 : 1a,4a
17. FAMILY – TILIACEAE						
43	*Corchorus aestuans* L.	Kagler, kag ki chonch	Herb	Wasteland	Aug. - Dec.	CM-1080 : 1a,,3b,3c,4b
44	*Corchorus capsularis* L.	Patta, Amberi	Herb	Wet habitat	Aug. - Oct.	CM-1532 : 1a
45	*Corchorus depressus* (L.) Chris.	Cham ghas, Kagler, kurand	Herb	Dry and wasteland	Throughout year	CM-132 : 4b,4c
46	*Corchorus fascicularis* Lam.	Chonchi	Herb	Dry sandy areas	Sept. - Nov.	CM-588 : 1a,1b
47	*Corchorus tridens* L.	Kagler	Herb	Common in wasteland	Sept. - Dec.	CM-1084 : 1a,1b,2a,3c
48	*Corchorus trilocularis* L.	Chamghas	Herb	Common in wasteland	Oct. - Nov.	CM-1536 : 1a,1b,2a

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49	*Triumfetta pilosa* Roth	Pahari kagler	Undershrub	Open wastelands	Aug. - Oct.	CM-936 : 2c,3b,3c
50	*Triumfetta rhomboidea* Jacq.	Pahari kagler	Herb	Common in wasteland	Aug. - Oct.	CM-1388 : 2c,3b,3c,4b
18. FAMILY – ZYGOPHYLLACEAE						
51	*Fagonia indica* Burm.f.	Dhamaso	Shrub	Hard sandy soil	Sept. - March	CM-1612 : 3b,3c,4b,4c
52	*Peganum harmala* L.	Harmala,Gandhiya	Herb	Dry soil	March - Oct.	CM-780 : 4b,4c
53	*Tribulus terrestris* L.	Bhankar, chhota gokhru	Herb	Open wastelands	Aug. - Dec.	CM-928 : 1b,1c,2b,2c2d,3d
54	*Zygophyllum simplex* L.	Lunwa	Herb	Sandy and dry places	Sept. - Jan.	CM-456 : 4b,4c
19. FAMILY – OXALIDACEAE						
55	*Oxalis corniculata* L.	Khatari/Khatti buti	Herb	Shady places in moist area	Throughout year	CM-316 : 2a,3b,3c
20. FAMILY – BALSAMINACEAE						
56	*Impatiens balsamina* L.	Timadia	Herb	Moist and damp places	Oct. - March	CM-692 : 2d
21. FAMILY – RUTACEAE						
57	*Aegle marmelos* (L.) Corr.	Bel/Bil patar	Tree	Planted in Ashram	Jan. - July	CM-1420 : 1a,4a
58	*Murraya koenigii* (L.) Spreng.	Meetha neem	Tree	Planted in forest	April - June	CM-1256 :1a
22. FAMILY – SIMAROUBACEAE						
59	*Ailanthus excelsa* Roxb.	Ardu	Tree	Open forest	Dec. - April	CM-1428 : 2d,2e
60	*Balanites aegyptiaca* (L.) Delile	Hingoto	Tree	Open wastelands	Oct.	CM-516 : 2a,2e

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23. FAMILY – MELIACEAE						
61	*Azadirachta indica* A.Juss.	Neem	Tree	Planted in Ashram and roadsides	Mar. - May	CM-1460 : 1a,1b,3d,4a
62	*Melia azadirachta* L.	Bakain	Tree	Wastwland, along roadside	Dec. - May	CM-1692 : 1a,2c
24. FAMILY – CELASTRACEAE						
63	*Maytenus emarginata*(Willd.) Ding-Hou	Kankero	Tree	Near fields as fencing	Oct. - Feb.	CM-1688 : 2c,3d
25. FAMILY – RHAMNACEAE						
64	*Zizyphus mauritiana* Lamk.	Bordi	Tree	Dry wastelands	Sept. - Dec.	CM-452 : 1a,3a,3d
65	*Zizyphus nummularia* (Burm.f.) Wt.	Jhadi bor	Shrub	Wastelands and open forest	Aug. - Dec.	CM-952 : 2e,3d
66	*Zizyphus xylopyrus* Willd.	Gat bor	Tree	Occassionally in open forest	Oct.	CM-1404 : 1a,1b
26. FAMILY – SAPINDACEAE						
67	*Cardiospermum halicacabum* L.	Kapal-phori, Gandiyo	Climber	On hedges and bushes	Aug. - Oct.	CM-1488 : 3c,3d
27. FAMILY – ANACARDIACEAE						
68	*Mangifera indica* L.	Aam	Tree	Planted in the forest	Dec. - May	CM-284 : 1a
28. FAMILY – MORINGACEAE						
69	*Moringa oleifera* Lamk.	Sanjana	Tree	Along roadside	Jan. - June	CM-1252 : 1a,4a

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29. FAMILY – FABACEAE						
70	*Abrus precatorius* L.	Chirmi, Ratti	Climber	Climbing on hedges	Oct. - Nov.	CM-4 : 3c
71	*Acacia catechu* (L.f.) Willd.	Khair	Tree	Open forest	May - Sep.	CM-8 : 1b
72	*Acacia jacquemontii* Benth.	Kinkar	Shrub	Wasteland	Dec. - Feb.	CM-464 : 1b
73	*Acacia leucophloea* (Roxb.) Willd.	Rhonjh	Tree	Open forest	Sep. - Nov.	CM-960 : 3d
74	*Acacia nilotica* (L.)Willd.	Babool	Tree	Open forest	May - Oct.	CM-1412 : 1a,3d
75	*Acacia senegal* (L.)Willd.	Kumta	Tree	Open forest	July - Jan.	CM-12 : 1c
76	*Acacia tortilis* (Forssk.) Hayne	Israeli babul,Umbrella thorn	Tree	Planted along roadsides	April - June	CM-468 : 1a,2a
77	*Albizia lebbeck* (L.) Benth.	Siris	Tree	Open forest and roadsides	June - Aug.	CM-28 : 1a
78	*Albizia procera* (Roxb.) Benth.	White siris	Tree	Planted in forest	March - May	CM-484 : 1b
79	*Alysicarpus monilifer* (L.) DC.	Gumal	Herb	Rainy season weed	Aug. - Oct.	CM-984 : 2d,3b,3c
80	*Alysicarpus tetrangonolobus* Edgew.	Jalpati	Herb	Rainy season weed	Aug. - Oct.	CM-1436 : 2e,3c
81	*Alysicarpus vaginalis* (L.) DC.	Neel	Herb	Rainy season weed	Oct. - Nov.	CM-36 : 2b,2c
82	*Bauhinia racemosa* Lamk.	Jhinjha	Tree	Open forest	May - June	CM-64 : 1a,1b
83	*Bauhinia variegata* (L.) Benth.	Kachnar	Tree	Planted in forest	Jan. - April	CM-520 : 1a,1b
84	*Caesalpinia pulcherrima* (L.) Sw.	Karanju	Tree	Planted in forest	April - Dec.	CM-80 : 4a
85	*Cassia aungustifolia* Vahl	Senna, Sanai, Sonamukhi	Shrub	Wastelands	Aug. - Jan.	CM-544 : 4a
86	*Cassia fistula* L.	Amaltas	Tree	Planted in forest	Feb. - May	CM-1040 : 1a

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87	*Cassia italica* (Mill.) Spreng.	Phunwad	Herb	Wastelands	Aug. - Jan.	CM-1492 : 2d
88	*Cassia occidentalis* L.	Kesudo	Herb	Wastelands	Oct. - Dec.	CM-92 : 1b,4a
89	*Cassia siamea* Lam.	Siyama	Tree	Planted along roadsides	Throughout year	CM-548 : 1b
90	*Cassia tora* L.	Puadia	Herb	Wastelands	Aug. - Nov.	CM-1044 : 4a
91	*Clitoria ternatea* L.	Koyalri	Climber	Ornamental	Aug. - Oct.	CM-572 : 1a
92	*Crotalaria burhia* Buch.-Ham.	Shinio	Undershrub	Dry sandy areas	Aug. - Jan.	CM-1092 : 1b,1c
93	*Crotalaria medicaginea* Lamk.	Gugario	Herb	Occassionally in open forest	Aug. - Dec.	CM-1544 : 3b,3c
94	*Cyamopsis tetragonoloba* (L.)Taub.	Guwar	Herb	Near fields	Sept. - Nov.	CM-608 : 2d,2e
95	*Dalbergia sissoo* Roxb.	Shisham	Tree	Along roadsides	Feb. - May	CM-1124 : 1a,4a
96	*Delonix regia* (Boj.) Raf.	Gulmohar	Tree	Planted in the forest	March - July	CM-632 : 1a
97	*Indigofera caerulea* Roxb.	Neel	Herb	Rare in the locality	Aug. - Nov.	CM-1188 : 2b
98	*Indigofera cordifolia* Heyne ex Roth	Neel	Herb	Dry wastelands	Aug. - Nov.	CM-1640 : 2b
99	*Indigofera hochstetteri* Baker	Aadio-bekario	Herb	Wastelands and roadsides	Aug. - Oct.	CM-240 : 2b
100	*Indigofera linifolia* (L.) Retz.	Lambio-bekario	Herb	Wasteland and open forest	Aug. - Oct.	CM-696 : 2b,3b,3c
101	*Indigofera linnaei* Ali	Bakeria	Herb	Wastelands and roadsides	Aug. - Oct.	CM-1192 : 2b
102	*Indigofera oblongifolia* Forsk.	Goilia or jhil	Shrub	Dry and hard soil	Sep. - March	CM-1644 : 2b
103	*Indigofera tinctoria* L.	Neel	Shrub	Wastelands and open forest	Sept. - Nov.	CM-244 : 2b,2c,3c,4b

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104	*Lathyrus sativus* L.	Khaseri	Herb	Winter weed	Dec. - March	CM-264 : 1b
105	*Leucaena leucocephala* (Lam.) Wit.	Subabool	Tree	Planted near habitation	Feb. - May	CM-1676 : 1a,1b
106	*Medicago sativa* L.	Rijka	Herb	Winter weed	Nov. - June	CM-288 : 2e
107	*Melilotus indicus* (L.)All.	Metho, adak methi	Herb	Common winter weed	Dec. - March	CM-292 : 2d
108	*Mimosa hamata* Willd.	Alai, Bander ki Rakhi	Shrub	Wastelands and open forest	Aug. - Feb.	CM-296 : 3d
109	*Mucuna pruriens* (L.) DC.	Kirmich, Kaunch	Climber	Wastelands and near fields	Aug.- Nov.	CM-304 : 3c
110	*Parkinsonia aculeata* L.	Keshu	Tree	Planted along roadsides	Dec. - June	CM-1720 : 1b,4a
111	*Phaseolus trilobus* L.	Mungi	Climber	Wasteland and open forest	Aug. - Oct.	CM-1284 : 4b
112	*Pithecellobium dulce* (Roxb.) Benth.	Jungle jalebi	Tree	Along roadsides	Nov. - April	CM-1292 : 1b
113	*Prosopis cineraria* (L.) Druce	Khejri, Jaanti	Tree	Dry habitat	Dec. - June	CM-812 : 1a,2c
114	*Prosopis juliflora* (Swartz) DC.	Vilayti Babool, Bavalio	Tree	Dry wastelands	March - July	CM-1308 : 1a,1b,3b,4a,4b
115	*Psoralea odorata* Blatt. & Hallb.	Jhil	Herb	Among bushes and hedges	Nov. - March	CM-1760 : 3c
116	*Rhynchosia aurea* (Willd.)DC.	Batti	Herb	Sandy places	Aug. - Oct.	CM-1768 : 3b
117	*Rhyncosia minima* (L.)DC.	Chiri moth	Climber	Among bushes and shrubs	Aug. - Oct.	CM-368 : 3d,4a
118	*Sesbania bispinosa* (Jacq.)Wight	Ikad	Herb	Near pond, marshy places	Sept. - Nov.	CM-1336 : 3d
119	*Tephrosia falciformis* Ramaswami	Rati biyani	Shrub	Rare in the locality	Aug. - Oct.	CM-1820 : 3c

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120	*Tephrosia purpurea* (L.) Pers.	Bansa	Herb	Wasteland, along roadside	Juiy - Dec.	CM-420 : 2d,3c
121	*Tephrosia strigosa* (Dalz.)Sant.&Mahesh.	Jhino biyono	Herb	Wet and shady places	Aug. - Oct.	CM-920 : 2d
122	*Tephrosia subtriflora* Hochst. ex Baker	Biyano	Herb	Near agricultural fields	Aug. - Nov.	CM-1372 : 2b
123	*Trifolium alexandrinum* L.	Barseem	Herb	Near agricultural fields	Dec. - April	CM-932 : 2d
124	*Trifolium repens* L.	Barseem	Herb	Near agricultural fields	Dec. - April	CM-1384 : 2d
125	*Trigonella hamosa* L.	Chotti methi	Herb	Winter weed	Jan. - March	CM-1836 : 2d,2e
126	*Trigonella monantha* C.A Meyer	Metho	Herb	Winter weed	Feb. - March	CM-436 : 2d
127	*Vigna trilobata* (L.) Verd.	Arkmoth, Jangli moth	Climber	Open wastelands	Sept. - Nov.	CM-944 : 2c
128	*Zornia gibbosa* Span.	–	Herb	Wet and shady places	July - Oct.	CM-1856 : 2b,2c,2d
30. FAMILY – ROSACEAE						
129	*Potentilla supina* L.	–	Herb	Near drying ponds	Jan. - May	CM-356 : 2d
3						
130	*Quisqualis indica* L.	Jhumka bel	Climber	Ornamental	Throughout year	CM-820 : 1a
32. FAMILY – MYRTACEAE						
131	*Eucalyptus camaldulensis* Dehnh.	Safeda	Tree	Along roadside	Dec. - March	CM-1604 :1a
132	*Eugenia jambolana* Lam.	Jamun	Tree	Planted in forest		CM-204 : 1a

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33. FAMILY – LYTHRACEAE						
133	*Ammannia baccifera* L.	Jal Bhangro	Herb	Near pond, marshy places	Aug. - Nov.	CM-992 : 2d,3a
134	*Lawsonia inermis* L.	Mehndi	Shrub	Ornamental	Jan. - April	CM-1668 : 1a,4a
34. FAMILY – CUCURBITACEAE						
135	*Citrullus colocynthis* (L.) Schrad.	Tumba, Indrayan	Herb	Sandy soil	Throughout year	CM-112 : 1b,1c,2d,3c
136	*Citrullus lanatus* (Thunb.)Matsumara & Nakai	Matira	Herb	Sandy soil	Aug. - Nov.	CM-568 : 2d,2e
137	*Coccinia grandis* (L.)J.O. Voigt	Parwal	Climber	Wastelands, along roadside	Throughout year	CM-1068 : 1b,1c,2a,2c,3b
138	*Corallocarpus epigaeus* (Rottl. & Willd.)Hook. f.	Kadwi mirchi ki bel	Climber	Climbing on hedges	Aug. - Nov.	CM-584 : 2d,2e
139	*Ctenolepis cerasiformis* (Stocks) Naud.	Aankh phootni bel	Climber	Among bushes and hedges	Oct. - Feb.	CM-1096 : 1c,2a,3c
140	*Cucumis callosus* (Rottl.)Cogn.	Kachri	Climber	Climbing on field hedges	Aug. - Nov.	CM-1548 : 1b,1c,2c,3b,3c
141	*Cucumis prophetarum* L.	Khat-kachario	Climber	On waste ground or on hedges	Aug. - Jan.	CM-604 : 2d,3c
142	*Cucumis melo* (L.) var. *agrestis* Nanud	Kachari	Herb	Climbing on bushes	Aug. - Jan.	CM-148 : 1b,2e,3c,3d
143	*Dactyliandra welwitschii* Hook.f.	Badi aankh phootni bel	Climber	On bushes and hedges	Aug - Nov.	CM-1572 : 3c
144	*Luffa echinata* Roxb.	Dutar toru	Climber	Wastelands	Aug. - Nov.	CM-280 : 2e,3d
145	*Momordica balsamina* L.	Baad-karelio	Climber	On bushes and hedges	Aug. - Nov.	CM-1700 : 2c,2e,3a,3b,3c

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146	*Momordica charantia* L.	Karelo	Climber	Near fields, on boundaries	July - Nov.	CM-300 : 1b,3d
147	*Momordica dioica* Roxb. ex Willd.	Kakoda	Climber	Edges of fields, wastelands	Sep. - Dec.	CM-756 : 2d,3a,3c
148	*Mukia maderaspatana* (L.) Spreng.	Ankh phutani bel	Climber	On bushes and hedges	Aug. - Nov.	CM-760 : 2d,3a,3b
149	*Trichosanthes anguina* L.	Chachinda	Climber	Climbing on bushes	Aug. - Nov.	CM-1832 : 2c,2d
35. FAMILY – CACTACEAE						
150	*Opuntia elatior* Mill.	Nagphani	Shrub	Sandy and dry places	April - July	CM-1264 : 2d,3c
36. FAMILY – MOLLUGINACEAE						
151	*Gisekia pharnaceoides* L.	Sureli	Herb	Sandy areas	Aug. - Nov.	CM-1168 : 2d,2e,3b,4b
152	*Glinus lotoides* L.	Dholakni	Herb	Near drying pool & ditches	Nov. - March	CM-1620 : 1b,1c,2b
153	*Glinus oppositifolius* (L.) DC.	Dholakni	Herb	Near drying pool & ditches	Throughout year	CM-220 : 1b,1c,2c
154	*Mollugo cerviana* (L.) Ser.	Chirio ghas	Herb	Sandy places	Sept. - Nov.	CM-752 : 1c,2a,2c,2d,3c
155	*Mollugo nudicaulis* Lamk.	Hilro	Herb	Sandy places	Sept. - Nov.	CM-1248 : 2a,2d,I2184b
37. FAMILY – AIZOACEAE						
156	*Sesuvium sesuvioides* (Fenzl.) Verdc.	Lunio	Herb	Moist places	Oct. - Dec.	CM-1788 : 1b,1c
157	*Trianthema portulacastrum* L.	Safed santo	Herb	Wastelands	Aug. - Dec.	CM-1828 : 1a,1b,3a
158	*Trianthema triquetra* Rottl. ex Willd.	Lutanki	Herb	Hard soil	Oct. - Dec.	CM-428 : 1a,1b,3a
159	*Zaleya govindia* (Buch. Ham ex G.Don) Nair	Gudalio satto	Herb	Wasteland	July - Nov.	CM-1852 : 1a,2a,2b

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S. NO.	**BOTANICAL NAME**	**COMMON NAME**	**HABIT**	**HABITAT**	**FLOWERING FRUITING**	**SPECIES NO. AND SPECIFIC LOCATION**
38. FAMILY – RUBIACEAE						
160	*Borreria articularis* (L.f.) Willd.	Agio	Herb	Wastelands	Aug. - Nov.	CM-1476 : 2c,3c
161	*Borreria stricta* (L.f.) K. Schum.	Agio	Herb	Wastelands	Aug. - Dec.	CM-76 : 2a,3c
162	*Oldenlandia corymbosa* L.	Dhankar	Herb	Neglected areas	Sept. - Nov.	CM-1712 : 2a,3c
163	*Oldenlandia pumila (*L. f.) DC.	–	Herb	Moist places	Aug. - Nov.	CM-312 : 2a,3c
164	*Spermacoce hispida* L.	–	Herb	Moist habitat	Aug. - Oct.	CM-408 : 3c,3d
39. FAMILY – ASTERACEAE						
165	*Acanthospermum hispidum* DC.	Kanti	Herb	Wastelands	July - Oct.	CM-1416 : 2d,3a
166	*Ageratum conyzoides* L.	Bhakumar	Herb	Wet and moist soil	Throughout year	CM-976 : 1b,1c,2a,2c,3a
167	*Artemisia meritima* L.	Bana	Shrub	Open forest and wasteland	Aug. - Oct.	CM-1004 : 3b,3c
168	*Artemisia scoparia* Waldst. & Kit.	Bana	Shrub	Open forest and wasteland	Oct. - Feb.	CM-1456 : 3b,3c
169	*Bidens biternata* (Lour.) Merr. & Sherff	Katlo	Herb	Rainy season weed	Aug. - Jan.	CM-68 : 1b,1c,2a
170	*Blainvillea acmella* (L.) Phil.	Kanghi	Herb	Wasteland, moist places	Aug. - Nov.	CM-524 : 2a,3a
171	*Cirsium arvense (*L.) Scop.	Kateli	Herb	Wasteland and hard soil	Jan. - May	CM-564 : 2a,3a
172	*Cirsium wallichii* DC.	Brahm dandi	Herb	Wasteland and hard soil	Feb. - Aug.	CM-1060 : 1a,2a
173	*Conyza aegyptiaca* L.	Kaliziri	Herb	Waselands	June - Oct.	CM-1528 : 1c,2b
174	*Conyza bonariensis* L.	Asthmaweed	Herb	Common weed	July - Oct.	CM-128 : 1b,1c
175	*Cotula australis* L.	Buttonweed	Herb	Near pools	Jan. - March	CM-1540 : 1c,2a

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176	*Dicoma tomentosa* Cass.	Choloharna-charo	Shrub	Dry places and wastelands	Oct. - Dec.	CM-636 : 2d,3b
177	*Echinops echinatus* Roxb.	Unt kantilo	Herb	Wastelands, in dry areas	Dec. - April	CM-188 : 3d,4b
178	*Eclipta alba* (L.)Hassk.	Bhringraj/Bhangra	Herb	Wet & marshy places	Throughout year	CM-644 : 3a,3c
179	*Glossocardia bosvallia* (L.f.) DC.	Patharsua, Chiria chugga	Herb	Gravelly habitat	Oct. - Nov.	CM-676 : 4b,4c
180	*Gnaphalium pulvinatum* Del.	Assi fuledi	Herb	Near drying pool & ditches	Jan. - April	CM-1172 : 2d,3b
181	*Grangea maderaspatana* (L.) Poir.	Mutkhari, gorakh val	Herb	Near drying ponds	Throughout year	CM-224 : 1b,4a
182	*Ifloga spicata* (Forssk.)Sch. Bip.		Herb	Wet sandy soil	Dec. - March	CM-236 : 1b,2b
183	*Lactuca runcinata* DC.	Mooshakaani	Herb	Open wastelands	Throughout year	CM-716 : 1b,2a
184	*Launaea nudicaulis* (L.) Hook.f.	Jangali gobi	Herb	Roadside weed, wastelands	Oct. - March	CM-720 : 1a,1b
185	*Launaea resedifolia* (L.) Kuntze	Phulwalo unt kantelo	Herb	Dry and sandy places	Throughout year	CM-1216 : 2a,2b,3a,3c
186	*Oligochaeta ramosa* (Roxb.) Wagenitz	Brahm buti	Herb	Dry sandy soil	Oct. - March	CM-768 : 2c,2d
187	*Parthenium hysterophorus* L.	Gajar ghas, Congress weed	Herb	Wastelands, along roadside	July - Nov.	CM-320 : 1a,1b,2b,2d,3d
188	*Pulicaria angustifolia* DC.	Soneli	Herb	Wastelands	Sept. - March	CM-360 : 3b,3c

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189	*Pulicaria crispa* (Forsk.) Benth. & Hook.	Dhola lizru	Herb	Moist places	Sept. - March	CM-816 : 3b,3c
190	*Pulicaria wightiana* (DC.) Clarke	Sonfuladi	Herb	Moist and shady places	Aug. - Dec.	CM-1312 : 3b,3c
191	*Sonchus asper* (L.) Hill.	Kalijibi	Herb	Wastelands	Nov. - Jan.	CM-1352 ; 2c,3c
192	*Sonchus brachyotus* DC.	Pili Dudhi	Herb	Wastelands	Nov. - Jan.	CM-1804 : 3b,3c
193	*Sonchus oleraceus* L.	Ankhali	Herb	Winter weed	Dec. - March	CM-404 : 2b,2c,3c
194	*Sphaeranthus indicus* L.	Mundi	Herb	Wastelands	Jan. - March	CM-908 : 2d,3a,3c
195	*Tridax procumbens* L.	Sadabhar runkdi Ghavpatta	Herb	Open places and wastelands	Oct. - Nov.	CM-432 : 3b,3c,3d,4b
196	*Verbesina encelioides* (Cav.) Benth.	Jangli surajmukhi	Undershrub	Wastelands	Oct. - Feb.	CM-940 : 1a,1b,1c,4a,4b
197	*Vernonia cinerea* (L.) Less.	Sahdevi	Herb	Wastelands	Sept. - Nov.	CM-1392 : 2a,2c,2d,3a,3c
198	*Vernonia conyzoides* DC.	Sahdevi	Herb	Wastelands	Nov. - Feb.	CM-1844 : 2b,2d,3c
199	*Xanthium strumarium* L.	Bicchhoo Buti	Herb	Wastelands	Sept. - Dec.	CM-1400 : 1b,1c,2c,3a,3c
40. FAMILY – PRIMULIACEAE						
200	*Anagalis arvensis* L.	Neel	Herb	Winter weed	Dec. - April	CM-1444 : 2d,2e
41. FAMILY – PLUMBAGINACEAE						
201	*Plumbago zeylanica* L.	Chitrak	Undershrub		Oct. - Nov.	CM-1744 : 3b,3c
42. FAMILY – SALVADORACEAE						
202	*Salvadora oleoides* Decne.	Jaal, Pilu	Tree	Throughout the forest	March - June	CM-376 : All sites

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203	*Salvadora persica* L.	Jaal, Pilu	Tree	Dry wasteland	March - June	CM-832 : 2e
43. FAMILY – APOCYANACEAE						
204	*Alstonia scholaris* (L.) R.Br.	Saptparni	Tree	Ornamental	Oct. - March	CM-1432 : 1a
205	*Carissa congesta* Wight	Karounda	Shrub	Planted in the forest	Aug. - Jan.	CM-88 : 1a
206	*Catharanthus roseus* (L.) G. Don	Sadabahar	Herb	Ornamental	Throughout year	CM-1496 : 1a,2b
207	*Nerium indicum* L.	Kaner	Shrub	Planted in the forest	Throughout year	CM-1708 : 4a
208	*Plumeria rubra* L.	Champa	Tree	Planted in the forest	June - Oct.	CM-344 : 1a
209	*Tabernaemontana divaricata* L.	Chandni	Shrub	Ornamental	Throughout year	CM-1364 : 1a
210	*Thevetia peruviana* (Pers.) Merr.	Pili kaner	Shrub	Ornamental	May - Dec.	CM-424 : 1a
44. FAMILY – ASCLEPIADACEAE						
211	*Calotropis gigantea* (L.) R.Br.	Moto Aak	Shrub	Near Ashram	Oct. - July	CM-1032 : 1a,3d
212	*Calotropis procera* R.Br.	Aak	Shrub	Wastelands	Throughout year	CM-1484 : 1a,1b,1c,2a,2b,3a,4a,4b
213	*Ceropegia bulbosa* Roxb.var. *bulbosa*	Khadulo	Climber	Rae in forest among bushes	July - Oct.	CM-1052 : 2d,3d
214	*Ceropegia bulbosa* var. *lushii* (Grah.) Hook. f.	Khadulo	Climber	Rare in forest among bushes	July - Oct.	CM-1504 : 1a,3d
215	*Cryptostegia grandiflora* R.Br.	Rubber-bel	Climber	Wasteland	July - Jan.	CM-600 : 1a,4a

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216	*Leptadenia pyrotechnica* (Forsk.) Decne.	Khimp	Shrub	Dry sandy soil	Aug. - March	CM-728 : 1b,1c,2b,2c,2e,3a,3d
217	*Leptadenia reticulata* (Retz.) Wt.& Arn.	Jeewanti	Climber	Open forest	Throughout year	CM-1224 : 3b,3c
218	*Marsdenia tenacissima* (Roxb.) Moon	Jiti Marua bel	Climber	Wastelands	May - Aug.	CM-740 : 3b,3c
219	*Pentatropis spiralis* (Forsk.) Decne.	Aakari-bel	Climber	Climbing on bushes	Dec. - Feb.	CM-328 : 3b,3c
220	*Pergularia daemia* (Forsk.) Chiov.	Gadaria ki bel	Climber	Wastelands	Aug. - Dec.	CM-1280 : 1b,1c,2a,2c,3a,3c
221	*Sarcostemma viminale* (L.)R.Br.	Khir khimp	Climber	Rare in the locality	Aug. - Nov.	CM-1328 : 3c
222	*Telosma pallida* (Roxb.) Craib	Akde ki bel	Climber	Dry wastelands	Aug. - Dec.	CM-1368 : 3b,3c
223	*Tylophora indica* (Burm. f.) Merr.	Dama ki bel, Antmul	Climber	Shady habitat	May - Nov.	CM-1840 : 1a,3d
45. FAMILY – GENTIANACEAE						
224	*Enicostema hyssopifolium* (Willd.)Verd.	Kutak chirayata	Herb	Open places	June - Dec.	CM-1596 : 3b
225	*Hoppea dichotoma* Willd.	Ramjeeta	Herb	Moist places	Sept.- Dec.	CM-1636 : 3c
46. FAMILY – BORAGINACEAE						
226	*Arnebia hispidissima* (Lehm.) DC.	Ram-bui	Herb	Dry sandy soil, along roadsides	Sep. - March	CM-508 : 2c,2d
227	*Heliotropium marifolium* Retz.	Choti sanatri	Herb	Dry and clayey soil	Throughout year	CM-1176 : 2b,3a,3b
228	*Heliotropium ovalifolium* Forsk.	Kundan, Kharchan	Herb	Near drying ponds	Nov. - April	CM-1628 : 3c

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229	*Heliotropium strigosum* Willd.	Arkali	Herb	Open and dry places	Aug. - Dec.	CM-228 : 3b,3c
230	*Heliotropium subulatum* Hochst. ex DC.	Kali bui, Pilo kharsan	Herb	Open and dry places	Oct. - April	CM-684 : 3a,3b
231	*Heliotropium supinum* L.	Ghedio kharsan	Herb	Near drying ponds	Aug. - March	CM-1180 : 3a,3b,3c
232	*Sericostoma pauciflorum* Stocks	Karbash	Shrub	Sandy areas	Throughout year	CM-1784 : 3c
233	*Trichodesma indica* (L.) R. Br.	Sial kanto, chhota kulpha	Herb	Wastelands	Aug. - Dec.	CM-1380 : 1b,1c,2a
47. FAMILY – EHRETIACEAE						
234	*Cordia dichotoma* Forst. f. Prodr.	Lasora	Tree	Planted in forest	Feb. - June	CM-136 : 1a
235	*Cordia gharaf* (Forsk.) Ehrenb.& Asch.	Goondi	Tree	Planted in forest	Mar. - April	CM-592 : 1a
48. FAMILY – CONVOLVULACEAE						
236	*Argyreia nervosa* (Burm.f.) Boj.	Ghav bel	Climber	Planted in the Ashram	Aug. - March	CM-504 : 1a
237	*Convolvulus arvensis* L.	Hiranpagi	Herb	Wasteland	Dec. - April	CM-124 : 3c,4a
238	*Convolvulus microphyllus* Sieb.ex Spreng.	Santari, Shankhpushpi	Herb	Sandy or gravelly places	Aug. - Dec.	CM-580 : 2b,2c
239	*Convolvulus prostratus* Forssk.	Santari	Herb	Wasteland	Aug. - Dec.	CM-1076 : 2c
240	*Cressa cretica* L.	Rudanti	Herb	Wasteland, saline soil	Nov. - March	CM-140 : 2c
241	*Evolvulus alsinoides* L.	Shankhpushpi, Phooli	Herb	Wasteland	Throughout year	CM-1160 : 1b,2a,2b,3a,3c
242	*Ipomoea pes-caprae* (L.) Sweet	Do patti bel	Climber	Dry sandy soil	Aug. - March	CM-1652 : 1a,1b

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243	*Ipomoea cairica* (L.) Sweet	Panchpatti, Railway creeper	Climber	among bushes and hedges	Throughout year	CM-700 : 1a,2d
244	*Ipomoea dichroa* (Roem. & Schult.) Choisy	Safed panni	Shrub	Dry habitat	Throughout year	CM-1196 : 1a,1b
245	*Ipomoea fistulosa* Mart. ex Choisy	Vilayati aak	Shrub	Wasteland, along roadside	Throughout year	CM-1648 : 2d,2e
246	*Ipomoea hederifolia* L.	Lal pungli	Climber	Wasteland, along roadside	July - Nov.	CM-248 : 1a
247	*Ipomoea indica* (Burm. f.)Merr.	Morning glory	Climber	Wastelands	Aug. - March	CM-704 : 1a,2b
248	*Ipomoea nil* (L.) Roth	Kaladana	Climber	Wastelands	Aug. - Nov.	CM-1200 : 1a,4a
249	*Ipomoea pestigridis* L.	Ghiabati	Climber	Wastelands	Aug. - Dec.	CM-252 : 1a,4c
250	*Ipomoea sindica* Stapf	Rotabel	Climber	Wastelands	Aug. - Nov.	CM-708 : 4c
251	*Merremia aegyptia* (L.) Urban	Rota bel, Ghata bel	Climber	Among bushes and hedges	Sept. - Nov.	CM-748 : 4a,4c
252	*Merremia dissecta* (Jacq.) Hall.f.	Rota bel	Climber	Wasteland	Throughout year	CM-1244 : 4a,4c
49. FAMILY – CASCUTACEAE						
253	*Cuscuta chinensis* Lamk.	Amar-bel	Climber	Parasite on small trees & shrubs	Oct. - Feb.	CM-1552 : 1a
254	*Cuscuta reflexa* Roxb.	Amar-bel	Climber	Parasite on small trees & shrubs	Nov. - Jan.	CM-152 : 1a

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50. FAMILY – SOLANACEAE						
255	*Datura metel* L.	Kala Dhatura	Herb	Near pump station in the locality	Sept. - Jan.	CM-1576 : 3a,3b
256	*Datura stramonium* L.	Dhatura	Herb	In wasteland and along roadside	Sept. - Dec.	CM-176 : 3b,3c
257	*Lycium barbarum* L.	Murali	Shrub	Common in sandy areas	Oct. - Jan.	CM-736 : 1b,3a,3c,3d
258	*Physalis minima* L.	Chirpotan, Pichoo	Herb	Common weed, wasteland	Aug. - Nov.	CM-340 : 1b,1c
259	*Physalis peruviana* L.	Chirpotan, Badi chirpoti	Shrub	Wasteland	Sep. - Nov.	CM-796 : 2a,3c
260	*Solanum elaeagnifolium* Cav.		Shrub	Rarely found in the locality	Aug. - Oct.	CM-896 : 4b
261	*Solanum incanum* L.	Dholi Ringni	Shrub	Wasteland	Sept. - March	CM-1348 : 3a,3c
262	*Solanum indicum* L.	Dhindra	Shrub	Wasteland, along roadside	Sept. - March	CM-1800 : 3b,3c
263	*Solanum nigrum* L.	Makoi	Herb	Open places, forest	Throughout year	CM-400 : 3c,3d
264	*Solanum xanthocarpum* Schrad. & Wendl.	Nili katili, pasarghatali	Herb	Wasteland, along roadside	Throughout year	CM-900 : 3b,3c
265	*Withania somnifera* (L.) Dunal	Ashwagandh	Undershrub	Dry places and wastelands	Throughout year	CM-448 : 2d,2e
51. FAMILY - SCROPHULARIACEAE						
266	*Bacopa monnieri* (L.) Wettst.	Nirbrahmi, Jal buti	Herb	Wet and marshy places	Throughout year	CM-60 : 2a,2b

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267	*Kickxia ramosissima* (Wall.)Janchen	Bhit val, Bhi chatti	Climber	Dry places	Throughout year	CM-260 : 3d
268	*Lindenbergia indica* (L.) Vatke	Patharphod buti	Herb	On walls of Ashram	July - March	CM-1680 : 3c,3d
269	*Peplidium maritimum* (L.f.) Asch.	–	Herb	Near pond	Dec. -April	CM-784 : 3c
270	*Veronica agrestis* L.	–	Herb	Near marshy places	Jan. - March	CM-444 : 3a,3b
52. FAMILY – OROBANCHACEAE						
271	*Orobanche cernua* Loefl.	Margoza	Herb	Parasite on Solanaceae	Dec. - April	CM-1716 : 2d,3e
53. FAMILY – BIGNONIACEAE						
272	*Tecoma stans* (L.) Juss. ex Kunth	Ticoma	Shrub	Ornamental	Throughout year	CM-416 :4a
273	*Tecomella undulata* (Sm.) Seem.	Rohida	Tree	Rare in the locality	Jan. - April	CM-916 :3a,3b
54. FAMILY – PEDALIACEAE						
274	*Pedalium murex* L.	Bara gokhru,Dakhni gokhru	Herb	Wasteland	Aug. - Dec.	CM-324 : 1b,2a3c
275	*Sesamum indicum* L.	Til	Herb	Wild among grasses	Aug. - Nov.	CM-384 : 3a,3c
276	*Sesamum mulayanum* Nair	Jangli til	Herb	Open forest	Aug. - Nov.	CM-840 : 2a,,3a4b
55. FAMILY – MARTYNIACEAE						
277	*Martynia annua* L.	Bagh nakhi, Bichhu kanto	Undershrub	Wasteland and open forest	Aug. - Sept.	CM-1236 : 3a,3b,I3593c
56. FAMILY – ACANTHACEAE						
278	*Adhatoda vasica* Nees	Adusa	Shrub	Open forest and wasteland	Oct.-Mar.	CM-968 : 3c,3d

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279	*Andrographis paniculata* (Burm.f.)Wall	Kalmegh	Herb	Open forest	Sep.- Dec.	CM-44 : 1b,3c
280	*Barleria acanthoides* Vahl	Bajradanti	Undershrub	Open forest	Sep.- Dec.	CM-1012 :1b,1c
281	*Barleria prionitis* L.	Bajradanti	Undershrub	Rare in the locality	Sep.- Dec.	CM-1464 : 3d,4b
282	*Blepharis sindica* T. Anders.	Unt- kantalo	Herb	Sandy habitat	Aug.- Nov.	CM-1020 : 4b,4c
283	*Elytraria acaulis* (L.f.) Lindau	Patthar chatti	Herb	Gravelly habitat	Aug.- Oct.	CM-192 : 3c,3d
284	*Justicia procumbens* L.	Kagner, Makhania ghas	Herb	Wastelands and open places	July- Oct.	CM-1208 : 2a,2c
285	*Justicia simplex* D. Don	Kagner	Herb	Wastelands and open places	Oct. - Nov..	CM-1660 : 2a,2c
286	*Lepidagathis cristata* Willd.	Bukharjadi	Undershrub	Hard soil	Oct. - Jan.	CM-1220 : 3b,4b
287	*Lepidagathis trinervis* Nees	Patharphod buti	Undershrub	Hard soil	Oct. - Jan.	CM-1672 : 3b,4b
288	*Peristrophe bicalyculata* (Retz.)Nees	Kagjangha, Peepal patti	Herb	Along hedges, wasteland	Sep. - Dec.	CM-1732 : 1b,1c,2a,2d
289	*Ruellia patula* Jacq.	Hadjod	Undershrub	Moist and shady places	July- Oct.	CM-1320 : 3b,3c
290	*Rungia repens* (L.) Nees	Ghati - pitpapra	Herb	Near ponds	July - Nov.	CM-828 : 3d,4b
57. FAMILY – VERBENACEAE						
291	*Clerodendrum phlomidis* L.f.	Arni	Shrub	Near settlements	Oct. - Nov.	CM-116 : 3a,3b3c
292	*Lantana camara* L.	Lalten	Shrub	Troublesome weed	Oct. - Dec.	CM-1212 : 1a,1b,1c,4a
293	*Phyla nodiflora* (L.) Greene	Jalbuti	Herb	Near waterbodies	Throughout year	CM-792 : 3a,3c
58. FAMILY – LAMIACEAE						
294	*Leucas aspera* (Willd.) Spreng.	Dargal	Herb	Open forest	Oct. - Nov.	CM-276 : 3c

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S. NO.	**BOTANICAL NAME**	**COMMON NAME**	**HABIT**	**HABITAT**	**FLOWERING FRUITING**	**SPECIES NO. AND SPECIFIC LOCATION**
295	*Leucas cephalotes* (Roth) Spreng.	Kubado dargal	Herb	Wasteland	Oct. - Dec.	CM-732 : 3b,3c
296	*Leucas urticaefolia*(Vahl)R.Br.	Dargal	Herb	Wasteland	Oct. - Nov.	CM-1228 : 3b
297	*Majorana hortensis* Moench.	Marwa	Herb	Wasteland	Aug. - March	CM-1232 : 1a
298	*Ocimum americanum* L.	Bapchi	Herb	Dry places and wastelands	Aug. - Oct.	CM-764 : 2c,3c
299	*Ocimum sanctum* L.	Tulsi	Herb	Planted in Ashram	Aug. - Oct.	CM-1260 : 1a
59. FAMILY – NYCTAGINACEAE						
300	*Boerhavia diffusa* L.	Punarnava, Santi	Herb	Wasteland, roadside	Throughout year	CM-1472 : 1a,2a,2d,3b,3c
301	*Boerhavia elegans* Choisy	Santhi	Herb	Hard soil	Throughout year	CM-72 : 3a,3c
302	*Boerhavia erecta* L.	Santa	Herb	Hard soil		CM-528 : 3b,3c
303	*Bougainvillea glabra* Choisy	Bogan bel	Climber	Ornamental	Throughout year	CM-1028 : 1a,I3894a
60. FAMILY –AMARANTHACEAE						
304	*Achyranthes aspera* L.	Latjira,Andhi Jhara	Undershrub	Wasteland	Sept. - Dec.	CM-16 : 1b,2a,2c,2d
305	*Aerva lanata* (L.) Juss. ex Schult.	Gorakh buti	Herb	Dry open places	Throughout year	CM-476 : 3d,4b
306	*Aerva persica* (Burm.f.) Merrill	Bui	Undershrub	Dry open and disturbed areas	Aug. - Jan.	CM-972 : 2a,2b,2e,3c,3d

ENUMERATION OF FLORISTIC DIVERSITY						
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307	*Aerva pseudotomentosa* Blatt. & Hallb.	Bui	Undershrub	Dry open and disturbed areas	Oct. - Feb.	CM-1424 : 3a,3b
308	*Alternanthera sessilis* (L.) DC.	Bhaji	Herb	Near ponds and marshy places	Throughout year	CM-488 : 2c,2d,3a
309	*Alternanthera bettzickiana* (Reg.) Nicol.	Lal Bhaji	Herb	Near ponds and marshy places	Throughout year	CM-32 : 3a
310	*Amaranthus blitum* L.	Shandalio	Herb	Wasteland and neglected places	Oct. - Nov.	CM-492 : 3b,3c
311	*Amaranthus graecizans* L.	Lal chaulai	Herb	Moist places	July - Sep.	CM-988 : 2c,2d,3c
312	*Amaranthus hybridus* L.	Poncha	Herb	Wasteland and neglected places	Oct. - Nov.	CM-1440 : 1a,2a,2c,3b
313	*Amaranthus spinosus* L.	Kanteli chaulai	Herb	Wasteland and neglected places	Aug. - Nov.	CM-40 : 1a,2c,3a
314	*Amaranthus viridis* L.	Chaulai	Herb	Wasteland and neglected places	Throughout year	CM-496 : 2a,2b,3a
315	*Celosia argentea* L.	Makhmal	Herb	Neglected and abondoned land	Aug. - Nov.	CM-96 : 1a,1b
316	*Celosia spicata* L.	Makhmal	Herb	Ornamental	Aug. - Nov.	CM-552 : 1a,1b
317	*Digera muricata* (L.) Mart.	Lolaru, Ghundro	Herb	Weed of rainy season	Aug. - Dec.	CM-1132 : 1c,2b,3a,3c
318	*Gomphrena celocioides* Mart.	Lehsunia	Herb	Dry and gravelly places	Throughout year	CM-1624 : 2b,3a
319	*Nothosaerva brachiata* (L.) Wight	Bhaji	Herb	Moist places	Oct. - Nov.	CM-308 : 3b,3c
320	*Pupalia lappacea* (L.) Juss.	Chiptio bharut	Herb	Hard soil	Aug. - Jan.	CM-1764 : 3b,3c

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321	*Pupalia orbiculata* (Heyne) Wight	Chiptio bharut	Herb	Moist places	Oct. - Nov.	CM-364 : 1a,3b,3c
61. FAMILY – CHENOPODIACEAE						
322	*Chenopodium album* L.	Bathua, Chilwo	Herb	Common in forest	Oct. - Feb.	CM-104 : 1a,2c
323	*Chenopodium murale* L.	Khartua	Herb	Common in forest	Oct. - Feb.	CM-560 : 1b,1c
324	*Haloxylon salicornicum (*Moq.) Bunge	Lana	Shrub	Saline soil	Aug. - Dec.	CM-680 : 4b,4c
62. FAMILY –POLYGONACEAE						
325	*Calligonum polygonoides* L.	Phog	Shrub	Rare in the locality	April - May	CM-536 : 2e
326	*Emex spinosus* (L.)Campd.	Khato-Palak	Herb	Winter weed	Jan. March	CM-1144 : 2d,2e
327	*Polygonum barbatum* L.	Jalmirchi	Herb	On margins of ditches	Sept. - Jan.	CM-1300 : 3a
328	*Polygonum plebeium* R. Br.	Lal buti, Gulabi	Herb	Near drying ponds	Oct. - March	CM-1752 : 2c,2d,3a
329	*Rumex crispus* L.	Jangali palak	Herb	Moist places	Jan. - April	CM-1772 : 1c,2a
330	*Rumex dentatus* L.	Jangali palak	Herb	Moist places	Jan. - April	CM-372 : 1b,I4191c
63. FAMILY - ARISTOLOCHIACEAE						
331	*Aristolochia bracteolata* Lamk.	Batakhbel, Keeramar	Climber	Wasteland	Sept. - Feb.	CM-52 : 2c,2d
64. FAMILY – EUPHORBIACEAE						
332	*Acalypha indica* L.	Kuppi	Herb	Rainy season weed	Aug. - Oct.	CM-964 : 1b,1c
333	*Croton sparsiflorus* Morong	Kala Bhangra	Herb	Wastelands, along roadsides	May - Sep.	CM-144 : 2b,2c,3a
334	*Emblica officinalis* Gaertn.	Anwla	Tree	Planted in forest	Feb. - May	CM-648 : 1a

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335	*Euphorbia caducifolia* Haines	Danda-thor	Shrub	Hard soil, rare in locality	Jan. - April	CM-660 : 3d
336	*Euphorbia cyathophora* Murray	Laal Patta	Herb	Wasteland,along roadsides	May - Oct.	CM-1156 : 1a
337	*Euphorbia hirta* L.	Lal dudheli	Herb	Wasteland	Throughout year	CM-1608 : 1a
338	*Euphorbia prostrata* Aiton	Dudhi	Herb	Wasteland, near habitation	Throughout year	CM-208 : 2a,2b
339	*Euphorbia thymifolia* L.	Chhoti dudhi	Herb	Disturbed areas, roadsides	Aug. - Dec.	CM-664 :4b
340	*Jatropha gossypifolia* L.	Ratanjot, Jamalghota	Shrub	Roadside weed	Throughout year	CM-256 : 1a
341	*Jatropha curcas* L.	Ratanjot, Jamalghota	Tree	Near villages, wastelands	Throughout year	CM-1656 : 1a
342	*Micrococca mercurialis* (L.) Benth.	Desi badam	Herb	Near ponds	June - Dec.	CM-1696 : 2d
343	*Phyllanthus amarus* Schum. & Th.	Hajardana, Googa janti	Herb	Wastelands	Throughout year	CM-1288 : 1a,1b
344	*Phyllanthus fraternus* Webster	Hajardana, Googa janti	Herb	Wastelands	July - Oct.	CM-1740 : 1a,1b,I4353a
345	*Ricinus communis* L.	Arandi	Small Tree	Wastelands,roadsides		CM-824 : 1a
346	*Securinega leucopyrus* (Willd.) Muell.	Ghatbor	Shrub	Open forest, rare in locality	April - Nov.	CM-836 : 3d

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65. FAMILY – ULMACEAE						
347	*Holoptelea integrifolia* (Roxb.)Planch.	Churel, Papri	Tree	Planted in the forest	Dec. - May	CM-1184 : 4a
66. FAMILY – MORACEAE						
348	*Ficus benghalensis* L.	Bar, Bargad	Tree	Roadside, Ashram	June - Sept.	CM-668 : 1a
349	*Ficus religiosa* L.	Pipal	Tree	Roadside, Ashram	April - June	CM-1164 : 1a
350	*Morus alba* L.	Sehtoot	Tree	Planted in forest	March - June	CM-1704 : 1a,4c
67. FAMILY – CANNABINACEAE						
351	*Cannabis sativa* L.	Bhang	Herb	Damp areas, near Ashram	Jan. - April	CM-540 : 1a
MONOCOTYLEDON						
1. FAMILY –CANNACEAE						
1	*Canna indica* L.	Keli	Herb	Moist places, near ashram	Throughout year	CM-84 : 1a
2. FAMILY – AMARYLLIDACEAE						
2	*Crinum defixum* Ker Gawl.	Sudershan, Jal kand	Herb	Near pools	Aug. - Oct.	CM-596 : 1a,4a
3. FAMILY – HYPOXIDACEAE						
3	*Curculigo orchioides* Gaertn.	Moosli	Herb	Rare in forest among bushes	Aug. - Nov.	CM-1100 : 3b
4. FAMILY – AGAVEACEAE						
4	*Agave americana* L.	Rambans	Undershrub	Grown along boundaries of fields	Feb. - May	CM-24 : 1a,2c

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5	*Agave cantala* Roxb.	Rambans	Undershrub	Boundaries of fields	Feb. - May	CM-480 : 1a,4a
5. FAMILY – LILIACEAE						
6	*Aloe vera* (L.) Burm. f.	Gwarpatha	Herb	Planted in Ashram	Aug. - Oct.	CM-980 : 1a
7	*Asparagus racemosus* Willd.	Satawar	Undershrub	Planted in Ashram	Nov. - Dec.	CM-56 : 1a
8	*Asphodelus tenuifolius* Cav.	Piazi	Herb	Winter weed	Nov. - Feb.	CM-512 : 2d,3e
6. FAMILY –COMMELINACEAE						
9	*Commelina albescens* Hassk.	Moriyabati	Herb	Common in moist places	Aug. - Nov.	CM-576 : 1b,2a,2b
10	*Commelina benghalensis* L.	Moriyabati	Herb	Common in moist places	Aug. - Dec.	CM-1072 : 2c,3a,3c
11	*Commelina forskalaei* Vahl	Moriyabati	Herb	Common in moist places	Aug. - Nov.	CM-1524 : 2a,3a,I4653c
7. FAMILY – ARECACEAE						
12	*Phoenix sylvestris* (L.) Roxb.	Khajur	Tree	Wasteland	Feb. - April	CM-1736 : 1a
8. FAMILY –JUNCACEAE						
13	*Juncus bufonius* L.	Pola	Herb	Wet and marshy places	Feb. - April	CM-712 :1a
9. FAMILY – LEMNACEAE						
14	*Lemna minor* L.	Kumudni	Herb	Ponds and ditches	July - Oct.	CM-268 : 4b
15	*Lemna perpusilla* Torrey	Chaupati	Herb	Pond scums	July - Sep.	CM-724 : 4b
16	*Wolffia microscopica* (Griff.) Kurz	–	Herb	Ponds and ditches	July - Oct.	CM-948 : 4b
10. FAMILY –CYPERACEAE						
17	*Cyperus alulatus* Kern	Motho	Herb	Moist places	Aug. - June	CM-612 : 2a,3a

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18	*Cyperus arenarius* Retz.	Motho	Herb	Sandy soil	Sept. - Dec.	CM-1108 : 2d,3c
19	*Cyperus atkinsonii* Clarke	Moth	Herb	Sandy areas	Sept. - Nov.	CM-1560 : 4b,4c
20	*Cyperus bulbosus* Vahl	Moth	Herb	Waste places	Aug. - Oct.	CM-160 : 3b,3c
21	*Cyperus compressus* L.	Mothio	Herb	Open dry waste places	July - Oct.	CM-616 : 3b,3c
22	*Cyperus conglomeratus* Rottb.	Mandusi	Herb	Moist & dry sandy areas	Sept. - Nov.	CM-1112 : 1b,1c
23	*Cyperus difformis* L.	Dila, Motha	Herb	In ditches & marshes	Oct. - Nov.	CM-1564 : 2b,2d
24	*Cyperus iria* L.	Moth	Herb	In marshes & swamps	Sep. - Dec.	CM-164 : 2b,3a,3b
25	*Cyperus laevigatus* L.	Chikna motha	Herb	In marshy places	Oct. - Dec.	CM-620 : 2b,2c,3a
26	*Cyperus pumilus* L.	Chhoto mothio	Herb	Moist places	Sept. - Nov.	CM-1116 : 3b,3c
27	*Cyperus pygmaeus* Rottb.	Chhotio motho	Herb	In ditches and wet places	July - Sep.	CM-1568 : 3b,3c
28	*Cyperus rotundus* L.	Bada nagarmotha	Herb	In marshes & swamps	Sept. - Dec.	CM-168 : 1a,2b,2c
29	*Cyperus squarrosus* L.	Dadhio motho	Herb	Moist places	Sept. - Nov.	CM-624 : 2c,2d
30	*Cyperus triceps* Rottb.	Musa dudhi	Herb	In gravelly moist soil	Sept. - Dec.	CM-1120 : 2a,3a,3b
31	*Eleocharis atropurpurea* (Retz.) Presl	Purple spikerush	Herb	In marshes & drying pond	Oct. - Nov.	CM-1140 : 2d,3a
32	*Fimbristylis dichotoma* (L.) Vahl	Nidhi mothi	Herb	Wet places	Oct. - Nov.	CM-1616 :3b,3c
33	*Fimbristylis ferruginea* (L.) Vahl	Rusty sedge	Herb	Marshy places	Oct. - Nov.	CM-216 : 3a,I4913b
34	*Scirpus roylei* (Nees) Parker	Morlo	Herb	Near ponds	Sept. - Nov.	CM-1780 : 2b,2d,3c
35	*Scirpus tuberosus* Desf.	–	Herb	Near moist places	Oct. - Jan.	CM-380 : 2b,2c
11. FAMILY –POACEAE						
36	*Acrachne racemosa* (Heyne)Ohwi	Chinki	Herb	Sandy soil	Sept. - Nov.	CM-472 : 2a,2b

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37	*Aeluropus lagopoides* (L.)Trin ex Thw.	–	Herb	Wasteland	Sept. - Dec.	CM-20 : 2d,3a,3b
38	*Andropogon pumilus* Roxb.	Bhanjari	Herb	Sandy soil	Aug. - Nov.	CM-500 : 1b,1c
39	*Apluda mutica* L.	Phulkia	Herb	Near agricultural fields	Sept. - Nov.	CM-996 : 1b,1c
40	*Aristida adscensionis* L.	Lampro	Herb	Dry and gravelly places	Aug. - Oct.	CM-1000 : 3d,4b
41	*Aristida funiculata* Trin. et Rupr.	Lamp	Herb	Open wastelands	Sept. - Nov.	CM-1452 : 2a,3a,3c
42	*Avena sterilis* L.	–	Herb	Escapes near habitation	Aug. - Oct.	CM-1008 : 3d,4a
43	*Bothriochloa pertusa* (L.)A.Camus	–	Herb	Sandy places	Aug. - Oct.	CM-532 : 3b,3c
44	*Brachiaria ramosa* (L.) Stapf	Kuri, Murat	Herb	Wastelands	Aug. - Oct.	CM-1480 : 2c,3a,3c
45	*Cenchrus biflorus* Roxb.	Bhurat	Herb	Common weed after rains	Aug. - Dec.	CM-1048 : 3a,3b,3c
46	*Cenchrus ciliaris* L.	Dhaman	Herb	Common weed after rains	Aug. - Dec.	CM-1500 : 2a,3b,3c
47	*Cenchrus prieurii* (Kunth) Maire	Lambio Bhurant	Herb	Common weed after rains	Sept. - Nov.	CM-100 : 2c,3a
48	*Cenchrus setigerus* Vahl	Dhaman	Herb	Common weed after rains	Aug. - Dec.	CM-556 : 3b,3c
49	*Chloris barbata* Sw.	–	Herb	Sandy areas	Aug. - Dec.	CM-1056 : 2c,2d,3b
50	*Chloris virgata* Sw.	Choto aranio	Herb	Varied habitat	July- Oct.	CM-1508 : 2c,2e,3c
51	*Chrysopogon fulvus* (Spreng.) Chiov.	–	Herb	Sandy places	Aug. - Nov.	CM-108 : 3a,3b
52	*Cymbopogon jwarancusa* (Jones) Schult.	Lemon grass	Herb	Open forest	Aug. - Dec.	CM-1104 : 2d,3a,4b
53	*Cynodon barberi* Rang. & Tad.	Doob	Herb	Open forest	Throughout year	CM-1556 : 1b,2b,3c

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54	*Cynodon dactylon* (L.)Pers.	Doob	Herb	In Ashram and forest chowki	Throughout year	CM-156 : 1a,3a,4a
55	*Dactyloctenium aegyptium* (L.)P.Beauv.	Makro	Herb	Wastelands	Sept. - Jan.	CM-172 : 1a,1b,1c,2a,2b,3a,3b,4b
56	*Dactyloctenium sindicum* Boiss.	Tantia	Herb	Gravelly or sandy places	Sept. - Jan.	CM-628 : 1a,1b,2a,2c,3a,3b
57	*Dendrocalamus strictus* (Roxb.)Nees	Bans	Tree	Planted in forest	Many years nterval	CM-1128 : 1c
58	*Desmostachya bipinnata* (L.)Stapf	Dab	Herb	Near moist places	Oct. - Jan.	CM-1580 : 1a,2e
59	*Dichanthium annulatum* (Forsk.)Stapf	Karad	Herb	Wastelands	Aug. - Dec.	CM-180 : 1b,2a
60	*Digitaria abludens* (Roem. & Schult.)Veldk.	Jherno	Herb	Open forest	July - Sep.	CM-1584 : 2b,2c
61	*Digitaria biformis* Willd.	Jhernio	Herb	Wasteland	July - Nov.	CM-184 : 2b,2c
62	*Digitaria ciliaris* (Retz.)Koeler	Jhernio	Herb	Moist and sandy places	Sept. - Nov.	CM-640 : 1a,2c,2d
63	*Echinochloa colonum* (L.)Link	Jirio	Herb	Near marshy places	Sept. - Nov.	CM-1136 : 2d,2e,3b
64	*Echinochloa crus-galli* (L.) P. Beauv.	Jirio	Herb	Wet and marshy places	Mar. - Aug.	CM-1588 : 2d,3a,4a
65	*Eleusine indica* (L.) Gaertn.	Maduo	Herb	Sandy places	Sept. - Nov.	CM-1592 : 1a,3b
66	*Eragrostis brachyphylla*Stapf	–	Herb	Sandy places	Aug. - Nov.	CM-652 : 3b,4a
67	*Eragrostis ciliaris* (L.) R.Br.	Under punchho	Herb	Moist and sandy places	Oct. - Feb.	CM-1148 : 2a,2b
68	*Eragrostis pilosa* (L.) P.Beauv.	–	Herb	Moist and marshy places	Oct. - Dec.	CM-1600 : 1a,2c

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69	*Eragrostis tenella* (L.)P.Beauv.ex Roem. & Schult.	Kalavo	Herb	Wasteland	Sept. - Dec.	CM-200 : 2c,4a,4b
70	*Eragrostis tremula* (Lam.) Hochst. ex Steud.	Dholpalio	Herb	Wasteland	Aug. - Dec.	CM-656 : 1b,4a
71	*Eriochloa nubica* (Steud.) Hack & Stapf ex Thell.	–	Herb	Moist sandy places	Sept.	CM-1152 : 2a,2b
72	*Heteropogon controtus* (L.)P. Beauv.	Suva ghas	Herb	Wasteland	Sept. - Nov.	CM-1632 : 1a,3a
73	*Ischaemum rugosam* Salisb.	–	Herb	Wet places	Oct. - Nov.	CM-1204 : 3a,3b
74	*Lasiurus sindicus* Henr.	Sewan ghas	Herb	Dry places and wastelands	Throughout year	CM-1664 : 3b,3c
75	*Melanocenchris jacquemontii* Jaub. & Spach.	Vekar	Herb	Gravelly or sandy places	Aug. - Nov.	CM-744 : 3c,4a,4b
76	*Pancium antidotale* Retz.	Garmano	Herb	Sandy areas	Oct. - Dec.	CM-772 : 2a,3a
77	*Panicum turgidum* Forsk.	Muratio grass	Herb	Sandy habitat	July - Nov.	CM-1268 : 1b,2a,3c
78	*Paspalidium flavidum* (Retz.) A. Camus	Sano sau	Herb	Moist places	July - Oct.	CM-776 : 3a,3b
79	*Paspalidium punctatum* (Burm. f.)A. Camus	–	Herb	Marshy places	Aug. - Nov.	CM-1272 : 3a,3c
80	*Paspalum scrobiculatum* L.	Kudro	Herb	Sandy places	Aug. - Oct.	CM-1724 : 3b,3c
81	*Pennisetum americanum* (L.) Leeke	Bajri	Herb	Wasteland	Sept. - Oct.	CM-1276 : 2e,3d,4a
82	*Pennisetum typhoides* (Burm.f.) Stapf	Bajri	Herb	Near agricultural fields	Sept. - Oct.	CM-1728 : 2e,3d,4a

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83	*Perotis hordeiformis* Nees	Lonki-puncho	Herb	Sandy places	Aug. - Oct.	CM-332 : 1b,1c,2c
84	*Phalaris minor* Retz.	Chiria bajra	Herb	Open places	Dec. - March	CM-788 : 2a,2b
85	*Phragmites australis* (Cav.)Trin. ex Steud.	–	Herb	Near ponds	Sept. - Jan.	CM-336 : 2c,2d
86	*Poa annua* L.	–	Herb	Moist shady places	Jan. - March	CM-800 : 2d,3d
87	*Polypogon monspeliensis (*L.) Desf.	Batalio gehun	Herb	Moist places	Dec. - March	CM-352 : 3a,3b
88	*Saccharum bengalense* Retz.	Kuncha	Herb	Sandy areas	Sept. - March	CM-1324 : 3a,3b,3c
89	*Saccharum spontaneum* L.	Dharbi ghas, Kaans	Herb	Moist and marshy places	Oct. - Feb.	CM-1776 : 2e,3d,4a
90	*Sehima nervosum* (Rottl,) Stapf	Searn	Herb	Sandy areas	Sept. - Dec.	CM-1332 : 1a,2a
91	*Setaria glauca* (L.) P. Beauv.	Bandra, Sani bhichdi	Herb	Wasteland	Aug. - Nov.	CM-388 : 2d,2e
92	*Setaria intermedia* Roem. & Schult.	Bandra	Herb	Moist shady places	Aug. - Nov.	CM-844 : 2d,2e,3c
93	*Setaria verticillata* (L.) P. Beauv.	Bandra	Herb	Moist shady places	Aug. - Nov.	CM-1792 : 2e,3d
94	*Setaria italica* (L.) P.Beauv.	Bandra	Herb	Moist shady places	Sept. - Nov.	CM-1340 : 2e,3c,3d
95	*Sorghum halepense* (L.) Pers.	Baru	Herb	Wasteland	Oct. - Jan.	CM-904 : 2d,2e
96	*Sporobolus coromandelianus* (Retz.) Kunth	Khariyo ghas	Herb	Moist places	Aug. - Nov.	CM-1360 : 2d,3a,3b
97	*Sporobolus diander* (Retz.) P.Beauv.	–	Herb	Moist places	Aug. - Nov.	CM-1812 : 1c,3d

ENUMERATION OF FLORISTIC DIVERSITY						
S. NO.	**BOTANICAL NAME**	**COMMON NAME**	**HABIT**	**HABITAT**	**FLOWERING FRUITING**	**SPECIES NO. AND SPECIFIC LOCATION**
98	*Sporobolus helvolus* (Trin.)Th.Dur.et Schinz	Khevai ghas	Herb	Sandy places	Oct. - Nov.	CM-412 : 2d,3b
99	*Tetrapogon tenellus* (Koen. ex Roxb.)Chiov.	–	Herb	Sandy areas	July - Nov.	CM-1824 : 1b,3d
100	*Tragus biflorus* (Roxb.) Schult.	Charchara	Herb	Wasteland, moist places	July - Dec.	CM-1376 : 1a,1b,2a
101	*Urochloa panicoides* P. Beauv.	Kuri	Herb	Wastelands	Aug. - Sept.	CM-440 :2c,2d,I4752e
GYMNOSPERM						
1. FAMILY – GNETACEAE						
1	*Ephedra foliata* Boiss. & Kotschy ex Boiss.	Unt phog	Climber	Climbing on trees and bushes	July - Nov.	CM-196 : 2c,2d,3a

Table 4.2: Rare and Threatened Plants of Beer Jhunjhunu Conservation Reserve

S. No.	Botanical name	Local Name	Family	Habit	Major Threats	Status	Status in the present study
1.	*Acacia catechu* (L.f) Willd.	Khairi	Fabaceae	Tree	Habitat loss	EN – Delhi	LC
2.	*Acacia jacquemontii* Benth.	Bu-banvali	Fabaceae	Shrub	Habitat degradation	NT – Rajasthan	EN
3.	*Abutilon bitdentatum* Hochst.	Kanghi	Malvaceae	Undershrub	Habitat loss	Endemic & EN – Rajasthan	EN
4.	*Abutilon fruticosum* Guill.& Perr.	Imarati	Malvaceae	Undershrub	Habitat loss	Endemic & EN – Rajasthan	EN
5.	*Ailanthus excelsa* Roxb.	Ardu	Simaroubaceae	Tree	Habitat loss	NE – IUCN	LC
6.	*Alternanthera bettzickiana* (Reg.) G.Nichol.	Lali	Amaranthaceae	Herb	Overgrazing	NE- IUCN	NT
7.	*Alysicarpus monilifer* (L.)DC	Leel	Fabaceae	Herb	Overgrazing	Endemic & EN – Rajasthan	EN
8	*Argyreia nervosa* (Burm.f.) Boj.	Ghav-bel	Convolvulaceae	Climber	Habitat loss	Invulnerable-IUCN	EW
9.	*Aristida funiculata* Tri. & Rupr.	Lampi	Poaceae	Herb	Overgrazing	R – Rajasthan	NT
10.	*Albizia procera* (Roxb.)Benth.	Safed siris	Fabaceae	Tree	Habitat loss	NE- IUCN	EX
11.	*Barleria prionitis* L.	Bajradanti	Acanthaceae	Undershrub	Exploited for medicine	EN- Raj.	EN
12.	*Boerhavia erecta* L.	Punarnava	Nyctaginaceae	Herb	Exploited for medicine	NE – IUCN	EN
13.	*Calligonum polygonoides* L.	Phoglo	Polygonaceae	Shrub	Habitat degradation	V- IUCN	CR

S. No.	Botanical name	Local Name	Family	Habit	Major Threats	Status	Status in the present study
14.	*Cenchrus prieurii* (Kunth) Maire	Lambo bharut	Poaceae	Herb	Overgrazing	NE– IUCN	EN
15.	*Ceropegia bulbosa* var. *bulbosa* Roxb.	Khadula	Asclepiadaceae	Climber	Exploited for medicine	V – IUCN EN – Rajasthan	CR
16.	*Ceropegia bulbosa* var. *lushii* (Grahm) Hook.f.	Khadula	Asclepiadaceae	Climber	Exploited for medicine	V – IUCN EN – Rajasthan	CR
17.	*Citrullus colocynthis* (L.)Schard.	Tumba	Cucurbitaceae	Trailing herb	Exploited for medicine	EN – Rajasthan	LC
18.	*Cleome gynandra* var. *nana* (Blatt. & Hallb.) Bhandari	Safed bagro	Capparidaceae	Herb	Habitat loss	Endemic & EN – Rajasthan	LC
19.	*Convolvulus scindicus* Stocks	Kaland	Convolvulaceae	Herb	Overgrazing	EN – Rajasthan	EN
20.	*Cuscuta chinensis* Lamk.	Amar-bel	Cuscutaceae	Climber	Habitat loss	LC – IUCN EN – Delhi	LC
21.	*Enicostemma hyssopifolium* (Willd.)Verdoon	Kutak-rayacho	Gentianaceae	Herb	Exploited for medicine	Invulnerable – IUCN	VU
22.	*Ephedra foliata* Boiss. & Kotschy ex Boiss.	Unt phog	Gnetaceae	Climber	Exploited for medicine	LC – IUCN CR – Rajasthan & Gujarat	LC
23.	*Indigofera caerulea* Roxb.	Neel	Fabaceae	Undershrub	Overgrazing	R – IUCN, Rajasthan & Gujarat	CR
24.	*Ipomoea cairica* Sweet	Rota – beldi	Convolvulaceae	Climber	Habitat loss	EN – Rajasthan	EN
25.	*Lasiurus sindicus* Hxenr.	Sewan	Poaceae	Herb	Overgrazing	EN – Rajasthan	EN

S. No.	Botanical name	Local Name	Family	Habit	Major Threats	Status	Status in the present study
26.	*Leptadenia reticulata* (Retz.) Wt. & Arn.	Jiwanti	Asclepiadaceae	Climber	Habitat loss	NE – IUCN	EN
27.	*Micrococca mercurialis* (L.) Benth.	Desi badam	Euphorbiaceae	Herb	Habitat loss	NE- IUCN	EN
28.	*Peganum harmala* L.	Harmal	Zygophyllaceae	Herb	Exploited for medicine	NE – IUCN	NT
29.	*Ranunculus muricatus* L.	Jal dhania	Ranunculaceae	Herb	Habitat loss	NE – IUCN	EN
30.	*Rhynchosia capitata* (Roth)DC.	Batti	Fabaceae	Trailing herb	Habitat loss	Invulnerable – IUCN	NT
31.	*Salvadora persica* L.	Jal, Pilu	Salvadoraceae	Tree	Exploited for medicine	NE – IUCN	EN
32.	*Sarcostemma viminale* (L.)R. Br.	Khir-khimp	Asclepiadaceae	Shrub	Exploited for medicine	LC- IUCN NT- Rajasthan	EN
33.	*Solanum elaeagnifolium* Cav.	Chandi	Solanaceae	Undershrub	_____	NE-IUCN EN – Gujarat	EN
34.	*Tecomella undulata* (Sm.) Seem.	Rohida	Bignoniaceae	Tree	Exploited for timber	EN -Rajasthan & Gujarat	EN
35.	*Tephrosia falciformis* Ramaswamy	Bansa	Fabaceae	Shrub	Habitat loss	R- IUCN, Rajasthan	EN

Abbreviations: EX- Extinct, EW- Extinct in wild, CR- Critically endangered, EN- Endangered, VU- Vulnerable, NT- Near threatened, LC- Least concern, NE – Not evaluated, R- Rare

RESULTS

The floristic composition of the study area was dominated by angiospems. A total of 453 plant taxa (including variety) belonging to 452 species, 289 genera and 79 families of spermatophytes have been collected from the study area (Table 4.1). Among these dicots and monocots were recorded with 229 and 59 genera respectively. Only one gymnosperm *Ephedra foliata* was recorded from the area. The statistical synopsis of the flora in the study area enumerated in the present work is summarizing in the Table 4.3 and Figure 4.1.

Table 4.3: Statistical Synopsis of Flora in the Study Area

S. No.	Taxonomic groups	Species		Genera		Families	
		No	**%**	**No**	**%**	**No**	**%**
1.	**Angiosperms**						
	Dicotyledons	350	77.43	229	79.24	67	84.81
	Monocotyledons	101	22.35	59	20.41	11	13.93
2.	**Gymnosperm**	01	0.22	01	00.35	01	01.26
Total		**452**	**100**	**289**	**100**	**79**	**100**

It is evident from the study that on the basis of number of species Poaceae and Fabaceae are the largest families among the monocotyledons and dicotyledons respectively. First ten dominant families of the present study are as follows: Poaceae (66 species), Fabaceae (59 species), Asteraceae (36 species), Cyperaceae and Amaranthaceae (18 species each), Convolvulaceae (17 species), Cucurbitaceae and Euphorbiaceae (15 species each), Acanthaceae (13 species) and Asclepiadaceae (12 species).

Herbs were the most dominant plant form in the study area represented by 288 species. It was followed by trees (52 species) climbers (50 species), shrubs (41 species) and undershrubs (22 species) as shown in the Figure 4.2.

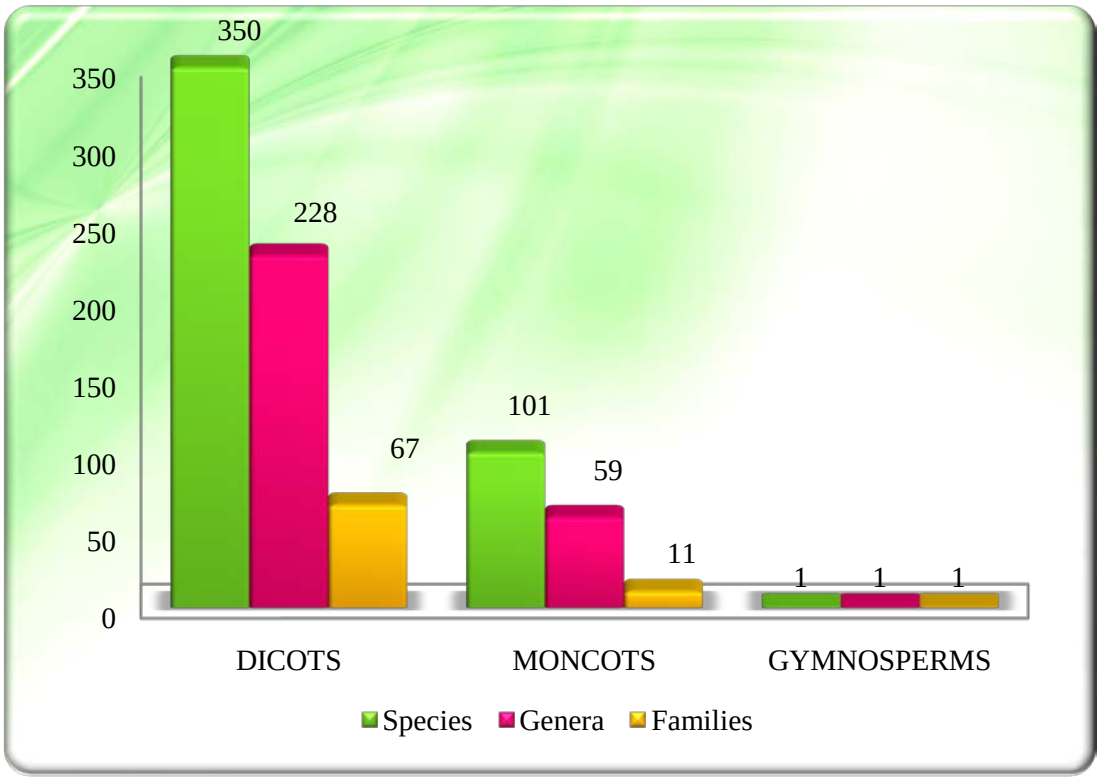


Figure 4.1: Diversity shows with Dicot, Monocot and Gymnosperm

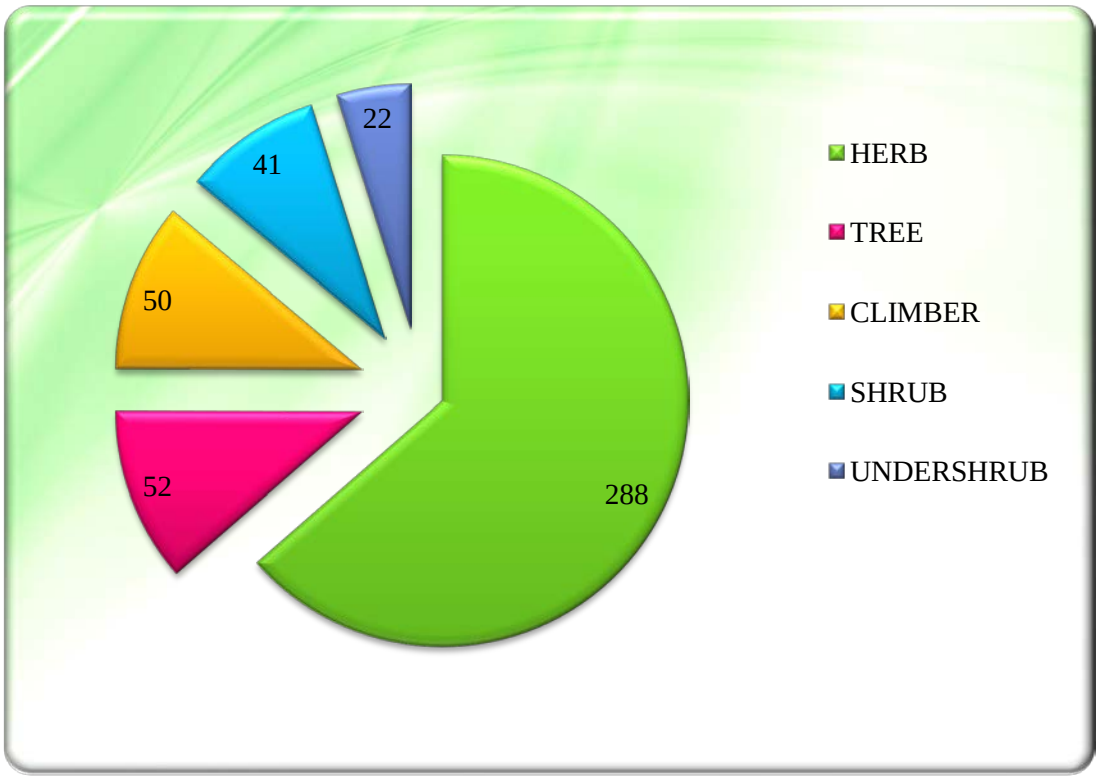


Figure 4.2: Representation of habits in present study

In the present observation, 27 families were represented by only herbs, 6 families were exclusively represented by climbers, while 15 families by only trees and one family represented by shrub only. Three families viz. Fabaceae, Apocyanaceae and Euphorbiaceae were represented by all the habitat form (herb, shrub and trees). Asclepiadaceae, Fabaceae and Menispermaceae were represented by perennial climbers also.

There are 38 monogeneric families, out of which 32 are dicots and 6 are belonging to monocots. 28 families are monotypic. On the basis of number of genera present in the study area, the following families are standing in first ten large families of Angiosperms: Poaceae (43 genera), Fabaceae (31 genera), Asteraceae (26 genera), Cucurbitaceae (10 genera), Acanthaceae (10 genera), Asclepiadaceae (10 genera), Amaranthaceae (9 genera), Euphorbiaceae (9 genera), Apocyanaceae (7 genera) and Convolvulaceae (6 genera).

Among the dicots, the Polypetalae group is the largest and represented by 159 species belonging to 103 genera and 37 families. The families represented by single genus and single species are: Balsaminaceae, Bombacaceae, Cactaceae, Celsatraceae, Combretaceae, Fumaricaceae, Moringaceae, Oxalidaceae, Rosaceae, Sapindaceae, Tamaricaceae, Violaceae and Annonaceae.

The class Gamopetalae finds second place among dicots and is represented by 21 families having 95 genera and 139 species. The families represented by single genus and single species are: Martyniaceae, Orobanchaceae, Plumbaginaceae and Primulaceae.

The class Monochamydae is represented by 52 species belonging to 31 genera and 9 families. It is interesting to note that Monochlamydae is having lowest representation among monocots and dicots. The families represented by single genus and single species are: Aristolochiaceae, Cannabinaceae and Ulmaceae.

In contrast to dicotyledons, monocots are poorly represented in the area. Out of 101 species of 59 genera; 85 species under 47 genera belong to two dominant

families *i.e.* Poaceae (66 species and 43 genera) and Cyperaceae (19 species and 4 genera).

Out of the total 289 genera, 61 are represented by two species each, 18 by three to four species and 11 by 5 or more species each. The genera with 5 or more species are: *Cyperus* (14), *Ipomoea* (9), *Indigofera* (7), *Acacia* (6), *Cassia* (6), *Corchorus* (6), *Amaranthus* (5), *Euphorbia* (5) *Solanum* (5) and *Eragrostis* (5).

Out of the 453 plant taxa documented in floristic analysis, 35 taxa have been reported as rare, endemic and threatened in the present study, which have been also mentioned in the Red Data Book of Indian plants, IUCN list of threatened species, list of BSI Arid Zone Circle, Jodhpur and ENVIS centre on floral diversity, BSI Kolkata. Among these, *Ephedra foliata* was the only gymnosperm and the rest were angiosperms. During the field survey various criteria of IUCN for categorizing threatened plants, *viz*. extent of occurrence, area of occupancy, number of individuals, probability of extinction etc. were measured.

Interesting plant species observed

1. Calligonum polygonoides Linn. (Polygonaceae)

It is a perennial shrub and locally known as Phog. It is slow growing, branching shrub and 1-2m in height with very deep penetrating roots. Stem is modified into phylloclade and leaves are reduced , few or none, linear sublet, flowers are light pink, sweetscented in axillary fascicles, nuts are oblong, densely clothed with reddish brown bristles (Pullaiah,2006). The thick branching stem and roots are used as a fuel due to less smoke and good burning quality. Flower buds are effective in treating sunstroke (Singh *et al*. 1996). These buds are consumed with curd based preparation in the study area. The plant has been quoted in Red Data Book of IUCN as endangered plant species due to its large scale exploitation (Singh, 2004). The old age people reported its wide occurrence in the study area in the past but in the present investigation, it was observed critically rare in the study area (Plate-4.2c).

2. ***Ceropegia bulbosa*** Roxb. (Asclepiadaceae)

Two varieties of *Ceropegia bulbosa* were observed in the study area *i.e. Ceropegia bulbosa* var. *bulbosa* and *Ceropegia bulbosa* var. *lushii*. The former is characterized by broad leaves and later is narrow leaved variety (Cooke, 1958). It is small perennial twining herb with a spherical or oblong turnip like root tuber was observed at few sites of the study area. In recent years, the genus has attracted an attention of several workers due to rarity of its species and recognized importance of conservation of rare plants of the globe. Among different species, *Ceropegia bulbosa* is one of the widely distributed species but still threatened (Yadav and Kamble, 2008). *C. bulbosa* var. *lushii* is considered as endemic (Nayar and Shastry, 1987-1989). The plant is considered as vulnerable in the red data book of IUCN and in the present study also. It was observed at Morchhala and Nahran ki Johdi study sites in the present investigation. It has high medicinal importance in the present study area. Tubers are edible and eaten by herders and local communities. Rural ladies used them to promote fertility and vitality. Leaves and tubers are eaten orally to get rid of urinary bladder stones (Plate 4.1a & 4.2 d).

3. ***Enicostemma hyssopifolium*** (Willd.) Verd. (Gentianaceae)

It is very useful medicinal herb which has been in regular demand amongst practitioners of medicines. It is an erect glabrous herb, branching from the base with quadrangular stems, sessile, linear oblong 3-nerved leaves, white small flowers in axillary clusters and an ellipsoidal capsule containing many globose seeds. The plant is used as a substitute for ‘Chirayata’ and locally known as “Kutakrayacho”. It has a lot of medicinal value in the study area. Local people exploit it to cure fever, joint pain and diabetes. It is observed occasionally in the Beer area (Plate 4.1 b).

4. ***Ephedra foliata*** Boiss. ex C.A. Mey (Gnetaceae)

Only gymnosperm in the Thar desert, is an evergreen perennial woody evergreen climber. In India, it is distributed in drier parts of Punjab, Haryana and Rajasthan. It is abundant in the study area climbing on *Salvadora oleoides* and *Capparis decidua.* It is a well known medicinal plant and used to treat allergies, bronchial asthma, cold, cough and fever. It is a source of alkaloids such as ephedrine

and pseudoephedrine. It was reported as critically rare in the list of endangered plants of state Rajasthan (Plate 4.1e).

5. ***Leptadenia reticulata*** R.Br. (Asclepiadaceae)

Leptadenia reticulata is known as Jiwanti means that the plant is considered to have the capacity of bestowing good health as well as vigour in a person. It is a much branched twining shrub with yellowish deeply cracked bark.

Jiwanti (*L. reticulata*) is an important medicinal plant used in Ayurveda. The mention of jivanti is even found in Athrva Veda. It promotes vitality and life. Jiwanti is considered a stimulant and tonic in Ayurvedic literature. It is described as an herb with sweet, cold, aphrodisiac, light to digest and rejuvenile properties. It enhances life vigour and fertility (Plate 4.1c).

6. ***Peganum harmala*** Linn. (Zygophyllaceae)

It is a branched, perennial shrub restricted on the margin of saline water bodies or on calcareous soil. Stem is dichotomously branched and sulcate. Leaves are divided into several narrow segments up to 5-8 cm long. Flower appears single from the axil of the leaves and white in colour. Fruit is a globose capsule with many angled seeed. Local rural and tribal people used it in the treatment of jaundice and rheumatism. Smoke of whole plant relieves toothache and also in asthma. They used its powdered roots mixed in mustard oil to kill lice in hair. Plants kept in house to repel mosquitoes. It was observed behind the Forest Chowki restricted to Khadans in the study area (Plate-4.1d).

7. ***Sarcostemma viminale*** Linn. (Asclepiadaceae)

The plant is almost leafless, straggling shrub with many branches and an important medicinal plant known as ‘Khirkhimp’ in the study area.

‘Sarco’ is a Greek word meaning fleshy, while ‘Stemma’ refers to the fleshy inner corona. The caustic vine is the common name referring to the burning power of released latex. It has rich medicinal value and infusion of whole plant is applied by the rural lpeople on wound of snake bite. Plant paste is also applied externally to cure fractured bones. Plant extract is given in digestive disorders.

This plant is typically endangered in the study area and needs most care and conservation (Plate-4.2j).

8. ***Solanum elaeagnifolium*** Cav. (Solanaceae)

A new plant species *Solanum elaeagnifolium* is recorded at the site 'Patharla' of the study area. However, this plant species has never been explored before in the study area and even not mentioned in any of the flora of Rajasthan.

It is a multi stemmed broad leaved herbaceous and woody perennial, growing up to 1m tall. Leaves are dark to pale greyish, petiolate with undulating margins. Leaves, stem and calyx are highly pubscent, giving the plant its typical silver green appearance. Yellow to brown prickles usually occur on the stem and also on the main veins of the leaves. Flowers are bright blue to purple. The fruit is an irregularly dehiscent berry, initially spherical green and fleshy, drying and becoming yellow to orange at maturity.

It has been unintentionally introduced new weed in the study area and considered as one of the most invasive plants worldwide (Plate 4.1f).

DISCUSSION

Biodiversity refers to the variety of life on earth. It is essential for human survival and economic well being and for the ecosystem function and stability (Naeem *et al*., 2016). Loss of biodiversity may trigger large unpredictable change in an ecosystem. Increasing requirements of the human population, agriculture and spread of invasive species poses severe threats to Earth's life supporting system. Increasingly, protected areas (PAs) are expected to serve dual goals as to protect biodiversity and secure ecosystem services.

Protected areas are designated with the objective of conserving biodiversity. The conservation of species in their natural environment i.e. *in-situ* conservation is considered the most appropriate way of conserving the biodiversity. *In-situ* conservation includes biosphere reserves, national parks, wildlife sanctuaries, conservation reserves and community reserves. Conservation reserves are the planned and scientific management of natural resources of a particular area to retain

the natural balance, diversity and evolutionary change in the environment. The major aim of conservation reserves are protection of existing forests and restoration of the degraded forests in ecological sensitive areas.

Vegetation of the area

General:

Beer Jhunjhunu Conservation Reserve is situated near the Jhunjhunu city and considered as the "lungs of Jhunjhunu city". The vegetation of conservation reserve is xerophytic and Mixed xeromorphic woodland type. Most of the area of investigation comes under the semi-arid climate. Consequently, it is characterized by sandy plain and sand-dunes. The bulk of vegetation is a mix of non-spiny evergreen species and spiny species consists of stunted, thorny or prickly shrubs and perennial herbs capable of drought resistance. Permanent vegetation of the entire area is xerophytic in characters like deep root system, dry hard stem, well developed spines and leaves either absent or reduced.The area is characterized by lush-green vegetation during rainy season and occupied by the different floristic elements (Plate 4.3-4.7).

Salvadora oleoides-Capparis decidua forms the dominant community of the area.The other common trees are *Salvadora persica, Acacia senegal, A. nilotica, A. catechu, A. leucophloea*, *Zizyphus mauritiana, Maytenus emarginata*, *Balanites aegyptiaca, Albizia lebbeck, Dalbergia sissoo, Ficus benghalensis, Ficus religiosa*, *Prosopis cineraria*, *Bauhinia racemosa, Holoptelia integrifolia, Pongamia pinnata*, *Tecomella undulata*, *Azadirachta indica* and *Cordia dichotoma*.

Species composition of the study area at shrub and ground layer is common as in other semiarid part of Rajasthan. The common shrub species included: *Calotropis procera, Mimosa hamata, Zizyphus nummularia, Capparis decidua, Nerium indicum, Thevetia peruviana, Securinega leucopyrus, Lawsonia inermis*, *Hibiscus ovalifolius* and *Lycium barbarum*. In addition, undershrubs and herbs like *Crotalaria burhia, C. medicaginea, Leptadenia pyrotechnica, Tephrosia purpurea*, *Aerva persica, A. pseudotomentosa, Clerodendrum phlomidis, Indigofera cordifolia*, *Farsetia hamiltonii, Heliotropium strigosum, Abutilon indicum, Artemisia scoparia*,

Sida cordifolia, Alysicarpus tetragonolobus, Celosia argentea and *Ipomoea sindica* are also common.

After careful observation of habitat, it was interesting to note that some plants in the Beer region, particularly in the south segment, showed resemblance with hilly tract vegetation. These are: *Hibiscus ovalifolius*, *Barleria prionitis*, *B. acanthoides*, *Lindenbergia indica*, *Triumfetta rhomboidea*, *Ruellia patula*, *Lepidagathis bandraensis*, *L. trinervis*, *Rhynchosia minima*, *Ceropegia bulbosa*, *Sarcostemma viminale* and *Securinega leucopyrus* were found. It may be due to the influence of presence of offshoots of Aravalli hills in the south-eastern part of the district. The study area was also surrounded by few hillocks such as Moda Pahar, Kana Pahar, Mansa Mata Pahari located around the study area.

Climbers and Lianas

Most of the tree and shrub species like *Salvadora oleoides*, *Capparis decidua* and *Zizyphus nummularia* are often covered with a large number of climbers and ramblers in the Beerarea. The most common climbers and lianas found in the area are: *Coccinia grandis*, *Ephedra foliata*, *Leptadenia reticulata*, *Pentatropis spiralis*, *Telosma pallida*, *Aristolochia bracteolata*, *Cocculus pendulus*, *C. hirsutus*, *Momordica balsamina*, *M. dioca*, *Mukia medarspatana*, *Ctenolepis cerasiformis*, *Ipomoea pes-tigridis*, *Tylophora indica*, *Rhynchosia minima*, *Sarcostemma viminale*, *Abrus precatorius* and *Convolvulus auricomus*.

Grasses in study area

During rainy season the whole forest area of Beer exhibits excellent greenery due to glorious appearance of eyesoothing green carpet vegetation. The common grasses of the area are: *Aristida adscensionis*, *A. funiculata*, *Cenchrus biflorus*, *C. ciliaris*, *C. prieurii*, *Chloris virgata*, *Dactyloctenium aegyptium*, *D. sindicum*, *Dichanthium annulatum*, *Melanocenchris jacquemontii*, *Echinochloa colonum*, *Eluesine indica*, *Eragrostis ciliaris*, *E. tenella*, *Heteropogon contortus*, *Panicum turgidum*, *Perotis hordeiformis*, *Sehima nervosum*, *Setaria viridis*, *Sporobolus helvolus*, *Tragus biflorus* and *Urochloa panicoides*.

Naturalized Flora

These are exotic species which have naturalized outside their natural zone of distribution.

Most of the non-indigenous plants occurring in the area originate in the America and Africa. The American plants naturalized in this region are *Amaranthus hybridus*, *Datura innoxia*, *Croton bonplandianum*, *Gomphrena celosioides*, *Lantana camara*, *Martynia annua*, *Conyza bonariensis*, *Argemone ochroleuca*, *Opuntia elatior*, *Prosopis juliflora*, *Pithecellobium dulce*, *Physalis minima* and *Verbesina encelioides* among others.

Some of the plants introduced from Africa are *Cryptostegia grandiflora*, *Ricinus communis*, *Citrullus* and *Eragrostis curvula*. All exotic plants have not been completely naturalized, while *Prosopis juliflora*, *Ricinus communis* and *Argemone mexicana* form a prominent part of the flora.

In waterlogged area near the Ashram, the native vegetation has been replaced by exotic species like *Prosopis juliflora*, *Parthenium hesterophorus* and *Lantana camara*. Plant in wetland sites are mainly *Ipomoea carnea*, *Cyperus difformis*, *C. rotundus*, *Fimbristylis ferruginea*, *Bacopa monnieri*, *Sphaeranthus indicus*, *Polygonum plebeium*, *Glinus lotoides*, *Grangea maderspatana*, *Chenopodium album* and *C. murale*.

The present work enumerates 453 plants belonging to 452 species, 289 genera and 79 families of spermatophytes. All the families represented in the study area with their respective genera and species listed in alphabetical order is given in Table 4.1. It is clear from the table that the ratio of total number of genera to species is 1:1.57, which is very low as against 1:7 for the whole of India (Hooker, 1908), but is more or less in conformity with this ratio for the Gangetic plain region (1:2.2) by Hooker (1907), that of Delhi State (1:1.63) by Maheshwari (1963), Western Rajasthan (1:1.9) by Bhandari (1978) and North Eastern Rajasthan (1:1.8) as reported by Sharma and Tiagi (1979). It is also interesting to note from the Table 4.3 that the percentage occurrence of the genera (79.24) and species (77.43) of

Dicotyledons is more and less identical. This similarity is also evident in Monocotyledonous genera (20.48) and species (22.35).

In present investigation, the ratio of families of Monocotyledons and Dicotyledons is 1:6.1, of genera 1:1.39 and of species 1:1.3; which is more or less similar to that of Indian Desert (Western Rajasthan), where Bhandari (1978) reported this ratio 1:6.7 of families, 1:3 of genera and 1:2.7 of species.

Table No. 4.4 shows a comparison of ten dominant families in Indus Plain region (Hooker, 1907), Delhi (Maheshwari, 1963), West Rajasthan (Bhandari, 1978), Rajasthan (Shetty and Singh, 1993), Sharma (2002) and present work, given in order of the frequency of the species. There is a general resemblance of the Flora of this area as far as the ten dominant families are concerned, although the frequency of species amongst these ten families varies in different areas. However, Poaceae and Fabaceae occupy the foremost place in all these regions. Families Asteraceae and Cyperaceae take up the next position.

In the present study, family Poaceae occupies the top position followed by Fabaceae, Asteraceae, Cyperaceae, Amaranthaceae, Convolvulaceae, Cucurbitaceae, Euphorbiaceae, Acanthaceae and Asclepiadaceae from third to tenth positions respectively. It is more or less similar to that of Flora of the Indian Desert (Bhandari, 1978). The family Convolvulaceae occupied 5^{th} position in the Western Rajasthan, while it stands on 6^{th} position in the present study. A comparative statement of dominant families of present study and Flora of the Indian Desert (Bhandari, 1978) has been given in Figure 4.3.

Table 4.4: A Comparative Statement of First Ten Dominant Families of India, Rajasthan and Present Study.

Indus plains Region (Hooker, 1907)	**India Hooker (1908)**	**Delhi Maheshwari (1963)**	**The Flora of Indian Desert Bhandari (1978)**	**Flora of Raj Shethy & Singh (1993)**	**Flora of Rajasthan Sharma(2002)**	**Present work**
1. Poaceae	Orchidaceae	Poaceae	Poaceae 111	Poaceae 296	Poaceae 160	Poaceae 66
2. Leguminosae	(Fabaceae)	Fabaceae	Fabaceae 95	Fabaceae 230	Fabaceae 156	Fabaceae 59
3. Asteraceae	Poaceae	Asteraceae	Asteraceae 41	Asteraceae 125	Asteraceae 77	Asteraceae 35
4. Cyperaceae	Rubiaceae	Cyperaceae	Cyperaceae 36	Cyperaceae 100	Cyperaceae 55	Cyperaceae 19
5. Scrophulariaceae	Euphorbiaceae	Acanthaceae	Convolvulaceae 35	Acanthaceae 85	Euphorbiaceae 45	Amaranthanceae 18
6. Lamiaceae	Acanthaceae	Euphorbiaceae	Malvaceae 28	Euphorbiaceae 59	Malvaceae 40 & Acanthaceae 39	Convolvulaceae 17
7. Boraginaceae	Asteraceae	Convolvulaceae	Euphorbiaceae 23	Convolvulaceae 58	Convolvulaceae 31 & Scrophulariaceae 31	Cucurbitaceae 15
8. Malvaceae	Cyperaceae	Malvaceae	Acanthaceae 22	Scrophulariaceae 54	Cucurbitaceae 25	Euphorbiaceae 14
9. Euphorbiceae	Lamiaceae	Amaranthaceae	Cucurbitaceae 19	Malvaceae 53	Rubiaceae 23	Acanthaceae 13
10. Convolvulaceae	Urticaceae	Scrophulariaceae	Amaranthaceae 18	Lamiaceae 43	Lamiaceae 20	Aselepiadaceae 12

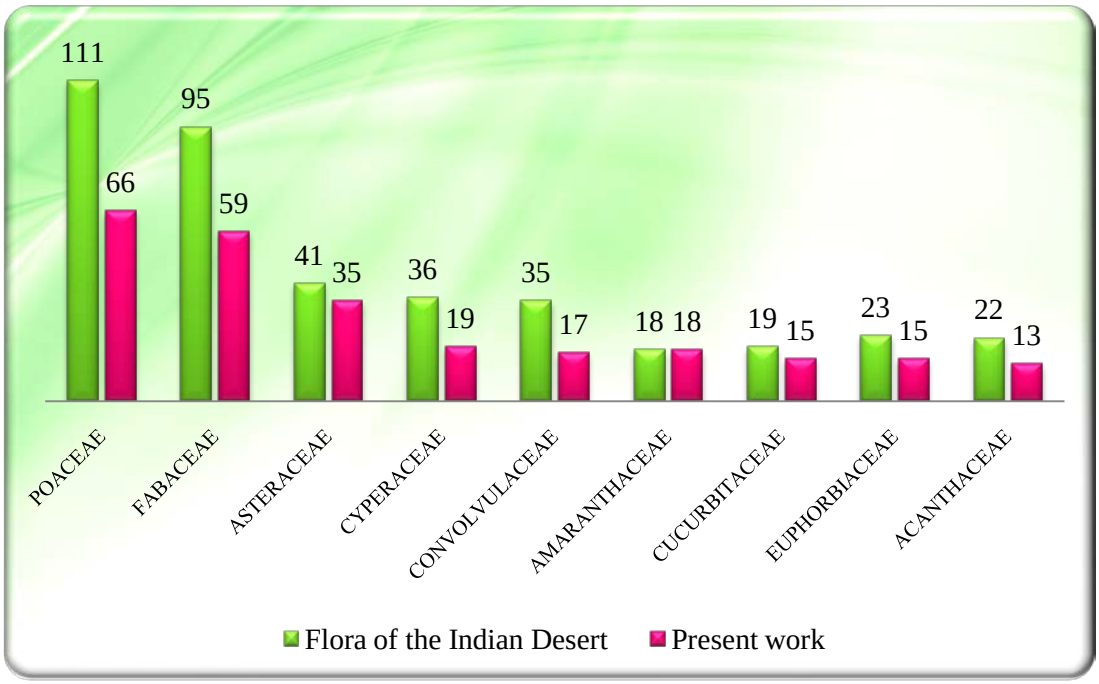


Fig. 4.3: Comparative statement of large families of "Flora of the Indian Desert" and Present work.

Rare and endangered plants of study area

All forests are islands of biodiversity protecting a good number of plant and animal species including some rare, endemic and threatened one. An extensive survey of the Beer protected forest area reveals that the area is luxuriant in vegetation and enriched with many medicinal, rare, endemic, endangered and threatened categories of plants. Many plants, which have been included in the Red Data Book of Indian Plants, CITES , IUCN Red list of threatened species and list of BSI Arid Zone Circle, Jodhpur and several other records from the country were observed in the present study.

According to IUCN an endangered species is a population of organism which is at risk of becoming extinct because it is either few in numbers or threatened by changing environmental or predation parameters, leaving it at risk of becoming extinct. 'Threatened species' is a related term, referring to a species likely to become endangered within the near future. The criteria for categorization of threatened species were based on the IUCN.

Critical studies of endangered species of the area reveal that 35 taxa of vascular plants belonging to 32 genera and 21 families have been marked as rare and threatened plants of the area. These plants were commonly found in the forest and various localities of the area previously, thus become rare due to the meager presence or on now the verge of disappearance (Plate-4.2).

On the basis of keen observation, it is noted that out of the total rare and threatened taxa of Beer Jhunjhunu Conservation Reserve, one species is of gymnosperm belonging to family Gnetaceae and rest are angiosperms. Dicots are represented by 30 species belonging to 28 genera and 19 families, while Monocots are having representation of 3 species belonging to 3 genera and only one family. Fabaceae is having highest representation of endangered taxa with 7 species not surprisingly; the largest families also contain the largest number of threatened species, while Asclepiadaceae, Poaceae and Convolvulaceae have representation of 3 species each.

During the study, occurrence of some rare plants like *Calligonum polygonoides, Indigofera caerulea* and *Tecomella undulata* were recorded at a few sites. However, the local people reported their wide occurrence in the area quite some time ago. It is an alarming situation where threatened taxa require more and more attention for preserving their genetic diversity. Special protective measures are needed to ensure their long term survival in the area.

The present investigation revealed that climbers like *Leptadenia reticulata, Sarcostemma viminale, Ipomoea cairica, Convolvulus scindicus, Ceropegia bulbosa* var. *bulbosa* and *C. bulbosa* var. *lushii* were recorded critically endangered in the study area. Among these *Ceropegia bulbosa* is particularly vulnerable owing to its edible tubers, which is often eaten by herders and local communities. During the study it was noted that plant species like *Albizia procera, Enicostemma hyssopifolium, Barleria prionitis, Tephrosia falciformis* and *Melhania futteyporensis* were drastically reduced population in the area.

As a result of exhaustive field surveys and plant exploration trips, endemic species *Indigofera caerulea, Abutilon bidentatum* and *A. fruticosum* were recorded from the study area. Endemic and rare taxa of an area are more vulnerable than widespread species because they occupy small geographic ranges and specific habitats. These species deserve immediate attention for their conservation. In addition to this, a new species *Solanum elaeagnifolium* has also been recorded from the locality known as Patharla during the exploration in the study area. A recent report about the occurrence of this species is rather interesting since hitherto, this species was not reported earlier from Rajasthan (Tiwari *et al*., 2016).

The endangered situation of herbs and grasses may be attributed to the overgrazing and trampling of these plants by bovine animals. It was observed in the present study that trampling by hooves of animals were more damaging than mouths especially when stocks were concentrated around watering points. Vegetation and some species which were more sensitive than others, quickly disappear to leave a sparse cover of hardier and usually less palatable plants. Thus, the proportion of bare ground increases rapidly.

The impact of overgrazing was more pronounced on the trees and shrubs browsed upon by animals. It was observed that browsing combined with looping effects on common top feed species such as *Zizyphus nummularia, Salvadora oleoides* which assume‘bush form’ whereas *Prosopis cineraria* become ‘pillow cushion’ form.

Extensive botanical exploration at various sites of Beer area and information collected from local people and forest department officials revealed that maximum numbers of woody plants were exploited for fuel requirements. However, threatening of *Tecomella undulata* may be attributed to its exploitation for timber.

In the last few decades over-exploitation of forest resources has led to species loss. As a result, 20-25% of existing plant species in India has become endangered. Medicinal plants are now under great pressure due to their exploitation. *Enicostemma hyssopifolium, Ceropegia bulbosa, Sarcostemma viminale, Barleria*

prionitis, Withania somnifera were widely used in medicines by rural and tribal people of the study area.

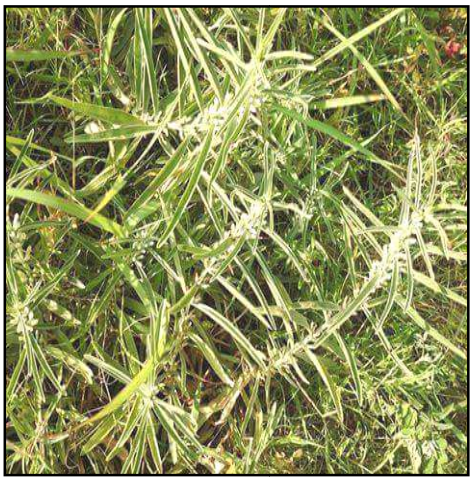
After extensive botanical explorations at various sites of Beer forest area, it was observed that several plants eg. *Tephrosia falciformis, Tecomella undulata, Convolvulus scindicus, Ceropegia bulbosa* etc. which are reported as threatened from the sandy habitat of Thar desert (Pandey et al., 1983; Bhandari, 1990) were present but struggling hard for survival in study area.

Plant species like *Ephedra foliata, Acacia catechu, Citrullus colocynthis* and *Cleome gynandra* considered as threatened in Red data categories, were found abundantly in the study area. It showed that Beer Jhunjhunu Conservation Reserve harbours a large number of endangered and rare plants. However, the region is subjected to enormous anthropogenic pressure such as habitat fragmentation, illegal harvesting, over exploitation of economically important plants, encroachment by nearby community, pollution due to sewage and solid waste dumping, alien species invasion, unchecked grazing, deforestation and unplanned developmental activities (Plate 4.8).

Conservation efforts in such areas cannot be achieved without involvement of the local communities, who are directly dependent on these resources for their livelihood. There is an urgent need for developing programmatic conservation strategies for rare, threatened and endemic plants in Beer Jhunjhunuarea, which may lead to their effective protection. Conservation of the species in natural habitat and artificial regeneration would be the best opinion to recover the species from near extinction. National parks, botanical gardens, wildlife sanctuaries and conservation reserves are essential efforts to conserve the rare and threatened species. They can play a vital role in *ex-situ* and *in-situ* conservation of the threatened plants.

PLATE 4.1: INTERESTING PLANT SPECIES OF THE STUDY AREA

(a) *Ceropegia bulbosa* Roxb.var. *bulbosa*



(b) *Enicostemma hyssopifolium* (Willd.)Verd.

(c) *Leptadenia reticulata* (Retz.) Wt. & Arn.

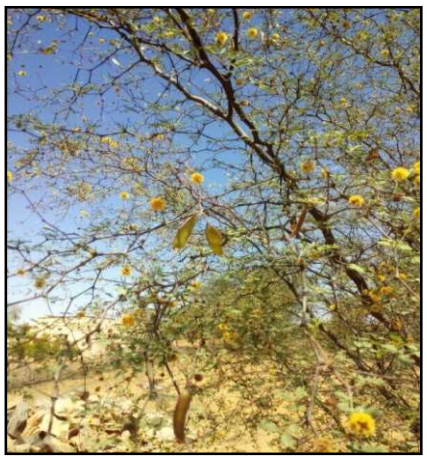
(d) *Peganum harmala* L.

(e) *Ephedra foliata* Boiss. & Kotschy ex Boiss

(f) *Solanum elaeagnifolium* Cav.

PLATE 4.2: RARE AND THREATENED PLANTS OF THE STUDY AREA

(a) *Abutilon fruticosum* Guill. & Perr.



(b) *Acacia jacquemontii* Benth.

(c) *Calligonum polygonoides* L.

(d) *Ceropegia bulbosa* var. *lushii* (Grah.) Hook. f.

(e) *Citrullus colocynthis* (L.) Schrad.

(f) *Cuscuta chinensis* Lamk.

(g) *Lasiurus sindicus* Henr.

(h) *Micrococca mercurialis* (L.) Benth.

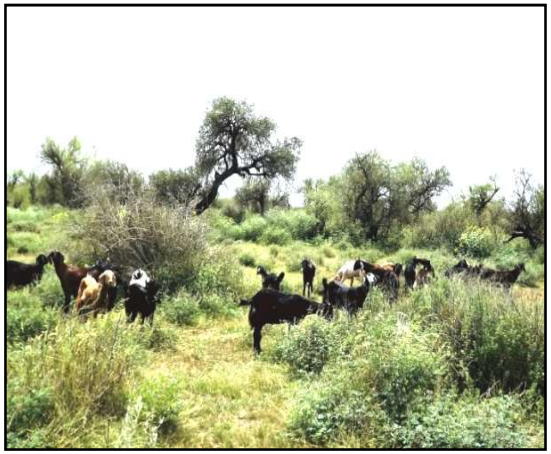
(i) *Salvadora persica* L.

(j) *Sarcostemma viminale* (L.)R.Br.

(k) *Tecomella undulata* (Sm.) Seem.

(l) *Tephrosia falciformis* Ramaswami

PLATE 4.8: THREATS TO PHYTODIVERSITY



(a) Enemies of phytodiversity

(b) Pollution

(c) Cutting of Trees

(d) Collection of wood

CHAPTER-5
ETHNOBOTANICAL STUDIES

INTRODUCTION

Ethnobotany is a multidisciplinary branch of science and simply defines as the existing interrelationship between plants and people. The close relationship beween plants and primitive ethnic people of the world gave birth to this new interdisciplinary science. The term ethnobotany was first introduced by Harshberger (1895) as “the study of plants used by primitive and aboriginal people”. Since then it has been defined as the traditional knowledge on indigenous communities, about surrounding plant diversity and as the study of how the people of particular culture and region make use of indigenous plants. The modern definition of ethnobotany does not restrict it to primitive societies but covers a total interrelationship between man and plants (Jain, 1986). Ethnobotanical study was escalated during 1980’s and the study became multidisciplinary (Cotton, 1996).

Ethnobotany deals with the direct relationship of plants with man. The term has often been considered synonymous either economic botany or with traditional medicine. The basic aspect of any ethno-botanical study is the recognition that humans form biological populations and are dependent on culture (Ford, 1978). Ethnobotany is an interdisciplinary science and has relevance to sociology, anthropology, taxonomy, phytochemistry, archaeology ecology, agriculture, medicine, linguistics, etc.

In last few decades ethnobotany has become an important thrust area of research for the documentation and preservation of historical traditional knowledge at tribal level as well as to develop resource management, conservation of biological diversity and socio-economic development.

Living close to nature, the traditional societies have acquired unique knowledge about the use of wild flora and fauna. After years of observation trial and error experimentation, the traditional people have selected useful and harmful members of the flora and fauna. These ethnic groups have their own culture,

customs, beliefs, taboos, totem, folklore, folk tales, songs, rituals, myths and medicine practices. Forest and plants play important role in their life style. India is the home to large number of indigenous people who are still untouched by the lifestyle of modern world. The Indian sub-continent is inhabited by over 53 million tribal people belonging to over 550 tribal communities, which belong to 227 ethnic groups (Anonymous, 1992). These constitute about 7.7% of India's population. During the last few decades there has been an increasing interest in the study of medicinal plants and their traditional use in different parts of India. According to All India Coordinate Research Project on Ethnobotany (AICRPE, 1982-93), about 9,500 wild plant species are being used by Indian tribals for meeting their varied requirement of which about 7,500 species are used for medicinal purposes. Apart from the tribal groups, many other forest dwellers and rural people also have unique knowledge about plants.

Rajasthan state has been home to numerous tribal and nomadic communities, the tribes of Rajasthan constitute approximately 13.5% of state population. Each of these tribes can be identified by their own culture, customs, trades, fairs and festivals. Bhil, Meena, Garasia, Damor, Dhanka, Saharia, Kathodia, Koli, Patelia and Kokna are included in tribes in Rajasthan. Out of these Meena and Bhil together constitutes 93 percent. Rajasthan state has some denotified and nomadic tribes also. Sansi, Bawaria, Kanjar, Nut, Bhat, Naik and Mogia are some denotified tribes. Banjara, Jogi, Kalbeliya, Gadoliya Luhar are nomadic tribes of Rajasthan. In addition, Rebari, Manglias, Jalukas, Jhangs etc. constitutes semi nomadic tribes of Rajasthan.

Around 39% of Rajasthan tribes comprising of the Bhils, are dominating in the Banswara, Dungarpur and Udaipur district. Meena is the second largest tribal group of Rajasthan. They are found dominating the region of Shekhawati and eastern Rajasthan.Along with Meenas, many nomadic and semi-nomadic tribes such as Bawaria, Sansi, Banjara, Gadoliya Luhar, Nat, Rebari, Naik etc. live near the present study area. Encroachment of Beer region in south-west region by these nomadic tribes creates a threat to the vegetation of area.

MATERIAL AND METHODS

The present ethnobotanical study was conducted in Beer Jhunjhunu Conservation Reserve for a period of three years during 2013-2016. In order to document the utilization of indigenous plants, intensive surveys were carried out in the study area. Same site was visited in different seasons of the year, so as to raise collection in all seasons. Knowledgeable people of different tribes like *Gurjar*, *Meena*, *Rebari, Nat, Sansi*, *Banwariya*, *Kalbeliya* inhabiting near the forest region were taken to the field for identification of medicinal plants used in folklore. Interviews were also organized during these surveys in which local people of different age groups, shepherds, woodcutters, old man, healers and medicine men, forest officials etc. were included. The survey was spread across the seasons so as to get maximum information. The information regarding medicinal uses of the indigenous plants have been described after gathering information from experienced people including elders, medicine men, herbal healers, birth attendants, woodcutters, shepherds and forest officials who are in touch with the forest environment.

Information about utensils, agriculture implements, household instruments, medicinal uses, musical instruments, plants used in rituals etc. were considered as fairly authentic original. The ethnobotanical data were collected by observation and with the help of interviews. The ethnobotanical studies of Beer areacan be subdivided into following:

Field Survey

To record the important information about the plants of medicinal and ethnobotanical importance for the tribal and rural people various localities of study area were visited in different seasons. The survey informations were also gathered through secondary sources. The study sites were visited accompanying the local medicine man. Cross check of collected information from different people has been done to understand the utility of a plant in its totality. Medicine men, rural folk, herbal practitioners and local herbal drug sellers provide important information on useful plants. Besides ethnomedicinal plants, enquiries were also made on the plant material used in different artifacts and in ritual ceremonies. During the study daily activities were closely observed and interpersonal contacts on different ritual ceremonies were established by participating in their social and religious

ceremonies. Data of these plants were collected by interviews, observation and participation (Plate5.1).

Collection, Identification and Preservation of Ethnobatanical Plants

The collected specimens were identified taxonomically with the help of published regional flora (Bhandari, 1990; Shetty and Singh 1987; 1991; 1993; Sharma, 2002) and by comparing voucher specimens with identified herbarium collections in the Herbarium, Department of Botany, University of Rajasthan Jaipur, India. The verification and authentification of collected data were made in the light of standard literature (Jain, 1963, 1991; Nadkarni, 1992).All the recorded plants have been presented alphabetically along with their scientific and local names, useful plant part, traditional uses and mode of administration in different ailments (Table 5.1).

Selection of Ethnomedicinal Plants for further study

To carryout detailed biological and pharmacological studies, the species of ethnomedicinal interest was selected on the basis of wider use for different ailments in the study area.

Enumeration of Ethnobotany

Many plant species were utilized by tribals and rural people inhabiting near the study area in different ailments, artifacts and traditional magico-religious. Hence the ethnobotanical investigation and observation has been undertaken in different headings.

- Ethnomedicinal Plants (Table 5.1) (Plate 5.2)
- Ethnoveterinical Plants (Table 5.2)
- Traditional Uses of Plants (Plate 5.3)
- Plants in Rituals (Table 5.3)
- Wild edible plants (Table 5.4) (Plate 5.5A&B)

Table 5.1: Ethno-medicinal plant diversity of Beer Jhunjhunu Conservation Reserve

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
1.	*Abutilon indicum* Sweet. (Malvaceae)	Kanghi	Whole Plant	Urination	Entire plant sap with milk and sugar is used to cure hyper urea.
2.	*Acacia catechu* Willd. (Fabaceae)	Khairi	Root	Rheumatism	Root made into a paste and applied on the joints for rheumatism.
3.	*Acacia nilotica* L. (Fabaceae)	Kikar	Bark	Ulcer	Powder of bark is applied externally in ulcers and toothache.
			Twigs	Toothache	Twigs are used for cleaning the teeth.
4.	*Acacia senegal* (L.) Willd. (Fabaceae)	Kumta	Gum	Intestinal trouble	Gum is demulcent and cures intestinal trouble. Used in malaria and cough.
				General weakness	It is used to prepare sweet dishes which are used after delivery.
5.	*Achyranthes aspera* L. (Amaranthaceae)	Modo kanto	Root	Cough	Powdered root in combination with pepper and honey is given in cough.
				Toothache	Root decoction is given in typhoid. Brushing teeth with fresh root is also useful in curing toothache.
6.	*Aegle marmelos* (L.) Corr. (Rutaceae)	Belpatra	Leaves	Ulcer	Leaves reduce inflammation and heal ulcers.
			Fruit	Constipation	Fruit pulp is very useful in constipation.
7.	*Aerva persica* (Burm.f.) Merr. (Amaranthaceae)	Bui	Whole plant	Ulcer	Used externally to remove swelling, relieve inflammation and promote healing wounds and ulcers.
			Seeds	Rheumatism	Woolly seeds stuffed in pillows relieve headache and protective against rheumatism.
8.	*Albizia lebbeck* (L.) Willd. (Fabaceae)	Siris	Leaves	Night blindness Antidote	Used to treat night blindness. Leaf paste is applied in snake-bite and scorpion sting.
9.	*Alternanthera sessilis* (L.) DC. (Amaranthaceae)	Garundi	Whole plant	Skin disease	Plant extract is given to treat and skin diseases.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
10.	*Alysicarpus monilifer* (L.) DC (Fabaceae)	Leel	Whole plant	Jaundice	Shoot are ground into a paste. Two teaspoonful of this paste is mixed in goat's milk and given internally twice a day in jaundice.
11.	*Amaranthus graecizans* L. (Amaranthaceae)	Chaulai	Leaves	Constipation	The leaves are cooked as a medicated vegetable to cure constipation and loss of appetite.
12.	*Ammannia baccifera* L. (Lythraceae)	Jal-bhangro	Whole plant	Fever	Plant decoction is taken twice a day in fever.
				Skin disease	Paste of leaves and inflorescence is applied over skin to check itching.
13.	*Anagalis arvensis* L. (Primulaceae)	Neel	Shoot	Rheumatism	2 g dried powdered shoots are mixed with 5 g wheat flour to make paste which is used once a day for a week to treat rheumatism.
14.	*Andrographis paniculata* (Burm.f.) Wall ex Nees (Acanthaceae)	Kalmegh	Whole plant	Jaundice	The extract of whole plant is useful in jaundice and liver troubles.
15.	*Argemone mexicana* L. (Papaveraceae)	Satyanashi	Leaves	Skin disease	Paste of tender leaves is applied as poultice for wounds and skin diseases. Also applied for cattle's eczema.
			Seeds	Pyorrhoea	Seed paste applied for tooth decay and pyorrhoea. Seed oil is used externally for skin diseases.
16.	*Aristolochia bractelolata* Retz. (Aristolochiaceae)	Kiramar or Batakhbel	Whole plant	Worm killer	Plant decoction is used against round worms.
			Leaves	Skin disease	Leaf juice is applied to neglected ulcers. Bruised leaves mixed with castor oil, are applied for eczema on children's leg.
17.	*Asphodelus tenuifolius* Cav. (Liliaceae)	Piazi	Leaves	Antidote	Leaf paste is used for rubbing on bites of bees and wasp for relief.
18.	*Azadirachta indica* A. Juss. (Meliaceae)	Neem	Twigs	Tooth decay	Used as 'Datun' to strengthening teeth and gums.
			Leaves	Skin disease	Leaves are very useful in skin diseases, boils, chronic ulcers, wounds and eruption of small pox.
				Hair loss	Decoction of leaves stops hair loss.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
				Malaria	Leaf decoction with inflorescence is taken orally to cure malarial fever.
19.	*Bacopa monnieri* L. (Scrophulariaceae)	Jal brahmi	Whole plant	Brain tonic	Plant decoction is used as brain tonic.
20.	*Balanites aegyptiaca* Del. (Simaroubiaceae)	Hingot (Hingun)	Fruit	Skin disease	Fruit pulp is used in skin disease.
				Antidote	Also applied to cure scorpion sting.
				Carbuncles	Paste of seed kernel mixed with oil is applied as poultice to relieve carbuncles.
21.	*Barleria prionitis* L. (Acanthaceae)	Bajradanti	Stem	Toothache	Twigs are used as toothbrush.
			Leaf		Gargling with leaf decoction relieves toothache.
22.	*Bauhinia racemosa* Lamk. (Fabaceae)	Ronz	Bark	Pimples, acne	Bark decoction is a good remedy for treating skin diseases like rashes, pimples and acne.
23.	*Bergia suffruticosa* (Del.) Fenzl. (Elatianaceae)	Ankh-phootni ki bel	Whole Plant	Wound healing	Plant paste is used to repair bones and heal wounds by rural people.
				Antidote	Also used in stomach troubles and as an antidote to scorpion bite.
24.	*Boerhavia diffusa* L. (Nyctaginaceae)	Santo	Root	Kidney stone	Root decoction is taken daily for one month in kidney stone.
				Dengue fever & Jaundice	Effective in treatment of dengue fever and jaundice.
				Coolant	Aqueous extract of roots act as coolant in summer season.
25.	*Borreria articularis* (L.f.) Willd. (Rubiaceae)	Aagio	Leaves	Eye disease	Leaves are used in inflammation of eye, blindness and conjunctivitis.
26.	*Calligonum polygonoides* L. *(*Polygonceae)	Phog	Flower	Sun-stroke	Flower buds mixed in curd is effective in sun-stroke.
27.	*Calotropis procera* R.Br. (Asclepiadaceae)	Aak	Root	Malaria	The decoction of root bark along with black pepper is used twice a day for three days in malarial fever.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
			Leaves	Abdominal pain	Leaves are tied on abdomen in abdominal pain.
28.	*Cannabis sativa* L. (Cannabinaceae)	Bhang	Leaves	Scabies	Leaf powder serves as a dressing for wounds and sores. Crushed leaves are rubbed on the affected areas to control scabies.
			Seed	Eczema	Seed oil is useful for eczema and psoriasis.
29.	*Capparis decidua* Edgew. (Capparaceae)	Kair	Stem	Pyorrhoea & Rheumatism	The stem is used in pyorrhoea and rheumatism.
			Fruit	Gastric trouble	Fruit prickle is used as tonic, and to cure gastric troubles.
30.	*Cassia italica* (Mill.) Lamk.ex Anders (Fabaceae)	Phunwad	Leaves	Blond henna	Leaves are used as a dye called neutral henna or 'blonde henna' to make the hair look glossy.
				Constipation	Powdered leaves and seeds and sugar mixed in lemon juice, filtered for treatment of constipation.
31.	*Cassia occidentalis* L. (Fabaceae)	Kesudo	Leaves	Skin disease	Paste of leaves used both externally and internally to treat skin disease like scabies, ringworms and itches.
			Root	Skin disease	Paste of root is effective in eczema, ringworm and other skin problems.
			Seeds	Asthma	Seed powder with hot water provides relief in asthma.
32.	*Celosia argentea* L. (Amaranthaceae)	Makhmal	Whole plant	Piles	Plant decoction is given in piles.
			Leaves	Abdominal pain	Leaf decoction is used as diuretic and given in abdominal colic.
			Seed	Uterine disease	Crushed seed is taken orally in uterine diseases.
33.	*Ceropegia bulbosa* Roxb. (Asclepiadaceae)	Khadulo	Tuber	Kidney stone	Decoction of tubers used orally to get rid of urinary bladder stone.
				Fertility	Rural ladies eat raw tubers to promote fertility and vitality.
				Antidote	Also used in deafness, scorpion bites.
34.	*Chenopodium album* L. (Chenopodiaceac)	Chilwo,	Leaves	Urinary troubles	Leaves cooked as vegetable is given in urinary troubles and colic.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
		Bathua		Piles	Leaf extract is administered orally for treating piles.
35.	*Citrullus colocynthis* (L.) Schard. (Cucurbitaceac)	Tumbo/ Indrayan	Fruits	Jaundice	Dried pulp of fruits is source of colocynth drug which is purgative. It is used in treatment of jaundice, and urinary tract disorders.
				Allergy	Fruits are stuffed with turmeric rhizome through a hole made in pericarp. After 4-5 days rhizomes are removed from pulp, dried and ground to a fine powder. Later is given with milk orally as a specific remedy for allergy in the study area.
			Roots	Rheumatism	Root paste of Indrayan and Asgandh mixed with honey is taken orally in rheumatism.
36.	*Citrullus lanatus* Mansf. (Cucurbitaceae)	Matiro	Fruit	Cooling effect	Fruit pulp is sweet, appetizer and refreshing with cooling effect.
				Antidote	Fruit juice stored for one year is used as an antidote in snakebite.
			Seeds	Urination	Seeds are diuretic. Seed powder is used during famine for preparation of bread.
37.	*Cleome gynandra* L. (Capparaceae)	Safed Bagro	Leaves	Rheumatism	Bruised leaves are used to treat headache, rheumatism and in boils to prevent formation of pus.
				Earache	Sap of young leaves is squeezed into ear to treat earache.
38.	*Cleome viscosa* L. (Capparaceae)	Bagro	Whole plant	Liver disease	In infantile convulsions (a disease of brain) and liver protection.
			Leaves	Piles	The boiled water of leaves is applied over bleeding piles.
39.	*Clerodendrum phlomoides* L. (Verbenaceae)	Arni	Leaves	Syphilis	The leaf juice is given in syphilis. .
				Arthritis	Also applied on joints in joint pain.
			Root	Gonorrhoea	Root decoction is used as demulcent in gonorrhoea.
				Measles	Also used as bitter tonic for children during convalescence from measles.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
40.	*Coccinia grandis* (L.) J.O. Voigt (Cucurbitaceae)	Tindori	Fruits	Asthma Diabetes	Used to treat fever, asthma and bronchitis. Also used in diabetes.
41.	*Cocculus hirsutus* (L.) Diels (Menispermaceae)	Bajar-bel	Leaves	Leucorrhoea	Decoction of leaves mixed with sugar is taken in the morning for a week to cure leucorrhoea.
				Coolant	Leaf paste applied on forehead gives cooling effect and cure headache.
			Roots	Rheumatism	Root powder along with milk or honey is given for 20-30 days in chronic rheumatism.
42.	*Cocculus pendulus* (Forst.) Diels (Menispermaceae)	Pilwani	Leaves	Skin disease	Leaf sap mixed with water form a green jelly which is used externally for skin diseases.
				Leucorrhoea	Decoction of leaves is used in leucorrhoea and kidney pains.
			Fruit	Dye	Juice of ripe berries makes durable purple blue ink.
43.	*Corchorus depressus* (L.) Chr. (Teliaceae)	Kurand	Whole plant	Liver disorder	Fresh plant decoction is useful in dysentery, indigestion and liver disorders.
				Coolant	Dried powder of whole plant taken with goat's milk reduces the heat surges felt in the body.
				Sexual power	Also used as a tonic to increase sexual impotency.
			Seed	Diarrhoea	*Sansi* and *Nut tribes* take seeds decoction with goat milk and jaggery during acute diarrhoea.
44.	*Cordia dichotoma* G. Forst. (Ehretiaceae)	Lasoda	Bark	Mouth ulcers	Stem bark is applied to mouth ulcers in the form of gargle.
			Fruit	Cough	Used for biliousness, cough and internal haemorrhage.
45.	*Crotalaria burhia* Buch. Ham. (Fabaceae)	Kharsana or Jhunda or Shinia	Root	Skin disease	Root decoction is used in treating various types of skin diseases.
				Coolant	Filtrate of boiled root is taken orally to give cooling effect.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
46.	*Cucumis callosus* (Rottl.) Cong. (Cucurbitaceae)	Kachri	Fruit	Skin moisturizer	Fruits are used as light cooling cleanser or moisturizer for the skin.
			Seed	Liver disorder	Seeds have cooling action and useful in bilious disorders.
47.	*Cucumis melo* Roxb. (Cucurbitaceae)	Kachro	Fruit	Skin disease	Fruit is eaten daily in chronic eczema.
			Seed	Tympanitis	Bruised seeds are applied as poultice in cases of tympanitis in children.
48.	*Cuscuta reflexa* Roxb. (Cuscutaceae)	Amar-bel	Whole plant	Baldness	Whole plant is grinded and applied on head for curing hair fall especially in men.
49.	*Cyperus rotundus* L. (Cyperaceae))	Motho	Tuber	Stomach disorder	Dried tubers are used in stomach disorders and irritation of bowels.
				Coolant	Also used for cooling effect
50.	*Dalbergia sissoo* L. (Fabaceae)	Shisham	Leaves Bark	Gonorrhoea	Leaf decoction is used in acute gonorrhoea. Used in leucoderma and dysentery.
51.	*Datura metel* L. (Solanaceae)	Kalo dhaturo	Leaves	Asthma	The dried leaves are used as antispasmodic and in critical condition of asthma and whooping cough.
			Fruit	Malaria	It is a specific remedy for phlegmatic and bilious type of malarial fever.
			Seed	Baldness	Paste of seed is useful in patchy baldness.
52.	*Datura stramonium* L. (Solanaceae)	Dhaturo	Leaves	Asthma	The smoking of the dried leaves and stem in a pipe is found successful in relieving spasmodic asthma.
53.	*Digera muricata* (L.) Mart. (Amaranthaceae)	Ghundro	Leaves	Constipation	Leaves and young shoots are locally used as a vegetable and given to relief in constipation.
			Root	Increasing lactation	Boiled root infusion given to mother after child birth for lactation purpose.
54.	*Echinops echinatus* Roxb. (Asteraceae)	Unt-kantelo	Root	Cough	Root extract in water is given orally to treat cold and cough.
				Wounds	Powdered roots are applied over wounds of cattle for early healing.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
55.	*Eclipta prostrata* L. (Asteraceae)	Jal-Bhangro	Whole plant	Hair growth	Fresh juice of leaves promotes growth of hair and stops the premature greying of hair.
				Bronchitis	Dry plants are used in bronchitis and asthma.
			Seed	Hair tonic	Seed oil is used as hair tonic.
56.	*Enicostema axillare* (Lamk.) Roynal (Gentianaceae)	Kutak-raycho	Whole plant	Diabetes Malaria Fever	The plant extract is useful against diabetes, malaria and fever.
57.	*Ephedra foliata* Boiss. & Kotschy ex Boiss. (Gnetaceae)	Unt-phog	Whole plant	Asthma	Extract of plant has ephedrine which is used to treat asthma and bronchitis.
				Diphtheria	It Is also used in diphtheria and pneumonia.
58.	*Euphorbia hirta* L. (Euphorbiaceae)	Dudhi	Latex	Wart, Leucoderma	Latex is used in warts and skin diseases (leucodermal spots).
			Root	Increasing lactation	Root paste mixed with honey given to nursing mothers for initiation or to increase lactation.
			Leaves	Asthma & Dengue	Leaf decoction is given in asthma, cough and bronchitis. Tea from fresh leaves is used to cure dengue fever.
59.	*Evolvulus alsinoides* L. (Convolvulaceae)	Phooli	Whole plant	Brain tonic	Decoction of whole plant is used as a brain tonic.
			Leaves	Asthma	Leaves smoked in chronic bronchitis and asthma.
			Flower	Uterine bleeding	Flowers are useful for treating the uterine bleeding.
60.	*Fagonia indica* (L.) Burm.f. (Zygophyllaceae)	Dhamaso	Whole plant	Skin disease	Decoction of the whole plant cures eczema and other skin diseases.
				Asthma	Smoke from whole plant inhaled to treat asthmatic attack.
61.	*Ficus benghalensis* L. (Moraceae)	Bargad or Bar	Aerial roots	Piles	The tips of adventitious roots are crushed and boiled in cow's milk and this decoction is strained and served hot in piles.
			Latex	Boil and blisters	The milky latex of the plants is applied externally in boils and blisters, and in cracked heels.
			Fruit	Spermatorrhoea	The fruits are powdered and taken with honey in the morning and evening for a week in spermatorrhoea.
			Bark	Antidote	The bark with black pepper is used in snake-bite.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
62.	*Ficus religiosa* L. (Moraceae)	Pipal	Leaves	Skin disease	Leaves useful in healing bruises, wounds and in the treatment of skin diseases.
			Latex		Applied externally for skin diseases.
			Fruit	Cold	Fresh fruit juice is effective in treating cold, cough and fever.
			Bark	Piles	Powder of bark is used in fistula of anus.
63.	*Fumaria indica* (Haussk.) Pugsely (Fumariaceae)	Pithpaparo	Whole plant	Skin disease	Used as an efficient liver tonic. Also used in skin disease and to purify blood.
				Jaundice	The dry plant is beneficial in jaundice and fever.
			Leaf	Urination	The leaf paste is taken with water to increase the flow of urine in fever.
64.	*Gisekia pharnaceoides* L. (Molluginaceae)	Sureli	Whole plant	Worms killing	Plant extract is given empty stomach to children to kill Ascaris (round worms).
65.	*Glinus lotoides* L. (Molluginaceae)	Dholakani	Whole plant	Weakness	*Gurjar* tribe give fresh plant juice orally to children to cure weakness and indigestion.
66.	*Heliotropium marifolium* Koen ex Retz. (Boroginaceae)	Choti-Santari	Whole plant	Worm killing	Plant extract is used for killing roundworms.
67.	*Hibiscus ovalifolius* (Forsk.) Vahl (Malvaceae)	Dokala	Leaves Fruits	Leucorrhoea	Fresh leaves and fruits are grind and paste and taken orally in leucorrhoea.
68.	*Indigofera linnaei* Ali (Fabaceae)	Bekario	Whole plant	Epilepsy	The decoction of whole plant is used in epilepsy.
				Sexual disease	The juice of plant is diuretic, and used to treat chronic venereal diseases.
				Migraine	The Leaf juice is used as an eye drop to cure migraine.
69.	*Jatropha gossypifolia* L. (Euphorbiaceae)	Ratanjot	Leaves	Worm killing	Leaves are tied locally in treatment of guinea worm.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
70.	*Justicia simplex* Don. (Acanthaceae)	Makhnio-ghas	Leaves	Rheumatism	Fresh leaf paste is used in rheumatism. Leaf paste mixed with butter is rubbed on affected area to treat chest pain.
71.	*Launaea procumbens* Roxb. (Asteraceae)	Jangli gobhi	Whole plant	Urination	The plant is grinded in water along with candy (Misri) and is given orally for painful urination.
72.	*Lawsonia inermis* L. (Lythraceae)	Mehandi	Leaves	Boil & Blister Rheumatism	Leaf paste is used in treatment of prickly heat, skin problems like boils, burn, rheumatic joints, bruises and inflammatory swellings.
				Dye	Henna is used as a colouring agent to make a hair dye.
			Bark	Liver disease	Bark of plant is useful in treatment of jaundice and liver enlargement.
			Seed	Micturition	Powder of seed is used in treatment of dysentery, fever and burning micturition.
73.	*Leptadenia reticulata* Wight & Arn. (Asclepiadaceae)	Jiwanti	Leaves Roots	Skin disease	The leaves and roots of the plant are used for curing skin diseases, inflammation of skin and to heal wounds and burns.
			Whole Plant	Tonic	Whole plant used as a tonic and gives strength to body.
74.	*Leptadenia pyrotechnica* (Forssk.) Decne. (Asclepiadaceae)	Khimp	Whole plant	Thorn injury	Plant sap is applied over thorn injury for removal of thorn from body.
			Fruit	Vegetable	Fruits (khimpoli) are used as vegetable.
75.	*Leucas cephalotes* (Roxb.ex Roth) Spr. (Lamiaceae)	Dargal	Leaves	Painful urination	Decoction of equal quantities of tender leaves of the plant and tender shoots of *Boerhaavia diffusa* L. is given once daily for a week to cure burning sensation and painful urination.
76.	*Lycium barbarum* L. (Solanaceae)	Murali	Fruits	Anaemia & Diabetes	Fruits are used in anaemia, menstruation disorders and bleeding haemorrhoids. Also used in diabetes and poor eye sight.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
77.	*Malvastrum coromandelianum* (L.) Clarke (Malvaceae)	Kharinti	Leaves	Inflammation	Leaves are chopped and boiled for half an hour. The filtrate is stored in container. One cup is drunk twice a day to heal inflammation and wounds.
78.	*Maytenus emarginata* (Willd.) Ding Hau (Celastraceae)	Kankero	Fruit	Piles	The fruits are sweet, cooling and blood- purifier. Used to treat ulcers and piles.
79.	*Mimosa hamata* Willd. (Fabaceae)	Alai	Leaves	Wound healing	Fresh leaf extract is applied to check bleeding from the wound and ulcer.
			Seed	Weakness	5 gm seed powder boiled in buffalo milk is given as a tonic in general weakness and also sexual weakness in males.
80.	*Mollugo cerviana* (L.) Seringe (Molluginaceae)	Chiri-bajro	Whole Plant	Uterine cleaning	The plant is cooked as vegetable and given to the ladies after childbirth to clean the uterus.
				Gonorrhoea	An infusion of plant is used in fever, gonorrhoea and purification of blood.
			Seed	Coolant	Seed decoction is taken orally to keep body cool during summer.
81.	*Momordica balsamina* L. (Cucurbitaceae)	Bar-karelo	Whole Plant Fruits	Fever	Used in fever, excessive uterine bleeding, rheumatism, hepatitis and skin disorders.
				Diabetes	Fruits are cooked as vegetable and useful in diabetes.
82.	*Nothosaerva brachiata* (L.) Wight (Amaranthaceae)		Root	Kidney stone	Roots are diuretic. Used in problem of urinary stones.
83.	*Ocimum americanum* L. (Lamiaceae)	Bapchi	Whole Plant	Cough, fever	Plant decoction is used in cough and fever. Also used for treating toothache.
			Seed	Leucoderma & Leprosy	Seed powder is used in treatment of skin disease as leucoderma and leprosy.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
				Cooling effect	The seeds are soaked either in curd or buttermilk and taken orally to cool the body during summer.
84.	Ocimum sanctum L. (Lamiaceae)	Tulsi	Leaves	Cold Bronchitis	Leaf decoction is given to cure cold, cough and bronchitis.
85.	*Oligochaeta ramosa* (Roxb.) Wagenitz (Asteraceae)	Unt Kantelo, Brahmbuti	Shoot	Cough Leucorrhoea	Used in fever and cough. Dried aerial part is powdered and taken in leucorrhoea.
86.	*Oxalis corniculata* L. (Oxiladaceae)	Khatari	Leaves	Coolant	Leaves are used as a coolant and refrigerant in stomach disorders, fever and acute headache.
87.	*Pedalium murex* L. (Pedaliaceae)	Dhakhni gokhru	Whole Plant	Tonic	Whole plant extract is used as tonic for health and vigour.
			Fruits	Urination	Decoction of fruit is used for continuance of urine and other complaints of urinary system, spermatorrhoea, nocturnal emission and in impotency.
				Rheumatism General weakness	Laddus (a type of sweetmeat) prepared from the seeds are given to patients suffering from joint pain and also given for better health.
88.	*Peganum harmala* L. (Zygophyllaceae)	Harmal	Seed	Piles	A teaspoon of powdered seeds taken early in the morning for three weeks is effective remedy in piles.
			Dried plant	Measles	Fumigation of shade dried plant is best treatment of measles.
			Roots	Anti- lice	Bath with roots decocted water serve as anti-lice shampoo.
89.	*Pergularia daemia* (Forsk.) Chiov. (Asclepiadaceae)	Gadriya ri-bel	Leaves	Carbuncles	Paste of leaves applied as a poultice to relieve carbuncles.
				Diarrhoea	Leaf juice is used in diarrhoea.
90.	*Phyllanthus fraternus* L. (Euphorbiaceae)	Hazardana or Guga-janti	Whole Plant	Hepatitis	Plant extract is used in viral hepatitis. It also increases appetite.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
				Skin diseases	Whole pounded plant is used as a poultice for ulcers, sores swellings and skin infections.
91.	*Physalis minima* L. (Solanaceae)	Pichoo	Whole Plant	Urinary problems	Used as diuretic for various urinary problems.
			Fruits	Stomach pain	Fruits are edible and used in colic complaints.
92.	*Polygonum plebium* R.Br. (Polygonaceae)	Gulabi	Whole Plant	Bowel complaints	Plant decoction is given in bowel complains.
93.	*Portulaca oleracea* L. (Portulacaceae)	Lunki	Whole Plant	Liver disease	Eaten as vegetable for the treatment of scurvy and disease of liver.
			Leaves	Blister and boils	A paste of leaves is applied externally to the burns, swelling and scalds for its cooling effect. Plant sap smeared on the body during summer provides relief in blister and boils.
94.	*Prosopis cineraria* (L.) Druce (Fabaceae)	Khejari or Janti	Bark	Rheumatism	Bark paste is effective in rheumatism, healing of injuries and scorpion bite
			Leaves	Boils	Leaf paste is applied on injured part for early healing and on boils to hasten suppuration.
			Pods	Pneumonia	Decoction of young pods used for curing pneumonia. Pods are eaten as vegetable called “Sangri”.
			Flower	Miscarriage	Flowers mixed with sugar are eaten by pregnant ladies to prevent miscarriage
95.	*Pulicaria crispa* (Cass.) Benth. & Hook. (Asteraceae)	Dhola lizru	Whole Plant	Cold and cough	Whole plant is pounded in hot water and filtrate is used to cure pneumonia, fever, cold and cough.
96.	*Pupalia lappacea* (L.) Juss. (Amaranthaceae)	Chiptio Bhurat	Leaves	Fractured bone	Poultice of leaves is used on fractured bone to heal quickly.
			Root	Urinary problems	Root decoction is given orally once daily for a week to cure scanty urination and to resume free flow of urination.
97.	*Rhynchosia minima* (L.) DC. (Fabaceae)	Chirimotio	Leaves	Piles	Leaf paste is used as a poultice in piles.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
98.	*Ricinus communis* L. (Euphorbiaceae)	Arand	Leaves	Pain	The leaves warmed and smeared with oil are applied to the abdomen to relief postnatal pains, on the knee and on affected parts to get relief in pain.
				Carbuncles	The leaves are tied on the boil and the carbuncle in order to burst it.
			Fruit	Piles	Fruit is used for piles and diseases of liver and spleen.
99.	*Ruellia patula* Jacq. (Acanthaceae)		Leaves	Wounds	Leaf paste is applied for healing wounds.
				Antidote	Five to six leaves are given in snake-bite.
			Stem	Bone fracture	Stem decoction with cow milk is taken orally for treatment of bone fracture and paste of stem with mustard oil is applied topically.
100.	*Salvadora oleoides* Decne. (Salvadoraceae)	Mitha Jal	Leaves	Cough	Leaves are used to cure cough.
			Fruit	Cooling effect	Fruits are edible and have cooling effect.
			Seed	Rheumatism	Seed paste and oil is applied to cure rheumatism.
			Root	Toothbrush	The young branches and roots are used for making Miswak which is used for cleaning teeth. It has been mentioned in the Holy Quran.
101.	*Salvadora persica* L. (Salvadoraceae)	Kharo Jal	Branch	Toothache	Young branches as toothbrushes cure the problem of toothache and gums.
			Fruit	Constipation	Fruits are employed in calculi, constipation and indigestion.
			Seed	Rheumatic pain	Seed oil is applied in rheumatic pain.
			Leaves	Rheumatism	The leaves heated and tied up in thin cotton cloth are applied in rheumatism.
102.	*Sarcostemma viminale* (L.) R.Br. (Asclepiadaceae)	Khir-khimp	Whole Plant	Rheumatism	Whole plant extract is used internally to relieve rheumatic pain.
				Bone fracture	Plant paste is applied on fractured bone.
			Root	Antidote	The root is ground and applied to snake bite and taken as an infusion in dog bite cases.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
103.	*Sida cordifolia* L. (Malvaceae)	Bal	Whole Plant	Fever	Plant extract is used in intermittent fever and rheumatism
			Seeds	Bowel complaints	Seed possess demulcent and laxative properties and are used in bowel complaints.
104.	*Sida ovata* Forssk. (Malvaceae)	Bal	Seed	Lumbago	*Laddus* prepared from powered seeds mixed with wheat flour and sugar is given to patients suffering from lumbago.
105.	*Solanum indicum* L. (Solanaceae)	Tindra	Fruit	Toothache	The inhalation of smoke of fruit kills the germs found in tooth.
106.	*Solanum nigrum* L. (Solanaceae)	Makoi	Whole Plant	Skin disease	Whole plant is effective in chronic diseases, such as acne, eczema and psoriasis.
			Fruits	Cough	A decoction of berries and flowers is used for relieving cough and cold.
107.	*Solanum surrattense* Burm. f. (Solanaceae)	Nili Kantili	Leaves	Skin disease	Fresh leaf extract is applied on ringworm and other skin diseases.
				Rheumatism	Leaf extract with black pepper is used in rheumatism.
			Fruit	Piles	Powder of ripe fruit is given orally in piles.
				Toothache	The smoke of fruit is inhaled for treatment of infected teeth.
108.	*Sphaeranthus indicus* L. (Asteraceae)	Mundi	Whole Plant	Sexual power	Shade dried plant at flowering stage is powdered and taken orally with butter and honey for 38 days to develop sexual power.
				Piles	Whole plant is used to treat anorexia, jaundice, piles and fever.
109.	*Tecomella undulata* (Sm.) Seem. (Bignoniaceae)	Rohida	Bark	Skin disease	Bark paste is applied to cure eczema and eruptions.
			Root	Leucorrhoea	Root powder mixed with sugar is given to women in leucorrhoea.
			Leaves	Pneumonia	Leaf juice is mixed with water and used in pneumonia and typhoid.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
110.	*Tephrosia purpurea* L. Pers. (Fabaceae)	Bansa or dhamasia	Whole Plant	Cough	Plant decoction is used as anthelmintic for children, as blood purifier and cure Dhamsia (cough with black phlegm), a common disease in rural areas.
			Leaves	Asthma	Leaves give relief in asthma.
			Roots	Liver disorder	Root powder along with black pepper is taken orally to cure dyspepsia and enlarged liver.
111.	*Tinospora cordifolia* (Willd.) Miers. (Menispermaceae)	Giloy	Whole Plant	Liver disorders	The aqueous extract of plant is widely used for the treatment of jaundice and liver ailments.
				Dengue & Chikungunia	It is effective for chronic fever such as dengue and chikungunia.
				Leucorrhoea	Paste of plant and five seeds of black pepper is taken orally once daily in morning in leucorrhoea.
			Stem	Fever	Stem juice is valued in high fever and given either alone or mixed with honey.
			Root	Antidote	Root decoction is emetic and is used as an antidote to snake bite.
112.	*Trianthema portulacastrum* L. (Aizoaceae)	Safed Santo	Whole Plant	Urinary disorder	It promotes urination. Also used in rheumatism and dropsy.
				Night blindness	Decoction of plant is effective in night blindness.
			Root	Root	Juice of young roots gives cooling effect.
113.	*Tribulus terrestris* L. (Zygophyllaceae)	Gokhroo	Fruits	Kidney stone	Fruits are diuretic and used to expel kidney stone.
			Seed	Spermatorrhoea	10 g powdered seeds mixed with 4 g maize flour is taken three times a day to expel kidney stone.
			Leaves	Painful gums	Decoction of leaves is useful as a gargle for mouth trouble and painful gums.
114.	*Tridax procumbens* L.	Sadabahar	Leaves	Boils & blisters	Leaf extract is applied locally against boils and blisters and taken to cure dysentery and diarrhoea.

S.No.	Name (Family)	Local Name	Part Used	Ailments	Ethno-medicinal uses
	(Asteraceae)	Runkdi		Cuts & wounds	Leaf juice is applied on cuts and wounds by *Gujar* and *Meena* tribes.
				Kidney stone	Leaf paste is used for kidney stone.
115.	*Triumfetta pilosa* Roth (Teliaceae)	Pahari Kagler	Whole Plant	Diarrhoea Intestinal worms	Used in diarrhoea, leprosy and migraine. Plant extract is used to treat intestinal parasites.
116.	*Triumfetta rhomboidea* N. Jacq. (Teliaceae)	Pahari Kagler	Leaves	Tumour	Leaves and stem are used as a poultice on tumour.
			Root	Diarrhoea	Roots and fresh leaves are used in diarrhoea, dysentery and leprosy.
117.	*Withania somnifera* (L.) Dunal (Solanaceae)	Padalsi, Aksan or Ashwagandha	Root	Leucorrhoea & Debility	Root decoction is useful in leucorrhoea and debility from old age.
				Rheumatism	Powdered roots are useful in rheumatism.
118.	*Xanthium indicum* Koen. ex Roxb. (Asteraceae)	Bichhu butti	Fruit	Scabies	Fruit oil is applied on eczema and scabies.
			Seed	Urination	Seed powder mixed with lemon juice and water is given orally to start urination.
119.	*Zizyphus nummularia* Wight & Arn. (Rhamnaceae)	Bordi	Fruits	Heat stroke	Fruits boiled in water and are used to take bath for curing fever caused due to heat stroke during summer season.
			Leaves	Coolant Cuts and boils	Paste of leaves gives cooling effect on burns and also used for healing cuts and boils.
			Root	Menstrual problems	Roots are boiled in water and *raang* is obtained. Rural ladies cooked wheat grains in the *raang* and prepared *laddus*, which are given to women against menstrual problems.
120.	*Zygophyllum simplex* L. (Zygophyllaceae)	Lunki	Leaves	Eye diseases	Infusion of leaves and seeds applied to the eyes in ophthalmia and glaucoma. Paste of warmed leaf is also applied to cure burning sensation and swelling over eyes.

Table-5.2. Enumeration of Ethnoveterinary Medicinal Plants of Beer Jhunjhunu Conservation Reserve

S. No.	Botanical Name/ Local Name/ Family	Part Used	Diseases	Use And Usage
1	*Abutilon indicum* (L.)Sweet Kanghi (Malvaceae)	Leaves Seeds	Constipation	Leaves and seeds are given in constipation.
2	*Acacia catechu* Willd. Khairi (Fabaceae)	Bark	Foot and mouth disease	Bark is boiled in water to make a solution is used in infection of foot and mouth.
3	*Acacia nilotica* Willd. Kikar (Fabaceae)	Fruits	Worm killing	Fruits are given to goats and sheep to kill the stomach worms.
4	*Achyranthes aspera* L. Undhokanto(Amaranthaceae)	Leaves	Ectoparasite	Leaves crushed with oil of *Brassica compestris* are applied as repellent of ectoparasite
5	*Aegle marmelos* (L.)Corr. Belpatra (Rutaceae)	Leaves	Pneumonia	Leaf paste is applied on chest to cure pain and improve breathing in pneumonia.
		Fruits	Diarrhoea	Fruit paste is given to animals to cure diarrhoea.
6	*Aerva persica* (Burm.f.) Merr. Bui (Amaranthaceae)	Whole plant	Eating soil	Whole plant extract is given to the calves to stop eating soil.
7	*Agave americana* L. Rambans (Asparagaceae)	Leaves	Fractured bone	Leaf fibres used to tie the fractured bones. Leaf paste is applied over broken horns for early healing.
8	*Ailanthus excelsa* Roxb. Ardu (Simaroubaceae)	Leaves	Wound healing	Leaf deccoction is applied on the wound to remove the maggots from the wounds.
9	*Albizia lebbeck* (L.) Willd. Siris (Fabaceae)	Leaves	Eye infection	Juice of crushed green leaves is dropped to the eyes to treat general eye problem in goats, cows and baffaloes.

S. No.	Botanical Name/ Local Name/ Family	Part Used	Diseases	Use And Usage
10	*Argemone mexicana* L. Satyanashi (Papaveraceae)	Leaves	Foot disease	Leaf extract is applied over foot suffering from infections.
11	*Aristolochia bracteolata* Lamk. Batakhbel (Aristolochiaceae)	Root	Fever	Root powder is given to cattles to treat fever.
12	*Azadirachta indica* A. Juss. Neem (Meliaceae)	Leaves	Worm killing	Leaves are used as antihelmintic in goats, sheeps and calves.
13	*Boerhavia diffusa* L. Santa (Nyctaginaceae)	Whole plant	Retain placenta	Whole plant is fed twice a day for removal of retained placenta in cows and buffaloes.
14	*Calligonum polygonoides* L. Phog (Polygonaceae).	Whole plant	Colic	Plant extract is given to the animals to treat colic.
15	*Calotropis procera* R.Br. Aak (Asclepiadaceae)	Leaves Latex	Teats problem Snake-bite	Leaves with ghee (clarified butter) are heated and applied externally to swollen teat. Latex is applied on wounds of snake bite to neutralised poison.
16	*Cannabis sativa* L. Bhang (Cannabinaceae)	Leaves	Ectoparasite	The leaf extract is used as anti lice to kill actoparasites.
17	*Cassia occidentalis* L. Kesudo (Fabaceae)	Leaves	Constipation	Ground leaves are added to water and lemon, filtered and given orally in constipation.
18	*Cissampelos pareira* L. Patha (Menispermaceae)	Leaves	Digestive disorders	Leaf paste is given orally twice a day for three days to cure digestive disorders.
19	*Citrullus colocynthis* (L.) Kuntze Tumba (Cucurbitaceae)	Fruits	Digestive disorders	Roasted fruits are given to animals to cure constipation, gastritis and digestive disorders.

S. No.	Botanical Name/ Local Name/ Family	Part Used	Diseases	Use And Usage
20	*Clerodendrum phlomidis* L. Arni (Verbenaceae)	Leaves	Ringworm	After crushing the leaves juice is extracted and applied on wounds of animals.
21	*Cocculs pendulus* (Forsk.) Diels Pilwani (Menispermaceae)	Stem	Mammary gland infection	Stem is cut into pieces and burnt. The ash is mixed with clarified butter and given to the animals.
22	*Cordia dichotoma* Forst.f. Prodr. Lasoda (Ehretiaceae)	Leaves	Cracked nipples	Warmed leaves are tied over cracked nipples in lactating animals.
23	*Crotalaria burhia* Buch Ham. ex Benth. Jhunda (Fabaceae)	Whole plant	Constipation	Plant extract is given to cure constipation.
24	*Cucumis callosus* (Rottl.) Cong. Kachra (Cucurbitaceae)	Fruit	Gastric problems	Fruit paste mixed with butter is given to animals to cure dysentry and gastric problems.
25	*Cuscuta reflexa* Roxb. Amar bel (Cuscutaceae)	Whole plant	Foot & mouth disease	A paste of whole plant is applied twice a day to treat foot & mouth disease.
26	*Cyamopsis tetragonoloba* L. Guwar (Fabaceae)	Seeds	Heat initiation	Boiled seeds are given to induce heat and to cure weakness in cattles.
27	*Cynodon dactylon* (L.)Pers. Doob ghas (Poaceae)	Whole plant	Eye infection Increasing lactation	Whole plant juice is applied on eyes for reducing redness. The aerial plant is given as fodder for increasing milk production.
28	*Datura metel* L. Kala Dhatura (Solanaceae)	Leaves, Fruits	Bleeding , wound	A paste is prepared from fresh leaves and roots and given to animals once daily for 7 days to stop bleeding and early healing.
29	*Datura stramonium* L. Dhatura (Solanaceae)	Fruits	Heat initiation	2-3 Fruits are given to young cow or buffalo to initiate its heat for sooner fertilization.
30	*Dalbergia sissoo* Roxb. Shisham (Fabaceae)	Leaves	Diarrhoea	Leaf juice mixed with churning curd and given to the animals for diarrhoea.

S. No.	Botanical Name/ Local Name/ Family	Part Used	Diseases	Use And Usage
31	*Ephedra foliata* Boiss.& Kotschy ex Boiss. Unt phog (Gnetaceae)	Whole plant	Constipation	Decoction of whole plant is given to the animals to cure constipation.
32	*Euphorbia hirta* L. Dudhi (Euphorbiaceae)	Whole plant	Increasing lactation	Plants are feed as a fodder to cattles for increase lactation.
33	*Ficus benghalensis* L. Bargad (Moraceae)	Root	Stomachache	Root powder is given to cattles suffering from stomachache.
34	*Ficus religiosa* L. Peepal (Moraceae)	Leaves	Tonsilites	Leaf juice is used to cure tonsils.
35	*Lawsonia inermis* L. Mehndi (Lythraceae)	Leaves	Skin disease	Leaf paste is applied over skin to cure burns.
36	*Holoptelia integrifolia* (Rox.) Planch. Churel (Ulmaceae)	Leaves	Skin disease	Leaf paste is applied on wounds and on skin to remove lice.
37	*Leptadenia pyrotechnica* (Forsk.) Decne. Khimp (Asclepiadaceae)	Shoots		Young tender shoots are given for parturitio induction.
38	*Maytenus emarginata* (Willd.) Ding Hou Kankeda (Celastraceae)	Leaves	Cracked nipples	Leaves are burnt and ash mixed with mustard oil is applied over cracked nipples in cattles.
39	*Melia azadirach* L. Bakain (Meliaceae)	Leaves	Swelling	Leaves are applied externally to treat swelling in cattles.
40	*Momordica dioica* Roxb.ex Willd. Kakoda (Cucurbitaceae)	Root	Wound healing	Powdered roots are used to stop bleeding and rapid healing to boils and wounds.
41	*Ocimum americanum* L. Bapchi (Lamiaceae)	Seed	Cooling effect	Seeds are soaked in water and given to animals for cooling effect.
42	*Ocimum sanctum* L. Tulsi (Lamiaceae)	Leaves	Fever	Leaves are fed to animals to cure fever.

S. No.	Botanical Name/ Local Name/ Family	Part Used	Diseases	Use And Usage
43	*Oxalis corniculata* L. Khatari (Oxalidaceae)	Leaves	Diarrhoea Eye infection	Leaf juice is mixed with churning curd and given to the animal for diarrhoea. Leaf juice is used to cure eye infection.
44	*Pedalium murex* L. Dakhani Gokhru (Pedaliaceae)	Whole plant	Cooling effect	Whole plant is fed to the animals to give cooling effect during summer.
45	*Pergularia daemia* (Forsk) Chiov. Gadaria ki bel (Asclepiadaceae)	Whole plant	Increasing lactation	Whole plant extract is given orally to increase lactation.
46	*Portulaca oleracea* L. Luni (Portulacaceae)	Whole plant	Excessive bleeding	Whole plant is given to cows & buffaloes as feedstuffs to prevent excessive bleeding during and after delivery.
47	*Prosopis cineraria* (L.) Druce Janti, Khejri (Fabaceae)	Leaves	Hamstrung of muscles	Leaves (Loong) are very nutritious and used as fodder. They are crushed and tied on joints and hamstrung of cattles.
48	*Ricinus communis* L. Arandi (Euphorbiaceae)	Leaves	Wound healing	Leaf poder is rubbrd on the body of animals to cure the wounds.
49	*Saccharum munja* Roxb. Kuncha (Poaceae)	Leaves	Removal of plecenta	Young and green leaves are fed to animals for removal of retained plecenta.
50	*Saccharum spontaneum* L. Kans (Poaceae)	Leaves	Heat production	Leaves are fed to cattles for heat production in buffaloes.
51	*Salvadora oleoides* Decne. Jal (Salvadoraceae)	Leaves	Increasing lactation	Leaves are nutritious and fed to goats and cows for milk production.
52	*Sarcostemma viminale* (L.) R.Br. Khir-khimp (Asclepiadaceae)	Whole plant	Snake-bite	Whole plant infusion is applied by rural people on wound of snake bite.
53	*Sesamum indicum* L. Til (Pedaliaceae)	Seed	Eczema	Seed oil with adding a spoonful of sodium chloride is used to cure asthma.
54	*Solanum indicum* L. Tindra (Solanaceae)	Leaves	Ringworm	Leaf juice is given for treating ringworm in cattles.

S. No.	Botanical Name/ Local Name/ Family	Part Used	Diseases	Use And Usage
55	*Solanum nigrum* L. Makoi (Solanaceae)	Whole plant	Digestive disorders	Whole plant paste with clarified butter is given orally in digestive disorders to cattles.
56	*Sorghum halepense* (L.) Pers. Jowar (Poaceae)	Leaves	Increasing lactation	Green leaves are cut into small pieces and fed to cattles for increasing lactation.
57	*Tamarix dioca* Roxb. Firans (Tamaricaceae)	Bark	Cracked nipples	Ash of bark mixed with wax is applied over cracked nipples.
58	*Tecomella undulata*(Sm.) Seem. Rohida (Bignoniaceae)	Bark	Skin disease	Bark oil is applied locally to cure rashes on skin.
59	*Tinospora cordifolia* (Willd.) Miers. Giloy (Menispermaceae)	Root	Debility	Grinded roots are given to cure debility.
60	*Trianthema portulacastrum* L. Safed santa (Aizoaceae)	Leaves	Diarrhoea	Leaf paste with *Piper nigrum* seeds is given orally to treat diarrhoea.
61	*Tribulus terrestris* L. Gokhru (Zygophyllaceae)	Whole plant	Diarrhoea	Whole plant extract is given orally to cure diarrhoea.
62	*Tridax procumbens* L. Sadabhar Runkdi(Asteraceae)	Leaves	Injury	Paste of leaves is applied on injuries to prevent bleeding.
63	*Withania somnifera* (L.) Dunal Aksan (Solanaceae)	Root	Digestive disorders	Root decoction is given to animals in digestive disorders.
64	*Zizyphus nummularia* Wight & Arn. Bordi (Rhamnaceae)	Root	Foot and mouth disease	Root decoction is applied for foot and mouth disease in cattles.

Traditional Uses of Plants

Indigenous Huts

Wood or timber is a fundamental part of the traditional life particularly in the construction of shelters. Folk people designed their dwellings according to the available material and prevailing environmental conditions. Locally available plants are used for the construction of the skeleton of the hut. The later consists of pillar, beam, poles, wall, roof, doors and thatch etc. During the survey in the nearby villages of Beer conservation Reserve, circular type of huts with conical roof was observed. There are usually no windows in the huts (*Jhumpas*). The entrance to the jhumpa is low so that one has to bend before entering. Apart from a low door, there is no opening in the structure. Fodder and grains are also stored in specially built jhumpas. A shelter made from bricks with thatched roof "*Chhan*" was also a common feature of the rural area. The cattle are tied at one corner of this "*Chhan*". Sometimes, it is used as kitchen. A special type of hut "*Obra*" made of mud with thatched roof is used to containing food items. The walls are covered with a plaster of clay, cow-dung and hay making a termite free (antiseptic) façade (Plate 5.4).

The wood of various plants used in the construction of huts are: *Acacia nilotica, Salvadora oleoides, Tecomella undulata, Zizyphus nummularia, Clerodendrum phlomidis, Calotropis procera, Saccharum munja, Crotalaria burhia* and *Leptadenia pyrotechnica.*

Agricultural Implements

The agricultural implements consist of plough, harrow, levellers, cold crushers, seed drillers and hoes. Besides, there are several other implements like *kuhad* (axe), *kulhadi* (pick axe), *favda* (spade), *Khurpi* (weeding hoe), *dantali* (rake with wooden teeth), *dortii* (sickle) and *paner* (crowbar). The wooden part of these implements is made from locally available plants. (Plate 5.3a)

Sower (*Orna*)

This agricultural implement made of hollow bamboo is used by the farmer for sowing seeds like bajra, wheat, juwar, moong etc. It is tied behind the plough and sseds are dropped into the conical mouth, trickle down to the furrows.

Land – levellar (*Pata*)

It is used for levelling the ground evenly so as to maintain and preserve the moisture content of the field. A levellar is also employed for covering seeds after broadcasting. Normally wood of *Acacia nilotica* is used for levellar.

Plough

Plough is an agricultural implement which is used to cut the soil and make it suitable for the process called seed sowing. Indigenous plough is made up of wood with an iron share point. It consists of body, shaft pole, share and handle. It is generally drawn with camel in Jhunjhunu district. The horizontal part of plough is made up with wood of *Acacia nilotica* and *Acacia leucophloea*.

Harrow

After the ploughing, harrow is used to break the clods. It fundamentally consists of a long metal blade fixed to the lower end of a wooden plank. These were originally drawn by draft animals, but in modern practices, they are trailed after the tractor by a drawbar. The wooden plank is made of wood of *Acacia nilotica*.

Pulley (Bhuun)

A pulley is used to draw water from the well. It is made of *Acacia nilotica* or *Prosopis cineraria* wood. The pulley is mounted on two obliquely placed poles of *Acacia nilotica* or *Tecomella undulata* converging at the upper end where it is fixed and held in place by two upright sticks. The *patia* (a wide slab of wood) rose above ground over the mouth of well with the aid of two pillars called *khambas* made of *Dalbergia sissoo, Acacia nilotica, Prosopis cineraria* and *Tecomella undulata*. The sticks assisting the pulley are fixed on these *khambas*.

Transport

Wheel Barrow or Gada

It is a simple construction used to carry grains, fodder and wood from one place to another. It is composed of two small wheels tied to the yoke with the help of two diverging sticks and tied to the camel or oxen. The wheel is constructed from the wood of *Dalbergia sissoo* and *Tecomella undulata*. Bully is constructed from the wood of *Acacia nilotica* and *Azadirachta indica* (Plate 5.3b).

Protection from Farm enemies: Fencing

Boundaries for houses and land holdings, called Baras, are made of the dry branches of thorny bushes, a deterrent for straying cattles. About five to six feet high thorn fencing is put around the compound to ward off animals, thieves and also as protection against strong wind. Spiny stem and branches of *Zizyphus nummularia*, *Acacia nilotica, Acacia catechu* and *Capparis decidua* are tied with the aerial roots of *Ficus benghalensis* or with young shoots of *Leptadenia pyrotechnica* for fencing around the house. *Saccharum munja, Opuntia elatior*, *Ipomoea fistulosa* and *Maytenus emarginata* are used for field fencing.

Machan

A temporary hut erected on poles, *machan*, is formed to protect the crops from wild animals. It is formed from wood of *Acacia nilotica*, *Zizyphus nummularia* and *Prosopis cineraria*.

Gate for huts (Jhanto or Jhanti)

A fencing using various live plants or dead ones or their wood is generally seen on the opening of a hut which forms the gate. Vertical support of the gate is made of *Tecomella undulata*, *Clerodendron phlomoides* or *Lycium barbarum* and tied with ropes of *Leptadenia pyrotechnica.*

Household Articles:

Grain Grinder *(Chaki)*

Indian traditional grinder *"Chaki"* or *"Ghatt"* is made of two circular stones in opposing pairs to crush grains. This is the simple way of making flour. The wooden handle of *"Chaki"* is made from wood of *Tecomella undulata* or *Dalbergia sissoo*. (Plate 5.3e)

Wooden Mortar and Pastle Set

Wood of *Acacia catechu, Azadirachta indica and Dalbergia sissoo* are chosen for making a pestle. Mortar is made of the wood of *Acacia leucophloea*, *Acacia nilotica* and *Albizia lebbeck.* (Plate 5.3d)

Butter Churn (*Bilona Stand and Jherna*)

A butter churn is a device used to convert cream into butter. A traditional butter churn is operated by the pulling the rope to spin the churning stick inside the narrow neck clay pot. Butter churn stand is made from wood of *Prosopis cineraria*, while churning stick is prepared from roots of *Zizyphus nummularia* (Plate 5.3c).

Winnowing pan *(Chhajlo or Supra)*

It is used for removing chaff from grains by the rural ladies. The flowering scape and culms of *Saccharum munja* are woven into winnowing trays (*Chhajlo*), which is used for cleaning grains (Plate 5.3f).

Brooms

Different types of brooms made up of plant materials are used by folk people.The stalk and culm of the inflorescence of *Desmostachya bipinnata*, *Saccharum munja* and *Saccharum spontaneum* are used for broom. Stem and branches of *Leptadenia pyrotechnica, Sida ovata* and leaves of *Phoenix sylvestris* are also used for making broom (Plate 5.3g).

Cots and Ropes

Sheath blade of *Saccharum benghalense* is beaten and used for making ropes (*Munj*). These ropes are employed for cots. Vertical, horizontal and base parts of cots are made from stem of *Zizyphus mauritiana, Azadirachta indica, Acacia nilotica, Dalbergia sissoo* and *Tecomella undulata*. Legs of cots are made from *Dalbergia sissoo, Acacia nilotica* and *Tecomella undulata*.

Young branches of *Leptadenia pyrotechnica* are employed for making ropes. These ropes are used by rural people to tie the stack of grasses and a circular ring made from these ropes is used to form *haari* on which pots are placed.

Miscellaneous Articles

Rakhwala* or *Bijuka

To protect the grains form birds and animals various kinds of figures resembling human are erected in the crop fields in nearby villages. Two wooden sticks of *Prosopis cineraria* or *Acacia nilotica* are tied in cross cris manner and

planted in the ground by tying grasses and leaves to these sticks giving the shape of hands. Earthen pot *(Matka)* is placed in reverse position as head. This wooden framework is decorated by putting old clothes of farmers (*dhoti, kurta, safa* or *payjama*). They are known by several names *Bijuka, Darawa, Howa or Rakhawala* etc. (Plate 5.3h)

Musical Instruments

Time immemorial some old traditions followed in the regions is a boom for the local populations. Conventionally the people inhabiting the Shekhawati region of Rajasthan were known for their love for music and style of singing. The tribals and rural people are fond of songs and music. Here are a few local instruments frequently used in traditional Rajasthani folk music.

Chang* or *Dhap

The chang provides the beats for a festive singing and dancing tradition from the Shekhawati belt of Rajasthan and genre *'Chang Nritya'* gets its name from the principal instrument so employed. *Chang* comprises of a circular, shallow wooden frame and at times is also a pentagon. It is mounted with leather on one end and is lift open on the other. The bottom of the palms provide the base while playing the *Chang* and the treble is generated by small pencil thin sticks that are used to strike the leather surface. Players carry the *Chang* as they sing, dance and play it simultaneously. Shekhawati region is famous for *'Chang dance'* which is starts from the Maha Shivratri festival and ends on *Dhulandi*, day after the Holi festival (Plate 5.4).

Dhol

It is a very popular folk drum instrument of music. It produces very powerful sound and is mainly used by *'Rana'* or *'Dholi'* community on the occasion of festival of Gangaur. The dhol is a barrel shaped drum made up of wood of *Azadirachta indica, Dalbergia sissoo* and *Mangifera indica*. They have parchments of animal skin on both the ends held by strings. Normally a 'Dhol' is "18 to 20" inches in length and 12" in breadth. Dholis hang their Dhols from the shoulder or

place it on their lap and play it with one or two wooden sticks that are made of *Calotropis procera* or *Clerodendrum phlomidis*.

Flutes

Tribal flutes are made up of *Denrocalamus*. A flute or bansuri is a simple cylindrical tube of uniform bore and vary in size. It is held horizontally and is inclined downwards when it is played. To produce sound melody one has to cover the finger holes with the fingers of the left and right hand. Variations in pitch are produced by altering the effective length of the air column.

Dholak

Dholak is a very popular folk drum of tribals as well as in of Northern India. It is barrel shaped with a simple membrane on the right hand side, basically it is just a smaller version of the dhol. The left hand side membrane has a special coating on the inner surface (dholak masala), which lowers the pitch and provides a well defined tone. Both ends and wooden body is tied with strips of *Dendrocalamus strictus*. The wood of *Acacia nilotica*, *Azadirachta indica*, *Dalbergia sissoo* and *Mangifera indica* is used in this instrument.

Tambura

The tambrua is a stringed instrument that is played as a folk instrument by tribals. It is one of the long neck lutes. It is usually stringed with 4 or 5 metal strings. The instrument is played by plucking the string with ones finger. Long piece of wood is attached over rounded part of the body. The wooden materials used for the construction of the body are *Acacia catechu*, *Mangifera indica*, *Moringa oleifera* and *Dalbergia sissoo*.

Algoza

Algoza is a pair of wooden flutes and the player works the Algoza by alternating three fingers on the holes on each side. A vigorous and swinging rhythm is created when the player breaths into the algoza rapidly. Hollow dry stem of *Calotropis procera* or bamboo are used for the pipes of the instrument which may be tied by string or held at an angle**.**

Ravanhatha

Ravanhatha is an ancient bowed violin. The bowl is made of a cut coconut shell that is covered with goat hide. A long piece of *Dendrocalamus strictus* is attached to this shell. The two main strings are made of steel and horsehair respectively. It is played with a curved bow of horse tail hair draw across the strings with rhythmic jerks. It is held by the left hand, the resonator resting on the left side of the chest (Plate 5.4).

Fun with Plants

Wooden tricycle (*Gadula*)

A trick made up of three wooden wheels which are attached to each other with three flat wooden piece of *Prosopis cineraria* or *Acacia nilotica*. Sometimes it is made by *Tecomella undulata*. This tricycle will be fun for baby from about a year old. The toddler pushes it with the built in handle and learn to walk.

Slingshot (*Gulel*)

It is a Y shaped toy which requires a Y shaped stick, some rubber bands or rubber cut from old inner tube, small diameter string and some old shoe leather or suitable material to make a small pouch to hold projectile. The hardest part of making the slingshot is finding good handle. *Maytenus emarginata* is commonly used for making gulel in the study area, because it has a lot of forked limbs and the wood is light weight and strong. Children used this gulel for running away birds, because they spoil their foodgranis and fruits.

Pupadi

The leaves of *Ficus benghalensis*, *F. religiosa* and *Holoptelia integrifolia* are folded and held between the lips and blown like a whistle. This is the simplest musical instrument of rural children.

Toy Truck (*Gadi*)

Rural children played with self made toy truck trailed by them on the roads. Wheels are made of wood of *Acacia nilotica* or *Prosopis cineraria*. Sometimes wheels made of iron wire or rubber is also used.

Gilli – Danda

Children play on ground with gilli-danda, made from wood of *Prosopis cineraria*.

Bow and Arrow (*Tir-Kaman*)

Children play with self-made bow and arrow. It is made of wood of *Morus alba*.

Swings *(Hindo)*

Rope Swings are created by tying one end of a length of rope to a tree branch. A knot or loop is usually put on the other end to prevent fraying and help the swinger stay on. A wooden plank, made from *Acacia nilotica* or *Tecomella undulata* is suspended on both sides by ropes from a tree branch.

Plant Species in Rituals

Many plant species are utilized in different traditional magico-religious by the folk and rural people inhabiting near Beer forest area. Traditional socio-religious information of plant species used in different rituals was collected through participation in ceremonies and semi-structural personal interview with the knowledgeable elderly people. The collected plant species were carefully identified and enumerated with the help of relevant scientific literature (Table 5.3).

Wild Edible Plants

The Beer protected forest is enriched with many wild edible plants which are still consuming more or less by tribal and rural people inhabiting near the area. Information regarding the utilization of wild edible fruits and vegetables were obtained through interview, field observation and group discussion. The wild edible plant species are arranged alphabetically along with their botanical name, local name, family and their usage (Table 5.4).

RESULT

The present study reveals that more than 80%people of the rural area depend for their primary healthcare on folk medicine, mainly of plant origin. The use of medicinal plants is still trusted in the local health care system in the traditional societies. The study has brought to light some folk recipies, used currently by the

traditional healers of various cultures in Jhunjhunu district of Rajasthan for curing different ailments. According to present survey, the people inhabiting near the Beer Conservation Reserve of Jhunjhunu used 120 plant species belonging to 48 families for curing various ailments. The ethomedicinal plant species are arranged in alphabetical botanical names, family, local name, plant part used, ailments and ethnomedicinal uses. Present observation entails that the recorded plants are used in curing many diseases and health problems such as asthma, arthritis, bile, blood purification, body pain, rheumatism, gastric troubles, skin diseases, snake-bite, stomach-ache, jaundice, bronchitis, cold, piles, toothache, cough, diarrhoea, dysentery, urinary disorders, fever, dropsy, ulcer, leucoderma, gonorrhoea, kidney stone and debility. A total of 120 plant species of angiosperms including one gymnosperm were identified for medicinal purposes during the present study.

Different parts of plants like leaves, roots, stem, tuber, bark, flower, fruit, seeds etc. are being used for different purposes. The most common families in the study were Fabaceae (15species), Asteraceae (8 species), Amaranthaceae (8 species), Solanaceae (8 species), Asclepiadaceae and Cucurbitaceae (6 species), Malvaceae (5 species) Euphorbiaceae, Acanthaceae and Zygophyllaceae (4 species) Capparidaceae, Teliaceae, Molluginaceae and Menispermaceae (3species). Other families with low number are listed as : Lythraceae , Moraceare , Lamiaceae and Salvadoraceae (2 species) ; Papaveraceae, Aristolochiaceae, Liliaceae , Meliaceae, Simaroubaceae, Elatinaceae , Nyctaginaceae , Rubiaceae, Chenopodiaceae, Verbenaceae, Cyperaceae, Gentianaceae, Convolvulaceae, Fumaricaceae, Boraginaceae, Celastraceae, Oxalidaceae, Pedaliaceae, Polygonaceae, Portulacaceae, Bignoniaceae , Aizoaceae, Rhamnaceae, Primulaceae, Ehretiaceae, Cuscutaceae, Rutaceae, Scrophulariaceae and Gnetaceae(one species). On the behalf of quantitative analysis, the maximum plant species were herbs (76) followed by trees (20), climbers (14) and shrubs (10).These plant species were used for curing various diseases, ranging from simple abdominal pain to lightly complicated male and female urogenital disorders. Even jaundice and kidney stones were treated by them. Maximum numbers of plants were used for curing skin diseases, cough, asthma and

rheumatism followed by piles, liver disorder, toothache and urination. The various modes of administration are as follows:

(1) Plant part made edible either by powdering, burning or frying and mixing with other ingradient or food.
(2) Raw plants/ parts/ products.
(3) Extract by crushing or producing fresh drug or slicing or chopping it.
(4) Juice/ simple rubbing of plant.
(5) Decoction/ gargle.
(6) Ash of plant.
(7) Paste.
(8) Poultices.
(9) Herbal bath.
(10) Tying drug to body part.
(11) Oils.
(12) Cooking as vegetables, laddooes *etc*.
(13) Smoking of plant.

It was found that different parts of a single plant may be used for curing many ailments. Percentage of plant parts of ethnomedicinal plants used in the study areas are given in Figure 5.1. Local healers commonly use the following plants to treat many diseases:

Acacia nilotica, Acacia catechu, Azadirachta indica, Pedalium murex, Tribulus terrestris, Prosopis cineraria, Ficus benghalensis, Ocimum, Solanum xanthocarpum, Citrullus colocynthis and *Salvadora* species.

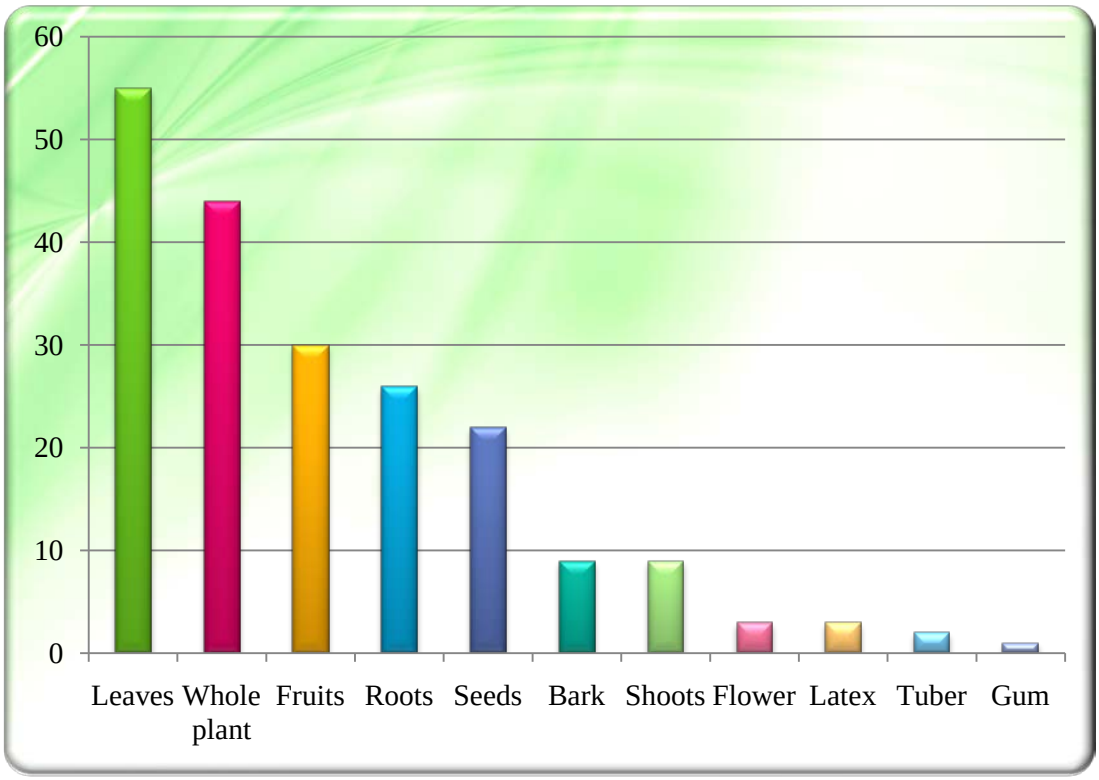


Figure 5.1(A): Various parts of Plants used in ethnomedicine

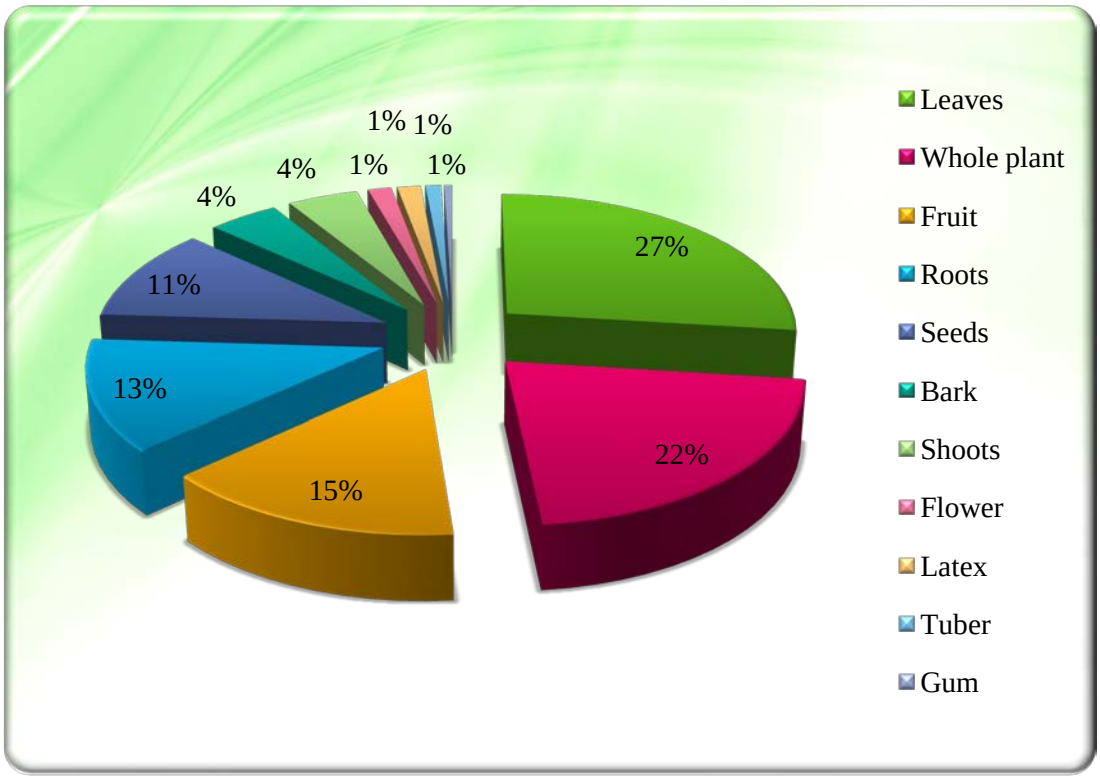


Figure 5.1(B): Various parts of plants used in Ethnomedicine

The medicinal plants have been categorized on the basis of diseases in which they are used:

- **Bowel complaints:** *Acacia senegal*, *Polygonum plebeium*, *Sida cordifolia.*
- **Ulcer**: *Aegle marmelos, Acacia nilotica, Aerva persica*
- **Constipation:** *Aegle marmelos*, *Amaranthus graecizans*, *Cassia italica*, *Digera muricata*, *Salvadora persica*
- **Antidote**: *Albizia lebbeck*, *Asphodelus tenuifolius*, *Balanites aegyptiaca*, *Bergia ammanioides*, *Ceropegia bulbosa*, *Citrullus lanatus*, *Ruellia patula*, *Ficus benghalensis*, *Sarcostemma viminale*, *Tinospora cordifolia*
- **Skin diseases (**Itching, eczema, eruptions, scabies, acne, psoriasis, ringworm**):** *Alternanthera sessilis, Bauhinia racemosa*, *Argemone mexicana*, *Ammannia baccifera, Aristolochia bracteolata, Azadirachta indica*, *Balanites aegyptiaca*, *Cassia occidentalis*, *Crotalaria burhia, Cucumis melo, Fagonia indica, Ficus religiosa, Fumaria indica, Leptadenia reticulata*, *Phyllanthus fraternus, Solanum nigrum, Solanum surattense*, *Tecomella undulata, Xanthium indicum, Cucumis callosus, Cannabis sativa*
- **Leucoderma:** *Euphobia hirta*, *Ocimum americanum*
- **Brain tonic:** *Bacopa monnieri*, *Evolvulus alsinoides*
- **Cold and Cough:** *Ocimum sanctum*, *O. americanum, Cordia dichotoma*, *Achyranthes aspera, Echinops echinatus*, *Oligochaeta ramosa*, *Pulicaria crispa*, *Salvadora oleoides*, *Solanum nigrum, Tephrosia purpurea*
- **Baldness/ Hair Loss:** *Eclipta prostrata, Cuscuta reflexa, Azadirachta indica, Datura metel*
- **General Weakness:** *Acacia senegal***,** *Glinus lotoides***,** *Leptadenia reticulata*, *Mimosa hamata, Pedalium murex*
- **Coolant:** *Calligonum polygonoides, Boerhavia diffusa, Citrullus lanatus*, *Mollugo cerviana, Ocimum americanum, Oxalis corniculata, Salvadora oleoides*
- **Wound and Sores:** *Bergia suffruticosa, Ruellia patula, Echinops echinatus*, *Mimosa hamata, Tridax procumbens*
- **Gonorrhoea:** *Dalbergia sissoo, Clerodendrum phlomiidis, Mollugo cerviana*

- **Urination:** *Abutilon indicum, Citrullus lanatus, Fumaria indica, Launaea procumbens, Lawsonia inermis, Leucas cephalotes, Pedalium murex, Trianthema portulacastrum, Xanthium indicum*
- **Rheumatism:** *Acacia catechu, Aerva persica, Anagalis arvensis, Capparis decidua, Citrullus colocynthis, Cleome gynandra, Cocculus hirsutus, C. pendulus, Justicia simplex, Lawsonia inermis, Pedalium murex, Prosopis cineraria, Salvadora oleoides, S. persica, Sarcostemma viminale, Solanum surratense, Withania somnifera*
- **Oral complaints (**Mouth ulcer, Pyorhhoea, Painful gums**,** Tooth decay**):** *Barleria prionitis, Azadirachta indica, Acacia nilotica, Salvadora oleoides, S. persica, Achyranthes aspera, Solanum indicum, S. surattense, Tribulus terrestris, Argemone mexicana, Capparis decidua*
- **Jaundice:** *Boerhavia diffusa, Andrographis paniculata, Alysicarpus monilifer, Citrullus colocynthis, Fumaria indica*
- **Fever:** *Enicostemma hyssopifolium, Tinospora cordifolia, Momodica balsamina, Sida cordifolia, Ammania baccifera*
- **Malaria:** *Azadirachta indica, Datura metel, Enicostemma hyssopifolium, Calotropis procera*
- **Dengue:** *Boerhavia diffusa, Euphorbia hirta, Tinospora cordifolia*
- **Epilepsy:** *Indigofera linnaei*
- **Worm killer:** *Aristolochia bracteolata, Gisekia pharnaceoides, Heliotropium marifolium, Jatropha gossypifolia, Triumfetta pilosa*
- **Carbuncles:** *Balanites aegyptiaca, Pergularia daemia, Ricinus communis*
- **Stone:** *Boerhavia diffusa, Ceropegia bulbosa, Nothosaerva brachiata, Tribulus terrestris*
- **Eye disease:** *Borreria articularis, Cleome gynandra, Zygophyllum simplex*
- **Abdominal pain:** *Calotropis procera, Celosia argentea*
- **Gastric trouble:** *Capparis decidua*
- **Asthma:** *Cassia occidentalis, Coccinia grandis, Datura metel, D. stramonium, Ephedra foliata, Euphorbia hirta, Fagonia indica, Tephrosia purpurea*

- **Piles:** *Celosia argentea, Chenopodium album, Cleome viscosa, Ficus benghalensis, F. religiosa, Maytenus emarginatus, Peganum harmala, Ricinus communis, Rhynchosia minima, Solanum surratense, Sphaeranthus indicus*
- **Uterine Disease and uterine cleaning**: *Celosia argentea, Evolvulus alsinoides, Mollugo cerviana*
- **Urinary Troubles:** *Chenopodium album, Physalis minima, Pupalia lappacea*
- **Sexual power and Fertility:** *Ceropegia bulbosa*
- **Hepatitis:** *Phyllanthus fraternus*
- **Liver Disease:** *Cleome viscosa, Corchorus depressus, Lawsonia inermis, Portulaca oleracea, Tephrosia purpurea, Tinospora cordifolia*
- **Syphilis:** *Clerodendrum phlomidis*
- **Arthritis:** *Clerodendrum phlomidis*
- **Measels:** *Peganum harmala, Clerodendrum phlomidis*
- **Diabetes:** *Coccinia grandis, Enicostemma hyssopifolium, Lycium barbarum, Momordica balsamina*
- **Leucorrhoea:** *Cocculus hirsutus, Hibiscus ovalifolius, Oligochaeta ramosa, Tecomella undulata, Tinospora cordifolia, Withania somnifera*
- **Allergy:** *Citrullus colocynthis*
- **Diarrhoea:** *Corchorus depressus, Pergularia daemia, Triumfetta pilosa, Triumfetta rhomboidea*
- **Tympanites:** *Cucumis melo*
- **Stomach disorder:** *Cyperus rotundus, Physalis minima*
- **Bone Fracture:** *Ruellia Patula, Pupalia lappacea, Sarcostemma viminale*
- **Increasing lactation:** *Digera muricata, Euphorbia hirta*
- **Thorn Injury:** *Leptadenia pyrotechnica*
- **Bronchitis:** *Eclipta prostrata, Ocimum sanctum*
- **Diphtheria:** *Ephedra foliata*.
- **Boil and Blisters:** *Ficus benghalensis, Lawsonia inermis, Prosopis cineraria, Tridax procumbens, Zizyphus nummularia, Portulaca oleracea*.

- **Spermatorrhoea:** *Ficus benghalensis, Tribulus terrestris.*
- **Migraine:** *Indigofera linnaei*
- **Anaemia:** *Lycium barbarum.*
- **Menstrual disorder:** *Lycium barbarum, Zizyphus nummularia*.
- **Inflammation:** *Malvastrum coromandelianum*.
- **Anti-Lice:** *Peganum harmala*
- **Pneumonia:** *Prosopis cineraria, Tecomella undulata*
- **Miscarriage:** *Prosopis cineraria*
- **Postnatal and Abdominal Pain:** *Ricinus communis*
- **Chikungunia:** *Tinospora cordifolia*
- **Tumour:** *Triumfetta rhomboidea*

In the present study 64 medicinal plant species of ethnoveterinary uses were documented. The routine maladies of livestock viz. diarrhoea, injury, fever, digestive disorders and maternity complications etc. are treated with these medicinal plants. Detailed information pertaining to these medicinal plants used in ethnoveterinary medicine with their botanical name, vernacular names, family plant part used, mode of drug preparation and disease cured is given in Table 5.2.During the present study 64 plant species belonging to 57 genera and 36 families were documented. Generally freshly collected plants or plant parts are used for treatment of various diseases in animals. Most commonly used part were seeds, leaves, whole plant and fruit, but in many cases roots, twigs, bark powder were also used for treatment. Single plant is used to treat some diseases as well as combination of two or more plants is also used to treat many other diseases. Percentage of plant parts of ethno veterinary medicinal plants used in the study areas are given in Figure 5.2.

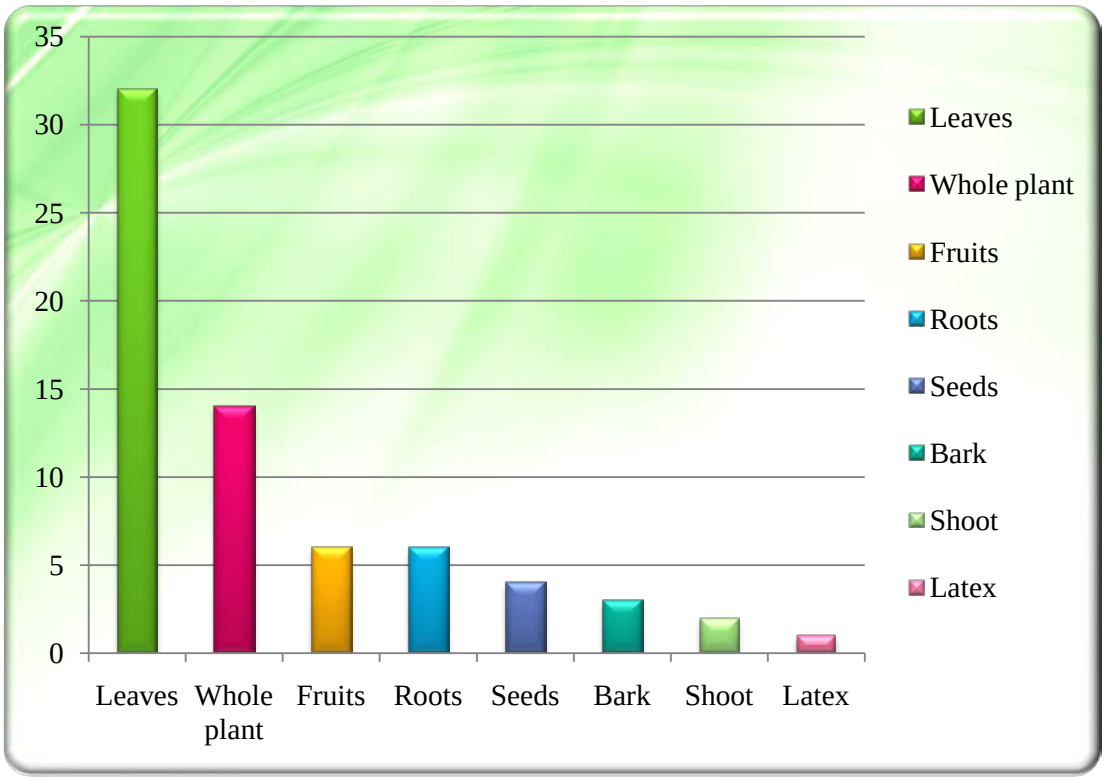


Figure 5.2A: Various Plant parts in ethnoveterinary uses

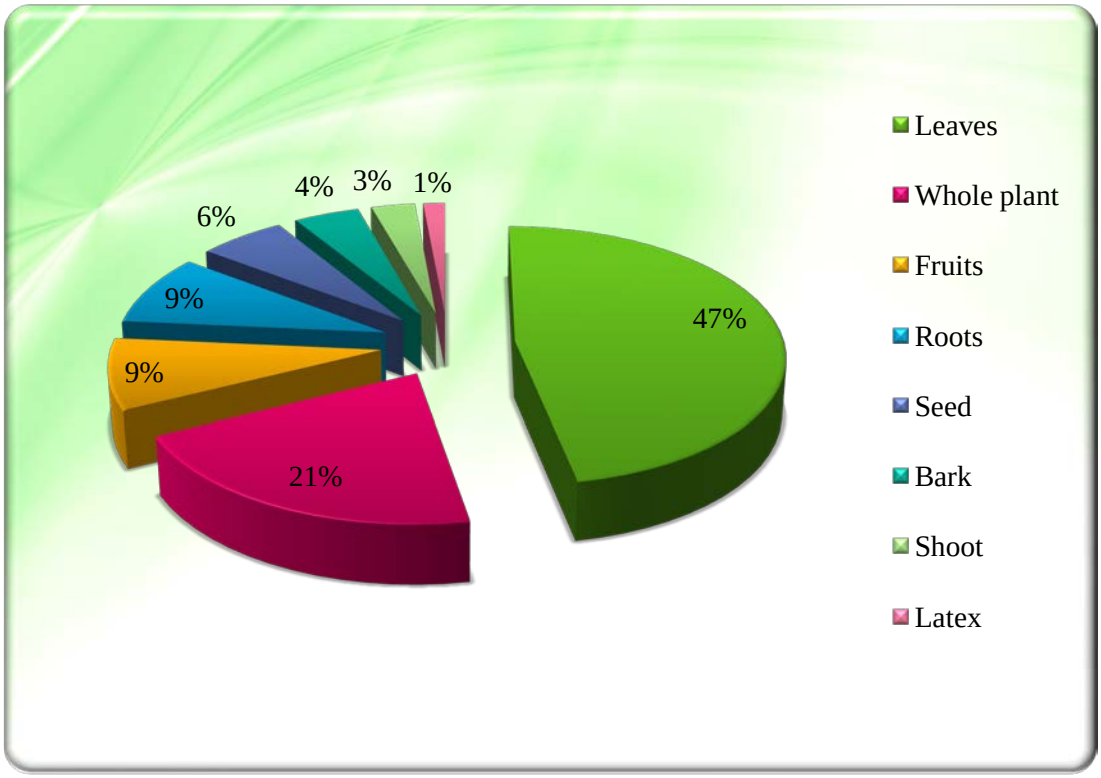


Figure 5.2B: Various Plant parts in ethnoveterinary uses

Many plant species were frequently used for shelter making. 'Jhumpha' and 'Chhan' are the traditional shelters in the villages nearby the Beer Jhunhunu Conservation Reserve. The wood of *Acaia nilotica, Tecomella undulata, Clerodendrum phlomoides, Zizyphus nummularia* and *Salvadora oleoides* are used for shelter making. The roof is thatched with a combination of *Crotalaria burhia, Calotropis procera, Saccharum munja* and *Leptadenia pyrotechnica*.

Many household items and miscellaneous articles made from locally available wood were traditionally used by tribal and rural people of the area. Wood of *Acacia nilotica, Tecomella undulata* and *Dalbergia sissoo* is used for agricultural implements such as plough, harrow, levelers, cold crushers and seed drillers. Various musical instruments made from wood of *Mangifera indica, Moringa oleifera, Dalbergia sissoo, Acacia catechu, Dendrocalamus strictus, Azadirachta indica, Clerodendrum phlomoides* and *Calotropis procera* were also observed during the study. It was observed during the study that different parts of plant or the whole plant is used as various cultural religious rites and ritual purposes. In the present study of Beer Jhunjhunu Conservation Reserve of Rajasthan, 23 plant species used by the rural people in ritual ceremonies are recorded (Table 5.3).

A number of plants from present study area are eaten by the rural and tribal people. Most of these food materials possess high nutritional values. There are large number of forest plants including trees, shrubs, herbs and climbers which yields edible fruits and vegetables. Leafy greens with tender shoots are boiled in water, squeezed and cooked with salt and condiments and taken along with the bread (chapati). These are eaten in a variety of forms. Some are eaten either ripened or unriped, while other are consumed after cooking. Some of the fruits are pickled and some are made into other products. Several leaves are good substitute for the green vegetables. Some leaves make a good soup. Seed of a large number of species are also edible. The present study deals with 38 plant species consumed by rural and folk people of the Beer Conservation Reserve area (Table 5.4).

Table 5.3: Plant Species used in Rituals

S. No.	Name of Plant	Plant Part Used	Rituals
1.	*Acacia nilotica* (L.) Willd	Whole plant	Used in sacred fire (Havans).
2.	*Azadirachta indica* A. Juss.	Leaves	Used in '*Bandarwal*' (string for door) on the occasion of Grih pravesh and child birth. Also used for *Neem jhuwari* marriage ceremony.
3.	*Aegle marmelos* (L.) Corr.	Leaves	Offered to Lord Shiva.
4.	*Calligonum polygonoides* L.	Twigs	Offered to Shiv Gauri on Gangaur pujan.
5.	*Calotropis procera* R. Br.	Flowers	Offered to Lord Shiva.
6.	*Calotropis gigantea* (L.) R. Br.	Flowers Leaves	Offered to Lord Shiva.
7.	*Cannabis sativa* L.	Fruits	Offered to Lord Shiva on 'Mahashivratri' and in festivals.
8.	*Citrullus lanatus* (Thunb.) Mats.	Flowers	Used in Diwali pujan.
9.	*Clitoria ternatea* L.	Fruits	Offered to Lord Vishnu.
10.	*Cucumis callosus* (Rottl.) Cogn.	Whole plant	Used in Diwali pujan.
11.	*Cynodon dactylon* (L.) Pers.	Flowers	It is used in almost all religious rituals supposed to please lord Ganesha.
12.	*Datura stramonium* L.	Whole plant	Offered to Lord Shiva.

S. No.	Name of Plant	Plant Part Used	Rituals
13.	*Desmostachya bipinnata* (L.) Stapf	Whole plant	Used in Sacred fires (Havan).
14.	*Emblica officinalis* Gaertn.	Whole plant	Holy tree and ladies worships on Aonla Navami.
15.	*Ficus benghalensis* L.	Whole plant	Holy tree, worship of Hanuman.
16.	*Ficus religiosa* L.	Flowers Leaves	Sacred tree associated with planet Saturn and Jupiter and worshiped to need off blessing on almost all rituals.
17.	*Hibiscus rosa-sinensis* L.	Leaves	Offerred to goddess *Kali Mata*.
18.	*Lawsonia inermis* L.	Flowers	Paste of leaves used in marriage and religious ceremony.
19.	*Mangifera indica* L.	Whole plant	Leaves are used in making string for door on every auspicious occasion to attract positive power.
20.	*Nerium indicum* L.	Whole plant	Used in festivals.
21.	*Ocimum sanctum* L.	Twigs	Sacred plant, associated with Saligram (Lord Vishnu).Worshipped daily in temples and homes due to a belief that it wards off the evil spirit from house.
22.	*Prosopis cineraria* (L.) Druce	Stem	It is worshipped on the occasion of Dushehra in Ashwin month.
23.	*Zizyphus nummularia* (Burm.f) Wt. & Arn.	Twigs	Twigs are used for ‘Mugdana’ in marriage ceremony of study area. Used in havan and Ahuti. Used in ritual of Hindu marriage ‘Toran Puja’ particularly in Rajasthan.

Table 5.4: Wild Edible Plants

Sr. No.	Botanical name	Common Name	Family	Fruits and Vegetables
1.	*Acacia senegal* (L.) Willd.	Kumta	Fabaceae	Fruits are used as vegetable.
2.	*Aegle marmelos* (L.) Corr.	Beel	Rutaceae	Ripe fruit pulp is eaten.
3.	*Amaranthus graecizans* L.	Chaulai	Amaranthaceae	Leaves are cooked and eaten as vegetable.
4.	*A. spinosus* L.	Chaulai	Amaranthaceae	Leaves are cooked and eaten as vegetable.
5.	*A. viridis* L.	Chaulai	Amaranthaceae	Leaves are cooked and eaten as vegetable.
6.	*Azadirachta indica* A. Juss.	Neem	Meliaceae	Fruits (nimbolis) are eaten.
7.	*Banhinia racemosa* Lamk.	Jhinjha	Fabaceae	Fruits are eaten.
8.	*Boerhavia diffusa* L.	Santo	Nyctaginaceae	Leaves are cooked as vegetable.
9.	*Calligonum polygonoides* L.	Phog	Polygonaceae	Flower buds are mixed in curd and eaten.
10.	*Capparis decidua* (Forsk.) Edgew.	Kair	Capparaceae	Fruits are eaten as pickles.
11.	*Ceropegia bulbosa* Roxb.	Khadula	Asclepiadaceae	Leaves and tubers are eaten.
12.	*Chenopodium album* L.	Bathua	Chenopodiaceae	Leaves are cooked and eaten as vegetable.
13.	*Citrullus lanatus* (Thunb.) Mats.	Matira	Cucubitaceae	Fruits are edible.
14.	*Coccinia grandis* (L.) Voigt	Tindori	Cucurbitaceae	Fruits are cooked as vegetable.
15.	*Commelina benghalensis* L.	Moriyabati	Commelinaceae	Leaves are eaten as vegetable.
16.	*Cordia dichotoma* Forst. f.	Lasoda	Ehretiaceae	Fresh fruits are edible.
17.	*Cucumis callosus* (Rottl.) Cogn.	Kachra	Cucurbitaceae	Fruits are eaten as vegetable. Also used in pickles.

Sr. No.	Botanical name	Common Name	Family	Fruits and Vegetables
18.	*Digera muricata* (L.) Mart.	Ghundro	Amaranthaceae	Leaves are cooked as vegetables.
19.	*Ephedra foliata* Boiss ex C.A. Mey	Unt-phog	Gnetaceae	So called fruits are edible.
20.	*Ficus benghalensis* L.	Bad	Moraceae	Fruits are eaten.
21.	*Gisekia pharnaceoides* L.	Sureli	Molluginaceae	Leaves are cooked as vegetables.
22.	*Holoptelea integrifolia* (Roxb.) Planch.	Churel	Ulmaceae	Fruits are eaten.
23.	*Leptadenia pyrotechnica* (Forsk.) Decne.	Khimp	Asclepiadaceae	Fruits (khimpoli) are cooked and eaten as vegetable.
24.	*Momordica balsamina* L.	Bar kareliya	Cucurbitaceae	Fruits are eaten as vegetables.
25.	*Momordica dioica* Roxb.	Kakoda	Cucurbitaceae	Fruits are eaten as vegetable.
26.				
27.	*Moringa oleifera* Lamk.	Sehjana	Moringaceae	Pods are used as vegetable.
28.	*Morus alba* L.	Shehtoot	Moraceae	Fruits are eaten.
29.	*Ocimum americanum* L.	Bapchi	Lamiaceae	Seeds are used for making cool and refreshing drinks.
30.	*Oxalis corniculata* L.	Khatti buti	Oxalidaceae	Leaves are eaten.
31.	*Pithecellobium dulce* (Roxb.) Benth.	Jangal Jalebi	Fabaceae	Fruits are eaten.
32.	*Physalis minima* L.	Pichoo	Solanaceae	Fruits are edible.
33.	*Portulaca oleracea* L.	Lunkia	Portulacaceae	Leaves are cooked as vegetable.
34.	*Prosopis cineraria* (L.) Druce	Janti	Fabaceae	Fruits (Sangri) are cooked as vegetable. Dried fruits (khokha) are eaten.

Sr. No.	Botanical name	Common Name	Family	Fruits and Vegetables
35.	*Salvadora olioides* Decne.	Mitha Jal	Salvadoraceae	Fruits (Pilu) are eaten.
36.	*Salvadora persica* L.	Khara Jal	Salvadoraceae	Fruits (Pilu) are eaten.
37.	*Trianthema portulacastrum* L.	Safed santo	Aizoaceae	Leaves are cooked.
38.	*Zizyphus nummularia* (Burm.f.) Wt.	Bordi	Rhamnaceae	Fruits are edible.
39.	*Zizyphus mauritiana* Lamk.	Ber	Rhamnaceae	Fruits are edible.

Famine food

Time immemorable some old traditions followed in the arid regions is a boon for the local population. Experience of generations, passed on to the successive generation have taught them well to survive in the harsh arid zone environment.Many times the state of Rajasthan has subjected to a severe famine due to the absence of regular rainfall during rainy season. The history reveals that there had been such severe famine during 1868-1870 and 1899-1901 which were termed as *Trikal* and *Chhappania Akkal* respectively. Since there was no food, fodder and adequate water for drinking, about one million human beings and cattle died due to hunger and thrust.

The wild plants of the famine affected area were also badly damaged and people exclusively remained dependent on such wild plants which were being used during famine period. The seeds of *Cenchrus biflorus* (Bhurut), *Panicum turgidum* (Murat), *Lasiurus sicndicus* (Sewan), *Dactyloctenium sindicum* (Garithia), *Eleusine compressa* (Tantia), *Citrullus colocynthis* (Tumba), *C. lanatus* (Matira), *Echinochloa colonum* (Soma), *Acacia nilotica* (Kikar), *Acacia senegal* (Kumta) , *Acacia leucophloea* (Ronz) and *Tamarindus* (Imli) are boiled, sundried and stored. These seeds are used during famine. The seeds are eaten raw or fried or mixed with Bajra and Jowar grains to increase the bulk and taste.

DISCUSSION

Ethnobotany deals with the direct relationship of plants with man. It includes study of food, fibre, dyes and other useful and harmful plants, taboos, avoidances and even magico-religious beliefs about plants (Jain, 1967; Ford, 1978). Throughout the ages, humans have relied on nature for their basic needs for the production of food, fodder, shelter, clothes, fertilizers, flavour, fragrances and medicines. Plants have formed the basis of sophisticated traditional medicine systems that have been in existence for thousands of years and continue to provide mankind with new remedies.

During the past few decades there has been renewed attention and interest in the use of traditional medicine globally. The World Health Organization (WHO) has listed 20,000 medicinal plants globally, in which contribution of India is 15-20%

(Gupta and Chadha, 1995). The WHO reported that 80% of global countries depend on the medicinal plants (Pareek, 1996). A large number of evidences are present to show potential of medicinal plants used in various traditional systems. In the past few years more than 13,000 plants have been studied for the various diseases and ailments in all over the world (Dahanukar *et al*., 2000). In developing countries like India, 65% of the population in the rural areas uses traditional form of medicine to meet their primary health care needs. Moreover, traditional medicine practices, conserved over decades from old civilization, can serve as an effective basis for the discovery and development of modern therapeutic drugs.

In Rajasthan where 80% of its people live in the rural areas cannot afford costly medicine. They depend on vegetation surrounding them and make prefect uses of them for their medicinal needs. About 610 species of medicinal plants have been used by 42 lakh population of tribals of Rajasthan (Singh and Pandey, 1998). The traditional healers of Shekhawati region of Rajasthan are having a commendable knowledge of the medicinal value of plants those grow around them (Katewa and Galav, 2004). These people successfully treat many difficult diseases using plant based medicines. Tribal and rural people of the study area frequently use the crude extract of locally available plants for medicinal and other purposes. A large number of plants and plant products are used for folk herbal medicines. Some of the plants reported for the treatment of various ailments from different parts of Rajasthan and from the country have also been reported from the area to have similar uses (Singh and Pandey, 1980; Sebastian and Bhandari, 1988; Joshi, 1995; Katewa and Arora, 1997; Singh, 1999; Trivedi, 2002; Sharma, 2002; Katewa *et al*., 2003).

Traditional healers indicated that the reason of using phytotherapy is that the plant medicines are cheaper and more efficient. Traditional medicine's efficacy was higher than that of conventional treatments including fewer side effects. There is higher perception of efficacy by both the patients and the clinics. The present study indicates that the flora of Beer, Jhunjhunu is rich in medicinal plant species in spite of being located in arid zone of the country. Rural and tribal people of the area used these medicinal plants as simple drugs and the drug remedies are used in the form of decoction, powder, juice or paste. These are administered internally or applied

externally. In most of the cases leaves (55) were used for curing ailments followed by whole plant (44), fruits (30), root (26), seeds (22), Bark (9) and shoots (9). Flowers (3), latex (3), tubers (2) and gum (1) were the least used parts for curing ailments (Figure 5.1 A, B).

Most of the recipes include only one plant, however, the mixture of different plant parts were also used for preparing medicines. Root paste of *Citrullus colocynthis* and *Withania somnifera* is mixed with honey and taken orally to cure rheumatism. The study revealed that many of the remedies consisted of different parts of the same plant to treat more than one disease e.g. roots and young branches (twigs) of *Salvadora oleoides* and *S. persica* are used in miswak for cleaning teeth, while seed oil and paste is applied in rheumatic pain. Fruits are edible and have cooling effect. Similarly plant parts of *Prosopis cineraria* are used for curing more than one disease. Bark paste of it is effective in rheumatism, while leaf paste is applied on injured part for early healing and on boils to hasten suppuration. Pods are nutritious and edible. Flowers mixed with sugar are eaten by pregnant ladies to prevent miscarriage.

Azadirachta indica leaves are very useful in skin diseases, wounds and eruption of small pox. Leaf decoction is used to prevent hair loss. Twigs of this plant species are used as 'datun' to strengthening teeth and gums. *Leptadenia reticulata* is an important medicinal plant used in Ayurveda and reported in the study area. It was mentioned even in *Atharva Veda*. It is considered as stimulant and tonic. It enhances life, vigour and fertility. Dried root powder and paste of leaves are used for curing skin diseases. Common health problems of the area were both infectious as well as contagious diseases. The most common diseases of the area are abdominal disorders, dysentry (*Dast*), cough and colds, acute respiratory disorders (*Sans chalna*), fever (*Bukhar/Tap*) Guinea worm, urinary tract disorders, skin diseases, eye troubles, wounds and toothache. Other problems common among adult females are leucorrhoea (*Safed Pani*), followed by swelling (*Soojan*), Syphilis (*Challe*) and Gonorrhoea (pus-discharge).

In the present investigations 24 species of plants have been recorded which are being potentially exploited by the rural people inhabiting near Beer region for various skin diseases. The paste or an extract of these plants are commonly applied externally on boils, wounds, cuts, swellings, burns, eczema and ringworm etc. Several studies have enumerated the uses of plants for wound healing and skin diseases in various parts of the world. Leaf extract of *Azadirachta indica* is applied on boils and blister (Joshi and Joshi, 2007). Kingston *et al*., (2009) has reported that leaf paste of *Lawsonia inermis* was useful on the affected parts to cure impetigo, a kind of skin infection.

Kidney stones and urinary disorders are most painful conditions and affected the people for several years. About 75% of kidney stones are composed of calcium oxalate crystals. Many medicinal plants and their parts were used in kidney stones and urinary troubles treatment without much preparation. Four plant species e.g. *Boerhavia diffusa*, *Ceropegia bulbosa*, *Nothosaerva brachiata* and *Tribulus terrestris* were recorded very useful in the treatment of kidney stone during the course of the present survey. Information gathered from the Beer region indicates that rural and tribal people of this area possess good knowledge of herbal plants. Species used in urinary disorders were from families Asteraceae, Chenopodiaceae, Cucurbitaceae, Fumaricaceae, Lamiaceae, Amaranthaceae, Lythraceae and Aizoaceae.

Jhunjhunu district located in the arid western region is highly vulnerable to extreme climatic conditions. The temperature is very high during summer. In order to survive such high ambient temperature inhabitants of the study area have evolved combating strategies including use of local plants in a specific manner. These plants can be called as coolants i.e., their use allows human body to cool down by way of metabolic adjustments. The information collected from rural and tribal people inhabiting near the study area revealed that many plants are used externally as coolant by applying the juice of plant to the body or taking herbal drugs. They are eaten raw or taken as decoction, infusion, juice of plant part or in dried powdered form. The information on medicinal plants having cooling effect has also been reported earlier (Shekhawat, 1986; Singh and Pandey, 1998; Jain, 1991; Kumar *et al*., 2008).

Edible fruits of *Salvadora oleoides* locally known as pilu were most commonly used for cooling effect in the study area. Other plants used as coolant were *Calligonum polygonoides*, *Citrullus lanatus*, *Corchorus depressus*, *Cucumis callosus*, *Maytenus emarginata*, *Ocimum americanum*, *Portulaca oleracea*, *Oxalis corniculata*, *Cyperus rotundus*, *Trianthema portulacastrum* and *Zizyphus nummularia*.

In the recent time malaria, dengue and chikungunia are serious diseases throughout the region. Plant extract of *Enicostemma hyssopifolium*, leaf decotion of *Azadirachta indica*, root decoction of *Calotropis procera* and fruits of *Datura metel* were used in traditional medicine by folk people. Root decoction of *Boerhavia diffusa* is used in dengue fever. Aqueous extract of *Tinospora cordifolia* is effective in dengue and chikungunia. In Philippines, *Euphorbia hirta* known locally as "*tawa-tawa*" is used in folk medicine to cure dengue fever by people in local areas (Kadir *et al*., 2013).

During the course of ethnobotanical survey of Beer areait was observed that dental caries, tooth decay and pyorrhoea are the common dental problems of the area. Generally the fresh tender sticks locally known as datun are widely used for brushing the teeth. Root bark, fruits and seeds are the other parts of plants being exploited for oral health care. Roots and tender twigs of *Salvadora oleoides* and *S.persica* are used for making *Miswak* which is used for cleaning teeth. Its importance has been mentioned in the *Holy Quran. Acacia nilotica*, *Azadirachta indica*, *Barleria prionitis* are the other important plants used by the local people for brushing and cleaning the teeth. The inhalation of smoke of fruits of *Solanum indicum* and *Solanum surattense* kills the germs and treat toothache.

Rural and tribal people, particularly women suffering from sexually transmitted diseases (STD), either do not discuss their ailments or only discuss them preferentially with traditional healers, who are common in every village. In the present investigation, 20 plant species have been enumerated which are used for treatment of leucorrhoea, syphilis, sexual debility, gonorrhoea, spermatorrhoea,

miscarriage, menstruation and general weakness. Gum of *Acacia senegal* was used to prepare sweetmeat which are used after delivery for one month.

Rural people used whole plant of *Sphaeranthus indicus* and fruits of *Pedalium murex* to increase sexual power. Rural ladies eat raw tubers of *Ceropegia bulbosa* to promote fertility and vitality. The information on medicinal plants having therapeutic value for women has also been reported by many workers (Dey, 1984; Trivedi, 2002; Tripathi *et al*., 2010). Gupta *et al*. (2013) reported 38 indigenous herbal plants used for improving their sexual performance and problem associated with sexuality by tribes of Banswara district of Rajasthan. Das *et al*. (2015) recorded 100 indigenous medicinal plants from eastern India for the treatment of gynaecological disorders.

Respiratory diseases such as respiratory flu, tonsillitis, pneumonia, asthma, cough etc. were the common disease in the study area. Respiratory tract infection continue to be a major health challenging worldwide especially due to the increasingly fast development of resistance to the drugs currently in use. 25 plant species are traditionally used for respiratory illness treatment in the study area, and some have been investigated for their efficacy with positive results. The study revealed that several herbs like *Achyranthes aspera*, *Coccinia grandis*, *Datura stramonium*, *Fagonia indica*, *Ephedra foliata*, *Oligochaeta ramosa* and *Tinospora cordifolia* were widely used in the treatment of respiratory disorders. Focho *et al*. (2009) reported 54 plants to treat respiratory tract illness in Cameroon, while Murthy and Vidyasagar (2013) reported 26 medicinal plants used to treat such diseases in Bellary district, Karnataka.

There is no unique treatment for jaundice and hepatitis by prescribing modern allopathic and homeopathic medicine. Tribal and rural people use medicinal plants to cure many liver disorders. 19 plant species were reported from the study area which is used to treat liver disorders. Tribal people of Bhor region, Maharashtra used 18 ethnomedicinal plants to cure jaundice (Kamble and Kulkarni, 2010), while Naikade and Meshram (2014) reported 25 plant species used to cure jaundice in Konkan region, Maharashtra. In the present study thirteen plants species were used

in the treatment of jaundice. *Boerhavia diffusa*, *Citrullus colocynthis*, *Fumaria indica*, *Corchorus depresseus*, *Cucumis callosus*, *Portulaca oleracea* were widely used in liver disorders.

Grey hair is becoming common nowadays and it affects all populations indiscriminately and almost all age groups and gender, men, women, teenagers and even children too. Whole plant of *Eclipta prostrata* was used to prevent grey hair and hair fall. Leaf extract of *Azadirachta indica* and *Eclipta prostrata* was applied to stop hair loss. Paste of seeds of *Datura metel* is useful in patchy boldness.

Snake-bite has been major cause of mortality in the desert region. After thorough investigation in the present study area, nine plant species recorded which were used as antidote against snake-bite and scorpion-bite. The local people mainly used leaf, root, bark, fruit and tuber of these plants as antidote against snakebite. The roots of *Sarcostemma viminale* (khirkhimp) were ground and applied to cure snake-bite and taken as an infusion in dog-bite cases. Other plants used as antidotes were *Ruellia patula*, *Aristolochia bracteolata*, *Ficus benghalensis*, *Tinospora cordifolia Albizia lebbeck*, *Bergia suffruticosa* and *Ceropegia bulbosa*. Sarkhel (2013) reported 20 ethnomedicinal plants from 16 families traditionally used in treatment of snakebite by the tribal population of Paschim Medinipur district of West Bengal.

Fruits of *Momordica balsamina*, *Balanites aegyptiaca* and *Lycium barbarum* were widely used by rural people to cure diabetes. Plant extract of *Enicostemma hyssopifolium* was reported very effective in diabetes.

The role of ethnoveterinary medicine in livestock development is beyond dispute. The indigenous knowledge of the veterinary healthcare system acquired by traditional healers and elderly learned people is orally transformed from one generation to other.

Ethnoveterinary medicine deals with traditional animal health care which encompasses the knowledge, skills, methods, practices and beliefs about health care. They provide cheaper options than comparable western drugs and the products are locally available and more easily accessible. Traditional knowledge of

ethnoveterinary medicinal plants and their use by indigenous cultures are not only useful for conservation of cultural traditions and biodiversity but also for community healthcare and drug development in the present and future (Sheng, 2001). 64 plant species of ethnoveterinary uses belonging to 36 families were recorded in the present study. The studies conducted in other parts of India also support to the findings of present study (Galav *et al*., 2010; Tiwari and Pande, 2010; Yadav *et al*., 2012; Yadav *et al*., 2014; Verma, 2014; Meena, 2014).

In this region, 12 plant species were reported for treating various problems of live stocks related with digestive system. Most commonly used plants for this purpose were *Aegle marmelos*, *Dalbergia sissoo*, *Crotalaria burhia*, *Citrullus colocynthis* and *Withania somnifera* etc. Rural people used *Boerhavia diffusa* and *Saccharum benghalense* for removal of retained placenta. People habituating near Beer area specifically use many plants for increasing the milk quantity. *Cynodon dactylon*, *Cyamopsis tetragonoloba*, *Euphorbia hirta*, *Salvadora oleoides* and *Sorghum halepense* were reported for this purpose. Medicinal plants such as *Acacia catechu* (bark), *Cuscuta reflexa* (whole plant) and *Zizyphus nummularia* (roots) were used for foot and mouth diseases. The usage of many medicinal plants for killing intestinal worms, facilitating smooth delivery, skin diseases, urinary problems are also documented. Some of the plants mentioned in the study are also documented in the other studies conducting in adjoining regions (Ali, 1999; Takhar and Choudhary, 2004).

Man from the beginning has a tendency to draw material from nature for his use. The use of plants in tradition art and technology remains an important aspect of traditional botanical knowledge. Traditionally many items such as tools, shelter and clothing as well as more decorative arts and crafts have been made from plant materials (Choudhary *et al*., 2008). A characteristic feature of the Thar Desert is construction of huts, which is a useful shelter in the villages. Rural people of the study area generally construct their huts (*Jhumpa*), close to the agriculture land and often inside the fields. It is generally circular in shape. The walls are either made up of mud or wood of various desert plants e.g. *Acacia nilotica*, *Calotropis procera*, *Tecomella undulata*, *Clerodendrum phlomidis*, *Zizyphus nummularia* and are about

four to five feet high. The trunk of *Salvadora oleoides* is used as a pillar in making huts. The roof is conical and consists of wood thatched with a combination of *Saccharum munja, Calotropis procera, Crotalaria burhia, Leptadenia pyrotechnica* and other wild grasses, the whole being secured by means of coarse string (*gunthelo*). The circular form of hut is favored because of the strong winds that blow almost the year round. Apart from a low door, there is no opening, but there is plenty of ventilation through the thatch.The thatched hut, walls made from bricks "*chhan*" was also used for shelter in the study area.

Agriculture is one of the important occupations of the rural and tribal people inhabiting near Beer protected forest area. Usually traditional techniques and implements are used by them. The plough, yoke, seed drill, levelers harrow etc. are chief agricultural implements. These are constructed from wood of *Tecomella undulata, Dalbergia sissoo, Acacia nilotica*, *Prosopis cineraria* and *Zizyphus nummularia*.

Traditionally wheel barrow or Gada is used for transport by the rural and tribal people in the study area. The various parts of the wheel barrow are made of wood of *Tecomella undulata, Dalbergia sissoo, Acacia nilotica* and *Azadirachta indica*. Many other items made from differnt plant parts like brooms, baskets, cots, butter churn, winnowing pan, handle of grain grinder *etc* have been traditionally used by the rural people.

Recreation and fun is essential part of the life. Rural people fulfill their fun necessities and recreational need from their surrounding flora. Children use so many small beautiful wooden items for fun sake in the study area. Wood of *Prosopis cineraria, Acacia nilotica, Tecomella undulata* is used for wooden toys.

Music and dance are deeply ingrained in the life of Rajasthan. The cool stillness of the desert after the searing heart of the day and upsurge of life in the short lived rainy season or spring are filled with soulful, full throated music and rhythmic dance. Shekhawati region of Rajasthan have their distinct folk entertainment. It is famous for "*chang nritya*" on Holi festival. The tribal and rural

people are fond of music. They make their musical instruments from the plant material collected from the nature (Joshi, 2008). Songs and music add to tribal life as they possess a wide variety of musical instruments chiefly made of wood from the forest. Little work has been done in the field of ethnomusicology in Rajasthan (Guria, 2000). The construction and working of many of these instruments has been described in detail by Joshi (1995), the present study also support his findings. Shah and Gopal (1986) also reported two musical instrument used by tribals of Gujarat.

Tribal and rural people have strong traditions, cultural activities, beliefs, taboos, totems performing religious rituals and valuable information about properties and medicinal uses of plants (Rana *et al*., 2016). Different plant parts (roots, stem, leaves, bark, fruits, flowers, seeds etc.) or the whole plant is used for various cultural, religious and ritual purposes. In the present study 23 plant species have been recorded which are used in traditional ritual ceremonies of the area. It is observed that these plants have the great property of medicine to cure various ailments. So, it is necessary to conserve and promote these religious and aesthetic values to conserve biodiversity and nature, which will assuredly play an important role in the amelioration of human being.

PLATE 5.1: OBSERVATION AND SURVEY OF THE STUDY AREA


Plant Collection and Observation of Study Area


Surveying Forest Area with Tribals and Forest Officials


Interviewing with Tribals

PLATE 5.2(A): ETHNOMEDICINAL PLANTS

***Argemone mexicana* L.**

***Azadirachta indica* A. Juss.**

***Balanites aegyptiaca* (L.) Delile**

***Barleria prionitis* L.**

***Boerhavia diffusa* L.**

***Capparis decidua* (Forsk.) Edgew.**

***Datura metel* L.**

***Eclipta alba* (L.) Hassk.**

PLATE 5.2(B): ETHNOMEDICINAL PLANTS

***Euphorbia hirta* L.**

***Ocimum americanum* L.**

***Pedalium murex* L.**

***Salvadora oleoides* Decne.**

***Solanum indicum* L.**

***Tribulus terrestris* L.**

***Withania somnifera* (L.) Dunal**

***Zizyphus nummularia* (Burm.f.) Wt.**

PLATE 5.3: TRADITIONAL USES OF PLANT MATERIALS

(a) Agriculture implements

(b) Transportation

(c) Butter Churn

(d) Wooden Mortar and Pastle Set

(e) Grain Grainder

(f) Winnowing Pan

(g) Brooms

(h) Bizuka

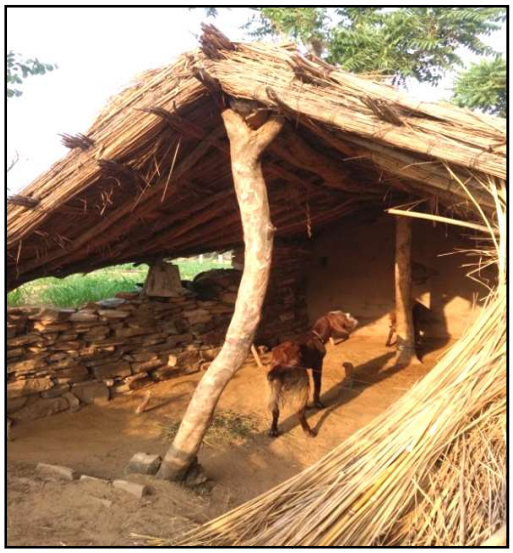
(i) Fun with plants

PLATE 5.4: TRADITIONAL SHELTERS & MUSICAL INSTRUMENTS

Typical hut (*Jhumpha*)

Thatched roof hut (*Chhan*)

Food storage hut (*Obra*)



Cattle shelter

Ravan Hattha

Chang

PLATE 5.5(A): WILD EDIBLE PLANTS

Ziziphus nummularia **(Burm. f.) Wt.**

Citrullus lanatus **(Thunb.) Mats.**

Capparis decidua **(Forsk.) Edgew.**

Prosopis cineraria **L.**

Cordia dichotoma **Forst. f.**

Salvadora oleoides **Decne.**

Morus alba **L.**

Physalis minima **L.**

PLATE 5.5(B): WILD EDIBLE PLANTS

Momordica dioica **Roxb.**

Prosopis cineraria **(L.) Druce**

Cucumis callosus **(Rottl.) Cogn.**

Amaranthus graecizans **L.**

Leptadenia pyrotechnica **(Forsk.) Decne.**

Momordica balsamina **L.**

Chenopodium album **L.**

Coccinia grandis **(L.) Voigt.**

CHAPTER-6

PHYTO-CHEMICAL ANALYSIS OF SELECTED MEDICINAL PLANTS

Introduction

Plants have been associated with the human health from time immemorial and they are the important sources of medicines since the dawn of human civilization. In spite of tremendous development in the field of allopathic medicines during 20^{th} century, plants still remain one of the major sources of drugs in modern as well as in traditional systems of medicine. Herbal medicines are universally accepted because of the fact that medicinal plants continue to play important role in healthcare system of a large number of world's population. In fact there are several medicinal plants all over the world which are being used traditionally in the prevention and treatment of several diseases. The screening of plants for their biologically active principal is done on the basic of either their chemotaxonomic investigations or ethno-botanical knowledge for a particular disease. The instance of medicinal plants lies in their biological active principles, which are the real healers in the process of medication. Nearby one third of pharmaceuticals are of plant origin. As all the plants are able to synthesize a multitude of organic molecules or phytochemicals, they are referred to as "secondary metabolites" (Harborne, 1982).

The importance of plants lies in their biological active compounds, which are the real healer in the process of medication. Phytochemicals are basically divided into two groups, *i.e.* primary and secondary constituents according to their functions in plant metabolism. Primary constituents comprise common sugars, amino acids, proteins and chlorophyll, while secondary constituents consists of alkaloids, terpenoids, saponins, phenolic compounds flavonoids, tannins and so on. These phytoconstituents work with nutrients and fibres to form an integrated part of defense system against various diseases and stress conditions. These compounds are also sources of pharmaceuticals, pesticides, flavoring agents, fragrances and food additives.

Plants derived compounds are playing an important role in the development of several clinically useful medicines (Madhuri and Pandey, 2009). The secondary metabolites constitute the medicinal value of a drug plant, which produces a definite

physiological action on human body (Sharma *et al*., 2007). Research on natural molecules and products primarily focuses on plants, they can be sourced and selected more easily based on their folklore use (Verpoorte *et al*., 2005). Plant derived medicines have been part of traditional health care system in most parts of the world for thousands of years and now a days there is increasing interest in plants as source of agents to fight microbial diseases (Natarajan *et al*.,2005).

About 90% of the drugs used in Indian system of medicines and homoeopathy are plant based and collected from wild sources. The drugs are derived either from the whole plant or from different organs like leaf, stem, bark, root, flower and seed. Some drugs are prepared from excretory plant products such as gum, resin and latex (Suniti Sharan, 2010). While some of these raw drugs are collected in smaller quantities by the local communities and folk healers for local uses, many other raw drugs are collected in larger quantities and traded in the market as the raw material for many herbal industries (Uniyal *et al*., 2006)

Different plants produce diverse products which are often related to a particular developmental stage, and are profoundly affected by seasonal variations. Cell cultures are attractive alternatives to whole plants for production of high value secondary metabolites due to consistency in quality and quantity of the desired products (Rao and Ravishankar, 2002). Plants synthesize a bewildering variety of phytochemicals but most are derivatives of a few biochemical motifs (Karen and Kutchan, 2009).

Polyphenols (also known as phenolics) are compounds contain phenol rings. The anthocyanins that give purple color to the grapes, the isoflavones as phytoestrogens from soy and the tannins that give tea its astringency are phenolics.

Flavonoids are one class of secondary plant metabolites that are also known as Vitamin P or citrin. These metabolites are mostly used in plants to produce yellow and other pigments which play a big role in coloring the plants. In addition, flavonoids are readily ingested by humans and they seem to display important anti-inflammatory, anti-allergic and anti-cancer activities. Flavonoids helps to prevent

cancer by inducing certain mechanisms that may help to kill cancer cells, and researches believe that when the body processes extra flavonoid compounds, it triggers specific enzymes that fight carcinogens. Good dietary sources of flavonoids are all citrus fruits, which contain the specific flavanoids hesperidins, quercetin and rutin, berries, tea, dark chocolate and red wine and many of the health benefits attributed to these foods come from the flavonoids they posses. Flavonoids are synthesized by the phenylpropanoid metabolic pathway where the amino acid phenylalanine is used to produce 4-coumaryol-CoA, and this is then combined with malonyl-CoA to produce chalcones which are backbones of flavonoids (Filippos *et al*., 2007).

Phytosterols and phytostanols, also referred to as plant sterols and stanols, are common plant and vegetable constituents and are therefore normal constituents of the human diet. Dietary intake of phytosterols ranges from 160-400 mg /day in a typical western diet (Ostlund, 2002). Phytosterols and phytostanols, in free or esterified form, are added to foods for their properties to reduce absorption of cholesterol in the gut and thereby lower blood cholesterol levels. It is now generally accepted that sterols and stanols have the same cholesterol lowering efficacy. Phytosterol intake reduces the LDL-C level of adult Australians and so reduces the current level of CVD (Plat *et al*., 2000). Plant sterols are well known for their effects on blood cholesterol levels, however research into their potential role in mitigating cancer risk remains in its infancy.

The present chapter deals with the phytochemical investigation of stem and leaves of common ethnomedicinal plant species *Aristolochia bracteolata* Lam. and *Ruellia patula* Jacq. and isolation of antimicrobial compound from them.

***Aristolochia bracteolata* Lam**.

Aristolochia bracteolata is an amazing plant that belongs to the genus *Aristolochia* of family Aristolochiacae, which has more than 400 species. Most of these species have medicinal uses and are commonly called birthworts. They are used especially in Chinese and Ayurvedic medicine.

Common Names:-

Aristolochia bracteolata is a medicinal herb. In different languages, the plant is referred by different names like *Kitamari* in Hindi, Worm killer in English, *Midari* in Gujrati, *Paniri* in Orissa, *Gandhari* in Marathi, *Kattckiru Banagida* in kanada, *Aaduthinnapalai* in Tamil, *Gadido gadapa* in Telugu and *Hukkiah bel* in Rajasthani. In Sanskrit it is Known as *Dhumrapatra* and *kitamari* due to use of its leaves for fumigation and for destroy the germs respectively.

Scientific Classification:-

Synonym	:	*Aristolochia bracteata*
Kingdom	:	Plantae
Order	:	Piperales
Family	:	Aristolochiaceae
Subfamily	:	Aristolochinideae
Genus	:	*Aristolochia*
Species	:	*bracteolata*

Geographical Distribution:

A. bracteolata is globally distributed in tropical Africa, Arabia, Sri Lanka, Pakistan and India. Within India, it is found in northern and central part from Haryana, Rajasthan to West Bengal and southwards to Tamilnadu and Kerala. It is common in dry areas, usually grows as a weed.

Botanical Description

A. bracteolata is an erect perennial climber on hedges and roadsides. The simple leaves are alternate, cordate and reniform with pointed tips. Leaves are much variable in size and shape. The flowers grow in the leaf axils with a large sessile, orbicular or subreniform leafy bract at the base. They are inflated and globose at the base, continuing as a long perianth tube with trumpet shaped mouth and dark purple in color. The fruit are oval to round shape capsule, one inch long. The seeds are triangular and flat. (Plate 6.1a)

Properties:

Genus *Aristolochia* comes from the Greek words aristos meaning best and locheia meaning childbirth; ancient people used pulverized dried leaves of these vines as the 'aristocrat' of medicines administered during child-birth. *Aristolochia bracteolata* is a herb mentioned in Ayurveda for the treatment of wound, intestinal worms, dysmenorrheal skin diseases and fever. It has following properties: *Rasa* (Taste) - *Tikta* (Bitter) *Guna* (Qualities) – *Laghu* (Light for digestion), *Ruksha* (Dry in nature), *Teekshna* (Strong), *Vipaka* (Pungent taste), *Veeryan* (Potency) – *Ushna* (Hot), *Karma* (Actions) – *Kaphavata Shamaka* (Reduced vitiated cough and vata dosha).

Chemical Composition:

Leaves and fruit contain ceryl alcohol, aristolochic acid and beta – sitosterol. Roots contain aristolochic acid and potassium chloride nitrates. It also contains bitter principle glucoside in nature named isoaristolochic and Allanton 0.5% alkaloid Aristoloclen, essential oil containing carbonyl compound and a small amount of an oil with above of Isovanilin.

Traditional Uses:

Aristolochia bracteolata is a medicinal herb used in traditional medicines as a gastric stimulant and in the treatment of inflammatory diseases, fever and insect bites. The roots are used to treat syphilis, gonorrhoea and skin diseases. It is also used during labor pain to increase uterine contraction. The leaves are used to rid the body of Guinea Worms by native tribal and the rural people. It is commonly called as "worm killer" or 'kitamari' because of the wonderful property of destroying parasitic worms. Leaf paste is applied over the wounds for helping in quick healing. It is also useful for treating eczema. Leaf decoction is useful in dysmenorrohea. A lotion is prepared by crushing or soaking seeds in water which is used for softening hairs.

***Ruellia patula* (Jacq.)**

Ruellia patula Jacq. (synonym *Dipteracanthus patulus* (Jacq.) Nees) belongs to family Acanthaceae, has numerous medicinal properties but is not exploited much in modern medicine.

Common Name

Ruellia patula is known as "Bell weed" in English. In Tamil it is commonly known as '*kayappechilai*. In Haryana and in the present study area, it is known as '*Haadjud*.

Scientific Classification

Kingdom	:	Plantae
Order	:	Lamiales
Family	:	Acanthaceae
Subfamily	:	Acanthoideae
Genus	:	*Ruellia*
Species	:	*patula*
Synonym	:	*Dipteracanthus patulus* (Jacq.) Nees

Geographical Distribution:

Ruellia patula is widely distributed in Africa, Aarbia, SriLanka, Pakistan and India (Akhtar *et al*. 1992). In India, it is found in Tamilnadu, Western Ghat, Andhra Pradesh, Rajasthan and Haryana.

Botanical Description

Ruellia patula is a hoary pubscent under-shrub, upto 50 cm. tall, it is basally woody with quadrangular twigs. Leaves are carried on 4-10 mm long leaf-stalks. Leaves are elliptic – ovate, rarely obovate, 1.5-5 x 3-6 cm, densely pubscent on both surfaces. Flowers are pale- white or pale- voilet, stalkless, axillary, usually solitary,rarely 2-3 in cymes ,bracteole foliaceous, spoon shaped. Sepals are linear-lens shaped, 4-5 mm long, fringed with hairs. Corolla white, 3-5 cm long, tube widely infundibuliform, sub- orbicular, rounded at apex. Filaments glabrous. Ovary glabrous. Style pubscent .Fruit is 12-17 mm long capsule, 8-10 seeded. Seeds suborbicular, margined with hygroscopic white hairs. Flowering and fruiting: July-Oct. (Plate 6.1b)

Traditional Uses

Ruellia patula Jacq. is a member of family Acanthaceae. It is widely consumed by cattles and humans. Traditionally in Rajasthan and Haryana, decoction of stem with cow milk is taken orally for the treatment of bone fracture and paste of stem with mustard oil is applied topically. It is also used in the treatment of wounds in the rural areas. The leaves are ground into a paste and applied on fresh wounds. (Saroja *et al*., 2009). The leaves are also used for treating insect bites, eye diseases, skin diseases, tumours, rheumatic complaints, cough, wounds, toothache, stomachache and kidney stone problems. (Gopalkrishnan *et al.*2011; Samy *et al*., 2011). Whole plant extract is also used to cure syphilis, gonorrhoea and renal infections (Singh and khan, 1990; Yadav and Yadav, 2009).

Ruellia patula is used as a single drug remedy for against the deadly poison of a special species of spider known as Tiger spider by Kani tribe of Kilamalai and Agasthiarmalai, India (Raja and Prakash, 2007; Kannikaparameswari and Chinnaswamy, 2013).

MATERIAL AND METHODS

Collection of plant material

The experimental plant material was collected from Beer Jhunjhunu Conservation Reserve forest area and authentification and recognition of species was done with the help of Botanical Survey of India (BSI), Jodhpur, Rajasthan. The samples were washed with sterile distilled water, shade dried and grounded into fine powder for biochemical analysis.

Qualitative analysis

Flavonoid Extraction

Different plant parts such as stem and leaves of *Aristolochia bracteolata* and Ruellia patula were air dried and powdered, separately. Each of these parts was extracted separately with 80% methanol on water bath (Subramanian and Nagarajan, 1969) for 24 h. The methanol soluble fractions were filtered, concentrated *in vacuo* and aqueous fractions were fractioned by sequential extraction with petroleum ether

(Fr1), diethyl ether (FrII) and ethyl acetate (FrIII) separately. Each step was repeated thrice for complete extraction, fraction 1 was discarded in each case because it contained fatty substance, where as fraction II and fraction III were concentrated and used for determining free and bound flavonoids respectively.

Fraction III was further hydrolyzed by refluxing with 7% sulphuric acid ($10mLg^{-1}$ plant material for 2 h), filtered and filtrate was extracted thrice with ethyl acetate. All ethyl acetate layers were pooled separately, neutralized by distilled water with repeated washings and concentrated *in vacuo.* Both fraction II and III were taken up in small volume of ethanol (2-5mL) before chromatographic examination. Moreover, Silica-gel thin layer chromatography (TLC) and Preparative thin layer chromatography (PTLC) were used to isolate flavonoids in the present study.

Thin Layer Chromatography (TLC)

Thin glass plates (20x20 cm) were coated with silica gel G (250mμ thick). The freshly prepared plates were air dried at room temperature; thereafter these were kept at 100 ^{0} C for 30 minutes to inactivate the enzymes and then cooled at room temperature. The freshly prepared and activated plates were used for analysis.

Each of the extract was co-chromatographed with authentic samples of flavonoid as markers (Quercetin, Luteolin, Kaempferol). These plates were developed in an air tight chromatographic chamber saturated with solvent mixture (Benzene: Acetic Acid: Water:: 125:72:3; Wong and Francis, 1968). The developed plates were air dried and visualized under UV light and by exposure to ammonia fumes. The mouth of a 100 mL bottle containing concentrated NH_4OH was held in contact with each spot for about 5-10 seconds and fluorescent spots corresponding to that of standard markers were marked. The developed plates were also sprayed with 5% $FeCl_3$, 0.1% alcoholic $AlCl_3$ and kept in I_2 chamber separately. The coloured spots thus developed were noted and the Rf value of each spot was calculated. Several others solvent systems such as n- butanol, acetic acid, water (4:1:5), tertiary butanol, acetic acid, water (3:1:1) were also tested, but the solvent system containing benzene, acetic acid, water (125:72:3) gave better results.

Preparative thin layer chromatography (PTLC)

PTLC of abovementioned flavonoid extracts was carried out using silica gel G coated plates (BDH; 500mμ in thickness) by spotting the extract as well as standard markers (luteolin, kaempferol, quercetin). These plates were developed in the solvent mixture of benzene, acetic acid and water (125:72:3), air dried and examined under UV light. Each of the spots corresponding with the standard markers were marked, scraped from 200 plates, and eluted with 50% methanol. The eluted fractions were filtered, air dried and again co-chromatographed along with standard markers to test their purity. The eluted fractions were subjected to crystallization separately and melting point (mp), mixed melting point (mmp) was determined. The isolates were also subjected to ultraviolet and infrared spectral studies.

Identification

The identity of the isolated flavonoids were confirmed by mp, mmp performed in capillaries (Toshniwal Melting Point Apparatus), IR (Infra-red spectrophotometer; Perkin, Elmer 337, Grating Infra-red spectrophotometer), UV (Ultraviolet and visible spectrophotometer; Carl Zeiss, Jena, DDR, VSU-2P spectrophotometer) analysis along with their respective authentic samples.

Quantification

The isolated flavonoids were estimated by spectrophotometer following the method of Mabry *et al* (1970).

Stock solution ($1mgL^{-1}$) of kaempferol, luteolin and quercetin were prepared separately by dissolving authentic compounds in methanol. Different concentrations ranging from 20μg to 160μg of each of the compounds spotted separately on silica gel G plates. For each concentration of reference authentic standards separate plates were used and developed in the same manner as described earlier. These developed plates were air dried and visualized under UV light. The fluorescent spots were marked and collected along with the absorbance in separate test tubes. Spectroscopy methanol grade (5mL) was added to each test tube, shaken vigorously, centrifuged and supernatants were collected separately. The volume of each of the eluate was

made up to 10mL by adding methanol. To each of these samples, 3mL of 0.1 M $AlCl_3$ solution was added again shaken vigorously and kept at room temperature for 20 min. Five such replicates were run in each case and their optical densities were measured using spectrophotometer at 426nm for kaempferol and luteolin and at 440nm for quercetin against blank (10mL of spectroscopic grade methanol and 3mL of 0.1 M $AlCl_3$). The standard curves were plotted between concentration and their respective average optical density of each of the compound. The regression curve so achieved followed Beer's law.

Each of the plant extract sample (ether and ethyl acetate sample) was dissolved in 5 mL of spectroscopic grade methanol and 0.1mL was applied on silica gel G coated plates along with standard markers, separately. The plates were developed as above and the spots coinciding with that of standard markers were marked on each plate under UV. Each spot was collected along with the silica gel, eluted in methanol and test samples were prepared in the same way as described above. The optical density in each case was recorded and concentration of each sample was computed using the regression curve of authentic flavonoids samples. The concentrations were calculated on mg/g dry weight basis.

Phytosterol Extraction

Dried and powdered plant material was defatted in petroleum ether (60-800 C) for 24 h on a water bath. Defatted material was air dried and hydrolyzed in 30% HCl (v/v) for 4 h. Each hydrolyzed sample was washed with distilled water till pH 7 was achieved and was dried later. The dried preparation was again extracted with benzene for 24 h. The extract was filtered and dried *in vacuo* .The crude extract was dissolved in benzene before chromatographic examination (Kaul and Staba, 1968).

Qualitative Analysis

Thin layer chromatography (TLC)

Glass plates coated with silica gels G were used. Each of the extract was co-chromatographed separately with authentic sterols as marker. These plates were developed in an airtight chromatographic chamber, saturated with solvent mixture (Hexane: Acetone:: 8:2; Fazli and Hardman, 1968). Other solvents such as benzene

and ethyl acetate (85:15; Heble *et al*, 1968) benzene: ethyl acetate (3:1, Kaul and Staba, 1968) was also used but hexane: acetone (8:2) gave better separation. These plates were air dried and visualized under UV light and fluorescent spots corresponding to that of standard markers were marked. These developed plates were sprayed with 50% sulphuric acid (Bennet and Heftmann, 1962) and anisaldehyde reagent, separately and heated at 110^0 C for 10 min.

Identification

Melting point and IR spectra of each of the isolated compounds were taken and a comparison of the TLC colour reaction was made, which was found to be in accordance with those of studied authentic compounds.

Quantification

In plant parts the levels of β-sitosterol, stigmasterol and campesterol were estimated by spectrophotometer following the method of Das and Banerjee (1980), which included the computation of standard curves. Stock solutions (1mgL-1) of β-sitosterol, stigmasterol and campesterol were separately prepared in chloroform. Aliquots containing different concentrations (0.01to 0.09 mg/L) were separately spotted on TLC plates and the developed air dried chromatograms were visualized under UV light. The fluorescent spots were marked and collected with the absorbent in separate test tubes. Chloroform (5mL) was added in each test tube, shaken vigorously, centrifuged and supernatants were collected separately which were later evaporated to dryness. To each of this 3mL of glacial acetic acid was added. Shaken for 1minute at room temperature and tubes were placed in ice chest. To these test tubes 2mL of freshly prepared chromogenic reagent (0.5ml of 0.5% anhydrous FeCl3 in glacial acetic acid +100 ml of 3.6M H_2SO_4 was added drop wise at 0^0 C) and mixed thoroughly (Klyne, 1965). Each of the reaction mixture was incubated at 40^0 C for 30 min and their optical densities were measured using a spectrophotometer set at 540 nm against a blank (3ml of glacial acetic acid +2mL of chromogenic reagent). In each case three replicates were run and mean value for each concentration was plotted against the respective concentrations to compute regression curves, which followed Beer's law.

Similarly, the extracts of all the isolated compounds were dissolved in benzene and were spotted on TLC plates along with reference markers and processed as above. The coinciding spots with the reference compounds in these extracts were marked, scraped, eluted dried, taken up in 5ml of chloroform, and processed further, like the authentic samples. The concentration of β-sitosterol, stigmasterol and campesterol was calculated (mg/gdw) by referring the experimental samples with the respective regression curve, three such replicates were run and their mean value was calculated.

RESULTS

Flavonoids

Three spots which were (yellowish brown in colour after keeping plates in iodine chamber) of flavonoids were observed in different plant parts of *Aristolochia bracteolata* and *Ruellia patula* on thin layer chromatography plates developed and sprayed with 5% $FeCl_3$. The Rf values of these spots matched with their respective authentic standards and were identified as kaempferol, quercetin and luteolin. Solvent system Benzene: Acetic Acid: Water (125:72:3) gave best results. Qualitative analysis of flavonoids showed the presence of three flavonoids viz., Kaempferol (Rf 0.86, brownish in visible light and blackish in UV after spraying 5% $FeCl_3$, yellowish in visible light and yellowish green in UV after spraying 5% $AlCl_3$, mp 276-278^{0}C), Quercetin (Rf 0.78, brownish in visible light and blackish in UV after spraying 5% $FeCl_3$, yellowish in visible light and yellowish green in UV after spraying 5% $AlCl_3$, mp 315-320^{0}C) and Luteolin (Rf 0.56, brownish in visible light and blackish in UV after spraying 5% $FeCl_3$, yellowish in visible light and yellowish green in UV after spraying 5% $AlCl_3$, mp 326-329^{0}C). They were confirmed on the basis of their Rf value, TLC behaviour, color, melting point and IR studies (Table 6.1). The isolated flavonoids Kaempferol, Quercetin and Luteolin were also characterized and confirmed by super imposable IR peaks (Fig. 6.1-6.3).

Table 6.1: Chromatographic data and colour reaction of the flavonoids isolated from different plant parts of *Aristolochia bracteolata* Lam. and *Ruellia patula* Jacq.

Isolated Compounds	R_f Value			Physical Appearance			Color after spray				Melting Point (°C)	IR Spectral Peaks v (KBr) cm^{-1}
	S_1	S_2	S_3	Day Light	UV ammonia	Iodine Vapor	R_1		R_2			
							Visible	UV	Visible	UV		
Kaempferol	0.86	0.86	0.55	GN-YW	BT-YW	YW-BN	BN	NK	YW	YW-GN	276-278	(O-H) (3410cm-1 (270, 295, 344, 1690)
Luteolin	0.56	0.83	0.77	GN-YW	YW	YW-BN	BN	BK	DL-YW	YW-GN	326-329	3421, 2965, 1736 (lactone), 1510 (furan), 1461, 1388, 1360, 1274, 1242, 1187, 1136, 1028, 903, 850 cm^{-1}
Quercetin	0.78	0.64	0.41	GN-YW	YW	YW-BN	BT-GY	BK	DL-YW	YW-GN	315-320	3423, 1739, 1655 (O-H), 1608, 1508, 1305, 1203, (C=C), 1088

Abbreviations:
S_1- Benzene: acetic acid: water (125:72:3), S_2-n-Butanol: acetic acid: water (4:1:5), S_3-Conc. Hydrochloric acid: acetic acid: water (3:30:10), R_1-5% $FeCl_3$ solution, R_2-5% alc. $Alcl_3$ solution, YW-Yellow, BK-Black, BN-Brown, BT-Bright, DL-Dull, GN-Green, GY-Gray.

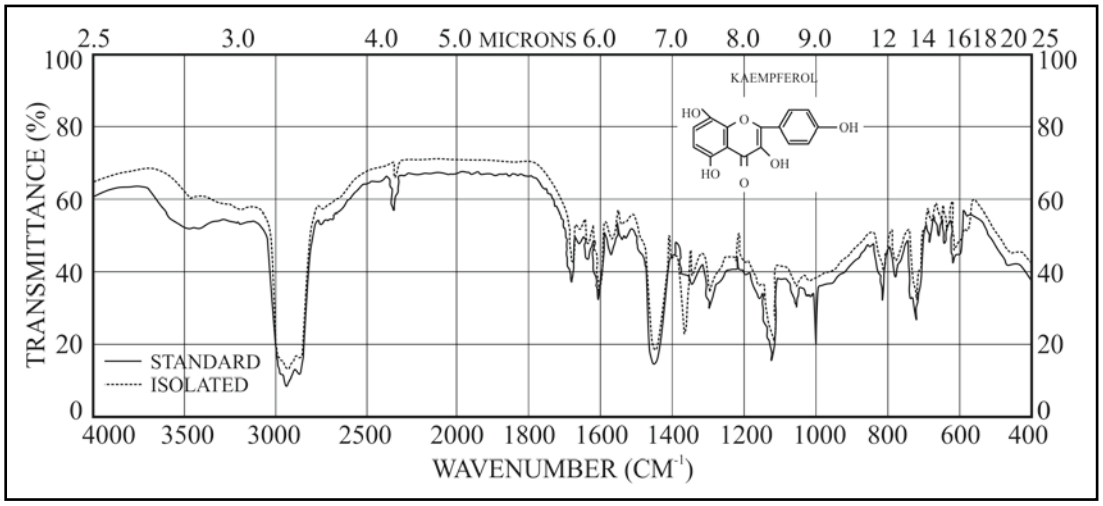


Fig 6.1: Infrared spectra of standard and isolated Kaempferol

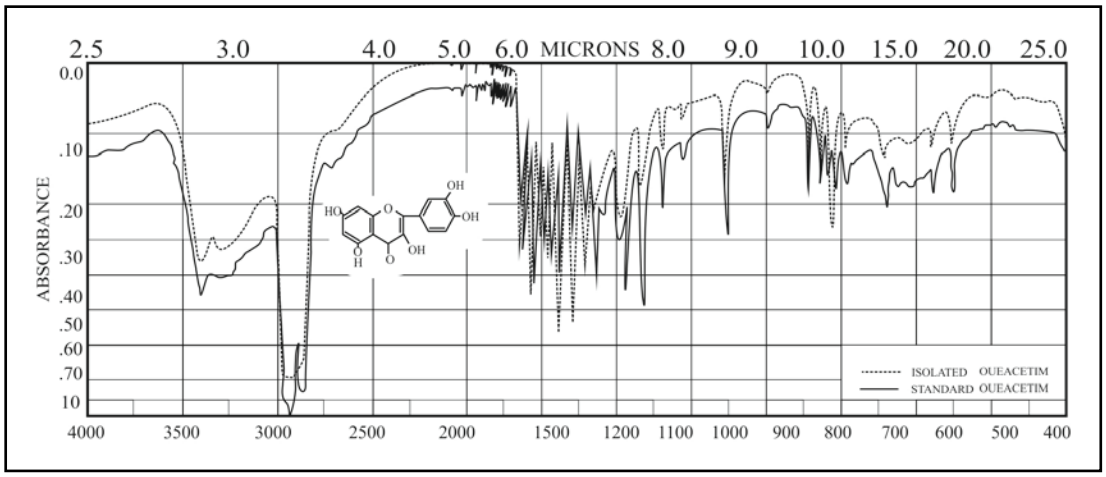


Fig 6.2: Infrared spectra of standard and isolated Quercetin

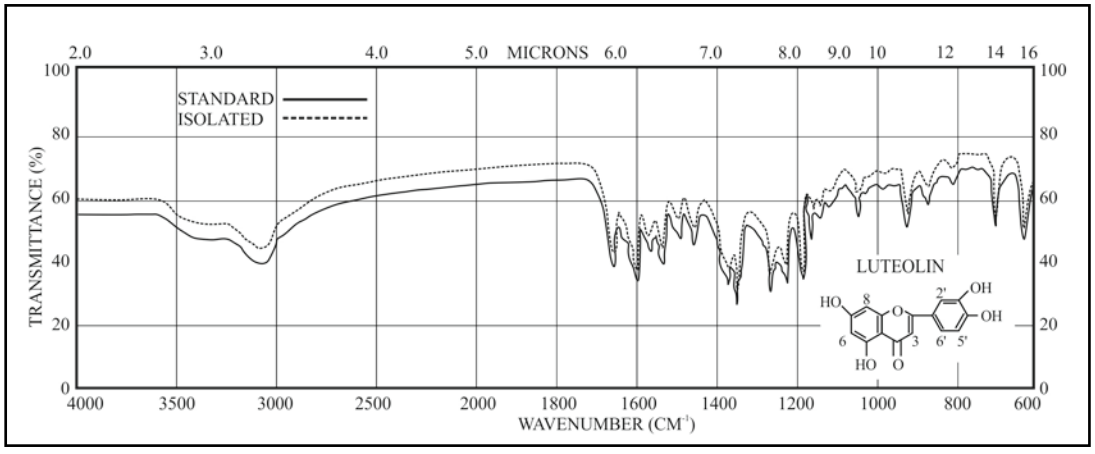


Fig. 6.3: Infrared spectra of standard and isolated Luteolin

Table 6.2: Flavonoids content in different plant parts of *A. bracteolata* Lam.

S. No.	Plant Parts	Free flavonoids (mg/gdw)				Bound flavonoids (mg/gdw)				Total flavonoids (free+bound) (mg/gdw)
		K	Q	L	T	K	Q	L	T	
1	Leaves	0.23	0.35	0.12	0.70	0.09	0.26	0.08	0.43	1.13
2	Stem	0.18	0.24	0.08	0.50	0.05	0.19	0.04	0.28	0.78

Abbreviation: K=Kaempferol ; Q= Quercetin; L=Luteolin; T=Total

Table 6.3 Flavonoids content in different plant parts of *R.patula* Jacq.

S. No.	Plant Parts	Free flavonoids (mg/gdw)				Bound flavonoids (mg/gdw)				Total flavonoids (free+bound) (mg/gdw)
		K	Q	L	T	K	Q	L	T	
1	Leaves	0.19	0.43	0.16	0.78	0.13	0.28	0.11	0.52	1.30
2	Stem	0.14	0.38	0.09	0.61	0.09	0.17	0.08	0.34	0.95

Abbreviation: K=Kaempferol ; Q= Quercetin; L=Luteolin; T=Total

After quantification it was observed that in *A. bracteolata* the total flavonoid content (free+bound) was higher in leaves (1.13 mg/gdw) followed by stem (0.78 mg/gdw). Total flavonoids in their bound form were maximum in leaves (0.43 mg/gdw) and lowest in stem (0.28 mg/gdw). The total free and bound Kaempferol content was higher in leaf (0.32 mg/gdw) than stem (0.23 mg/gdw). The total free and bound Quercetin content was higher in leaves (0.61mg/gdw) in comparison to stem (0.43 mg/gdw). Table 6.2 showed that the total free and bound Luteolin content was also higher in leaves (0.20 mg/gdw) than stem (0.12 mg/gdw).

In *R. patula* maximum amount of flavonoids was observed in leaves (1.30 mg/gdw) as compared to stem (0.95 mg/gdw). Individually free form was more as compared to bound form. Quercetin (0.43mg/gdw) in free form was found to be maximum in leaves. Overall this plant was found to be better source of flavonoids (Table 6.3).

Phytosterols

In the present investigation, three sterols viz., β-sitosterol, Stigmasterol, and Campesterol were extracted and identified from various plant parts of *Aristolochia bracteolata* and *Ruellia patula.*

These sterols were confirmed on the basis of their Rf value, TLC behavior, colour, melting point, UV, IR and spectral studies (Table 6.4). When the TLC plates were visualized under UV lamp three of the spots gave characteristic fluorescence and their Rf values were comparable to their respective standard compounds. β-sitosterol (Rf value: 0.86, colour: dull blue); Stigmasterol (Rf value: 0.70, colour: dark blue) and Campesterol (Rf value 0.23, colour dull blue) were isolated and identified from various plant parts. Melting points (β-sitosterol 135-136°C, Stigmasterol 140-142°C and Campesterol 137-138°C) were also measured and compared with authentic standards compounds. IR spectral peaks of three isolated sterols were found to be super imposable with those of their respective standard of β-sitosterol, stigmasterol and campesterol (Fig. 6.4-6.6).

Table 6.4: Chromatographic behavior and chemical characteristics of isolated sterols from different plant parts of *A. bracteolata* Lam. and *R. patula* Jacq.

Isolated compounds	Chemical formula	Rf value	Anisaldehyde reagent	Melting point°C	Colour in UV
β-sitosterol	$C_{29}H_{50}O$	0.86	PU	135-136°C	DL-BU
Stigmasterol	$C_{29}H_{48}O$	0.70	PU	140-142°C	DK-BU
Campesterol	$C_{28}H_{48}O$	0.23	BU	137-138°C	DL-BU

Abbreviation: BU = Blue; DK = Dark; PU = Purple; DL = dull

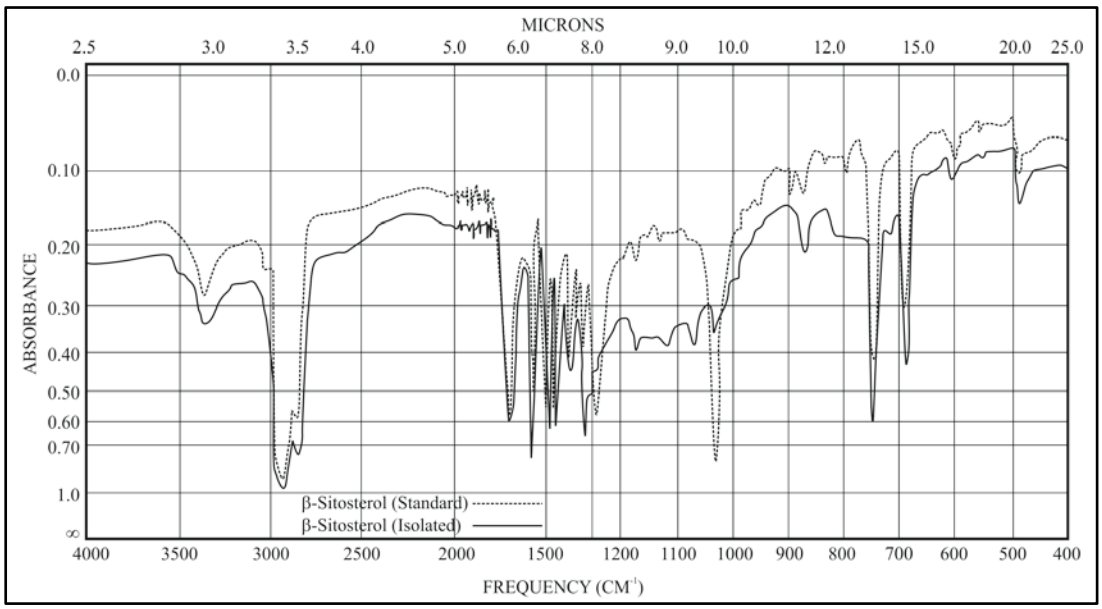


Fig. 6.4. Infrared spectra of standard and isolated β-Sitosterol

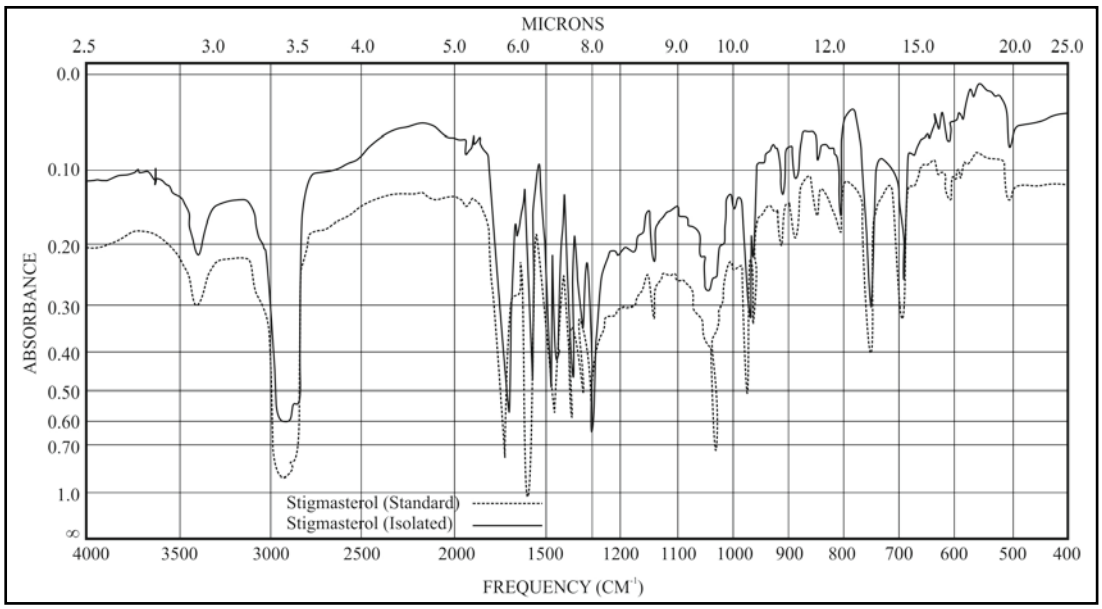


Fig. 6.5. Infrared spectra of standard and isolated Stigmasterol

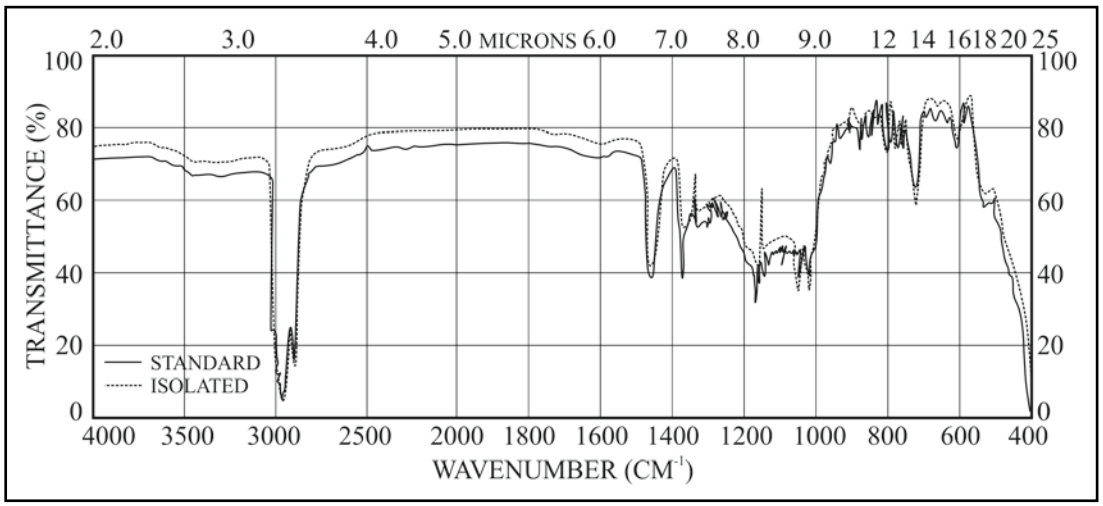


Fig. 6.6: Infrared spectra of standard and isolated Campesterol

After quantification it was observed that maximum amount of phytosterols was observed in stem of *Aristolochia bracteolata* (1.26 mg/gdw) as compared to leaves. Individually β-sitosterol was more as compared to other sterols. Overall this plant was found to be better source of phytosterols (Table 6.5). In *Ruellia patula* maximum amount of phytosterols was also observed in stem (0.97 mg/gdw) as compared to leaves. Individually β-sitosterol was more as compared to bound form (Table 6.6).

Table 6.5: Yield of sterols isolated from various plant parts of *A. bracteolata* Lam.

Plant parts	β-sitosterol	Stigmasterol	Campesterol	Total Sterols (mg/gdw)
Stem	0.88	0.23	0.15	1.26
Leaves	0.56	0.20	0.10	0.86

Table 6.6: Yield of sterols isolated from various plant parts of *R. patula* Jacq.

Plant parts	β-sitosterol	Stigmasterol	Campesterol	Total Sterols (mg/gdw)
Stem	0.67	0.20	0.10	0.97
Leaves	0.43	0.11	0.08	0.62

DISCUSSION

In recent times, ethnomedicinal and traditional pharmacological approaches are achieving great appreciation in modern medicine, because the search for new potential medicinal plants is often based on an ethnomedicinal origin (Muthu *et al*., 2006). Plants face many stresses, like diseases, pests, drought etc. in their life cycle and in the process to overcoming these stresses they produce secondary metabolites, which were not important for the metabolic functions of the plant buthelp to face the unfavourable conditions. Some of these secondary metabolites have capacity to figt microorganisms and can be used for medicinal purposes (Anon, 1994; Muthu *et al*., 2006).

Plant scientists and natural-products chemists are combing the Earth for phytochemicals and other compounds that could be developed for treatment of various diseases. In 2010 a survey of 1000 plants, 156 clinical trials for evaluation of their pharmacological activities and therapeutic applications gave encouraging results (Cravotto *et al*, 2010) that further led to the new search for drugs and dietary supplements derived from plants.

Herbal extracts with a broad spectrum of therapeutic effects are mostly mixture of various bioactive substances, unlike allopathy where a single active substance is identified to show its bioactivity. Many publications on phytoceuticals have reported them to be suitable for long-term and for follow-up treatment of chronic diseases. The phytoceuticals may have complementary or supplementary and rarely inhibitory interaction of the given phytodrug, and more proper and scientific evaluation including its application has been warranted. There are reports where single known substance was unable to give bioactivity when compared with phytoceuticals, substantiate above view (Butcher, 1977).

The medicinals or officinales are integral part of the natural biodiversity and history of traditional knowledge of a country (Okigbo *et al.,* 2008) and modern pharmacopoeia still contains about 25% drugs derived from plants and many others, which are synthetic analogues built on prototype compounds isolated from plants. Interest in medicinal plants as a re-emerging health aid has been fuelled by the rising

costs of prescription drugs, uncontrollable residual toxicity in the maintenance of personal health and the bioprospecting of new plant-derived drugs (Lucy and Edgar, 1999).

It has been emphasized that secondary metabolites have not been systemically assayed in the culture medium (Petiard and Courtois, 1983). Careful checks on the kinetics of cell death compared to the kinetics of metabolite excretion has shown that in most cases the excretion of phytochemicals is a real physiological process contributing to the overall dynamics of these metabolites. Secondary metabolites are usually not distributed uniformly within the whole plant (Strack *et al*, 1985). Some are restricted to specific organs e.g. the roots or seeds, others to specific tissues such as epidermis. While we have rather extensive knowledge of the biosynthetic pathways of secondary compounds, information on precise sites of accumulation is still scanty.

The use of medicinal plants in the treatment and prevention of infectious diseases has attracted the attention of scientist's worldwide (Cinmaga *et al*., 1998; Falodun and Usifoh, 2006). Phytochemical screening of the various plant parts of *Aristolochia bracteolata* and *Ruellia patula* indicated the presence of important bioactive compounds flavonoids and phytosterols in them.

Flavonoids are a series of related water soluble phenolic glycosides derived from aromatic amino acids, which occur almost universally in higher plants. They impart colour to flowers and fruits, which play a role in attraction of pollinating insects. Flavonoids have also been reported to have pathological significance in plants by providing resistance to the plants against pests and insects (Cruickshank and Perrin, 1964) besides physiological importance for animals.

The flavonoids usually present in their free form and at reactive sites in their bound form as glycosides. Therefore, the difference in content between free and bound forms shows their involvement at resting and active stages, thus giving higher or lower recovery of free and/or bound flavonoids (Harborne *et al*, 1975).

Sterols are ubiquitous in higher plants and probably also in plant tissue cultures. They are known to be the starting material for the synthesis of a number of plant steroids, which are pharmaceutically important group of compounds, as sex hormones, corticosteroids and oral contraceptives. According to Stumpf and Conn (1981) the meristematic part of the plant is most active in sterol synthesis. As the tissue ages, the rate of biosynthesis of metabolites decreases, but the sterols and alkaloids on the contrary continues to increase until the plant starts to senescence. This increase in sterols content may be due to a loss in primary metabolites such as carbohydrates, protein etc without a corresponding loss in sterols (Grunwald, 1981) might be responsible for higher content at 6-8 weeks after fresh subculturing and maintenance of more than 6 months by periodic subculturings.

Quantitative analysis is an important tool to provide information of the composition and level of the active components conained in a plant material. The phytochemical screening for the quantitative estimation of the phytosterols showed that the stem of *Aristolochia bracteolata* and *Ruellia patula* were rich in phytosterols in comparision to leaves, while amount of flavonoids was higher in leaves as compared to stem. Quercetin, Lueolin and Kaempferol are very important flavonoids and has anticancer, anti-inflammatory, antibacterial and metabolic syndrome properties. Quercetin is frequently used therapeutically in allegic conditions including asthma and hayfever, eczema and hives.

Many studies have demonstrated the medicinal properties of the extracts of various parts of A. bracteolata. Phytochemicals isolated from *A. bracteolata* have shown various biological activities such as antipyretic (Rajamanickam *et al*., 2009), anti-inflammaory (Shirwaikar and Someshkar, 2003), antioxidant (Thirugnansampandan *et al*., 2008), antifungal and antiplasmodial (Ramasubramania and NiranjanBabu, 2011), anti-implantation and abortifacient (Sathish Kumar *et al*., 2007).

A wide spectrum of phytoconstituents has been known for their medicinal values since ages. Studies on *Ruellia patula*, pertaining to wound healing (Saroja et al., 2009), antidiabetic (Manikandan and Doss, 2010) and cardiovascular

system (Akhtar et al., 1992) may be attributed to the phytochemical constituents present in it.

Presence and estimation of these phytochemicals, which occur rarely in plants, were very useful in taxonomic and medicinal purposes. Variations in the chemical constituents of different plants having different active compounds make them medicinally important than others. It can also help in the identification and classification of the plant species. It has been observed that no medicinal plant was functional without the active ingredients.

The results of present study revealed the presence of medicinally important constituents in *A. bracteolata* and *R. patula*. Several studies confirmed that the presence of phytochemicals contribute medicinal as well as physiological properties to these plants in the treatment of different ailments. Traditional medicine practice is recommended strongly that further work should be carried out to isolate, purify and characterize the bioactive compounds responsible for the activity of these plants.

PLATE 6.1: SELECTED ETHNOMEDICINAL PLANTS

(a) *Aristolochia bracteolata* Lamk.

(b) *Ruellia patula* Jacq.

CHAPTER-7
ANTIBACTERIAL ACTIVITIES OF SELECTED MEDICINAL PLANTS

INTRODUCTION

Most of the world population depends mainly on plants and plant extracts for health care. More than 30% of the entire plant species, at one time or other was used for medicinal purposes. It has been reported that in developed countries such as United States, plant drugs constitute as much as 25% of the total drugs, while in fast developing countries such as China and India, the contribution is as much as 80%.

Thus, the economic importance of medicinal plants is much more to countries such as India as compared to rest of the world. These countries provide two third of the plants used in modern system of medicine and the health care system of rural population depend on indigenous systems of medicine. Of the 2, 50,000 higher plant species on earth, more than 80,000 are medicinal.

In India, drugs of herbal origin have been used in traditional systems of medicines such as Unani and Ayurveda since ancient times. The Ayurveda system of medicine uses about 700 species, Unani 700, Siddha 600, Amchi 600 and modern medicine around 30 species. The drugs are derived either from the whole plant or from different organs, like leaves, stem, bark, root, flower, seed, etc.

Some drugs are prepared from excretory plant product such as gum, resins and latex. Even the Allopathic system of medicine has changed a number of plant-derived drugs which form an important segment of the modern pharmacopoeia. Some important chemical intermediates needed for manufacturing the modern drugs are also obtained from plants (eg. diosgenin, solasodine, ß-ionone).

Many publications on phytoceuticals have reported them to be suitable for long-term and for follow-up treatment of chronic diseases. The phytoceuticals may have complementary or supplementary and rarely inhibitory interaction of the given phytodrug, and more proper and scientific evaluation including its application has

been warranted. There are reports where single known substance was unable to give bioactivity when compared with phytoceuticals, substantiate above view (Butcher, 1977).

A disease is a meticulous abnormal condition, a disorder of a structure or function that affects part or all of an organism, associated with days functioning of the body's normal homeostatic processes. It is used more broadly as any condition caused due to infection, genetic problems and metabolic disturbances results in pain, dysfunction, distress, social problems, or death to the person afflicted, or similar problems for those in contact with the person. In this broader sense, it sometimes classified as disability, disorders, syndromes, infections, isolated symptoms, deviant behaviors, and atypical variations of structure and function, while in other contexts and for other purposes these may be considered distinguishable categories. Diseases can directly harm an individual not only physically, which can alter the affected person's perspective on life.

In present scenario, there are many of variations to divert from synthetic to herbal medicine, as a boon gift of nature. Medicinal plants have been known for millennia and are highly valued all globally as a rich source of therapeutic agents for the prevention of diseases and ailments (Sharma *et al*. 2008). The search for undying health and prolonged existence and for remedies to relieve pain drove human beings to explore immediate natural surroundings and led to the use of many plants and the development of a variety of therapeutic agents.

The worth of medicinal plants and traditional health systems in resolving the health care globally is gaining lot of attentions. Because of this resurrection of interest, the research on plants of having bioactive compounds is growing phenomenally at global level, often to the disadvantage of natural habitats. Most of the developing countries have acquired traditional medical practice as an integral part of their system. Earlier all medicinal drugs were derived from plants, whether in the easy way of unrefined plant materials or in the refined form of crude extracts, mixtures, etc. (Krishnaraju *et al*. 2005).

In the initial stages of modern medicine, biologically active compounds from higher plants have played an important role in providing medicines to combat pain and diseases. For example, in The British Pharmacopoeia (1932), over 70% of organic monographs are based on natural products. However, with the development of synthetic medicines, and afterward of antibiotics, the role of plant derived therapeutic agents significantly declined in the economically developed nations. In terms of new chemical entities introduced as medicinal agents over the past several decades, the share of plant-based drugs has been no more than 2% (Dev, 1997).

Plants are rich in wide variety of secondary metabolites such as tannins, terpenoids, alkaloids, flavonoids, sterols etc., which have been found *in vitro* to have antimicrobial properties. On the basis of traditional use, herbs are selected and studied for their ability to inhibit microbial growth. Herbal medicine is also known as phytomedicine and whole plant or part of plants such as seeds, berries, roots, leaves, bark and flowers are used to treat illness.

Isolation of biological compounds from plant material is largely dependent on the type of solvent use in the extraction procedure. Extraction of secondary compounds with different solvents results in partitioning of extract into different fraction, each containing a specific group of secondary compounds, depending on their solubility in a particular solvent, e.g., fixed and essential oil, steroids and aglycones get extracted with petroleum ether, alkaloids, quinines and many other non-polar compounds are extracted with chloroform (Harmala *et al*., 1992), whereas glycosides are soluble in alcohol. Similarly tannins and phenolics compounds can be extracted with water, alcohol and ethyl acetate particularly flvonols are generally soluble in polar solvens such as methanol (Houghton *et al*., 1998; Kokate, 1990).

Traditional healers use primarily water for extrat but plant extracts from organic solvents have been found to give more consistent antimicrobial activity compared to water extracts (Parekh *et al*., 2005). Water soluble compounds such as polysaccharides and poly peptides, including fabatins and lectins are commonly more effective as inhibitors of pathogen adsorption and have no real impact as antimicrobial agents (Cowan, 1999). Water soluble flavonoids (mostly

anthocyanins) have no antimicrobial significance and water soluble phenolics are only important as antioxidant compounds (Yamaji *et al*., 2005; Nang *et al*., 2007).

Antibiotics are undeniably one of the most important therapeutic discoveries of the 20th century that had effectiveness against serious bacterial infections. However, only one third of the infectious diseases known have been treated from these synthetic products. This is because of the emergence of resistant pathogens that is beyond doubt the consequence of years of widespread indiscriminate use incessant and misuse of antibiotic (Enne *et al*., 2001). Antibiotic resistance has increased substantially in the recent years and is posing an ever increasing therapeutic problem. One of the methods to reduce the resistance to antibiotics is by using antibiotic resistance inhibitors from plants (Alagesaboopathi, 2011). Plants are known to produce a variety of compounds to protect themselves against a variety of pathogens. It is expected that plant extracts showing target sites other than those used by antibiotics will be active against drug resistant pathogens (Ahmad and Beg, 2001).

There is need to develop alternative antimicrobial drugs. One such approach is to screen local medicinal plants which represent a rich source of novel antimicrobial agents. In the present study, plant parts such as stem and leaves of *Aristolochia btacteolata* and *Ruellia patula* have been selected for their antimicrobial activity of different plant extracts and isolation of active fractions from the plants showing best antimicrobial activity against selected pathogens.

MATERIAL AND METHODS

Antimicrobial activity of *Aristolochia bracteolata* and *Ruellia patula* was studied with their sequential extracts (Petroleum Ether, Chloroform, Benzene, Ethanol, Methanol and Water). Four bacterial strains were selected for the primary screening.

Microbial strains and culture maintenance

The pathological strains of test organisms were obtained from the Microbial Type Culture Collection (MTCC) from Institute of Microbial Technology, Chandigarh. These included two Gram positive bacteria *Staphylococcus aureus*

(MTCC 3160) and *Streptomyces griseus* (MTCC 4734); two Gram negative bacteria *Escherechia coli* (MTCC 9537) and *Pseudomonas aeruginosa* (MTCC 3542). These bacteria were grown in Nutrient agar medium (prepared by autoclaving 8% Nutrient agar of Difeco-Laboratories, Detroit, USA, in distilled water at 15 lbs psi for 25-30 min) and incubating at 37°C for 48 h. Each bacterial culture was further maintained on the same medium after every 48 h of transferring. A fresh suspension of test organism in saline solution was prepared from a freshly grown agar slant before every antimicrobial assay.

Preparation of Extract

The crude sequential extracts of *Aristolochia bracteolata* and *Ruellia patula* were obtained by macerating 30 g of dried plant powder in 95% methanol and kept on a rotary shaker for 24 h. The extract was filtered, centrifuged at 5000 rpm for 15 min and was dried under reduced pressure. The extract was stored at 4ºC in airtight bottles.

Determination of Antibacterial Assay

In vitro antibacterial activity of the crude methanol extract was studied against gram positive and gram negative bacterial strains by the agar well diffusion method (Perez *et al,* 1990). Mueller Hinton agar no. 2 (Hi Media, India) was used as the bacteriological medium. The extracts were diluted in 100% Dimethylsulphoxide (DMSO) at the concentrations of 5 mg/mL. The Mueller Hinton agar was melted and cooled to 48 - 50ºC and a standardized inoculum (1.5×108 CFU/mL, 0.5 McFarland) was then added aseptically to the molten agar and poured into sterile petri dishes to give a solid plate. Wells were prepared in the seeded agar plates. The test compound (100 µl) was introduced in the well (6 mm). The plates were incubated overnight at 37ºC. The antimicrobial spectrum of the extract was determined for the bacterial species in terms of zone sizes around each well. The diameters of zone of inhibition produced by the agent were compared with those produced by the commercial control antibiotics, streptomycin. For each bacterial strain controls were maintained where pure solvents were used instead of the extract. The control zones were subtracted from the test zones and the resulting zone

diameter was measured with antibiotic zone reader to nearest mm. The experiment was performed three times to minimize the error and the mean values are presented.

RESULTS

In the present investigation sequential extracts of selected plants were screened for their antibacterial activity against selected clinical isolates. Leaves of *A. bracteolata* showed maximum activity in aqueous fraction against *P. aeruginosa* (10 mm) while rest of the fractions was found to be ineffective. Similarly in stem maximum activity was observed in methanol fraction against *S.aureus* and *S. griseus* (12 mm). Ethanol fraction has also showed potency against *S. griseus* (8mm) which was at par with *S. aureus* and *E. coli*. Rest of the samples was not potent against selected microbes. (Table 7.1-7.2; Plate 7.1 A, B).

Further in leaves extracts of *R. patula* maximum activity was observed in methanol fraction against *P. aeruginosa* (12 mm) while benzene fraction also showed potency against *E. coli* (8 mm) and *P. aeruginosa* (6 mm). Other solvents did not show any significant activity.In stem maximum activity was observed in both in ethanol and methanol (both 12mm) against *S. aureus* which was at par with ethanol fraction against *P. aeruginosa* while other sequential extracts did not showed significantpotency as isolates were resistant to them (Table 7.3, 7.4; Plate 7.1 C,D).

DISCUSSION

Plants produce many bioactive compounds during biosynthetic pathways which keep on changes according to conditions. Researchers are combing the Earth for natural products in combating of various diseases. In 2010 a survey of 1000 plants, 156 clinical trials for evaluation of their pharmacological activities and therapeutic applications gave encouraging results (Cravotto *et al*, 2010) that further led to the new search for drugs and dietary supplements derived from plants.

Since last many years natural products is of keen interest due to their major inference for medicinal, nutritive and cosmetic purposes. Living beings are devoid of motility and immune system, have developed other defense mechanism. The

diversity of these bioactive compounds produced by them and relations displayed these metabolites serves as an implement to provide multiple protective uses ranging from toxicity and light/UV shielding to signal transduction (Vasconsuelo and Boland, 2007).

Therapeutic uses of medicinal plants are as early as human life itself. The relationship between man and his search for phytoceuticals dates is still evolving, of which there is ample proof from various sources: written and preserved monuments, including original natural drugs. Awareness of medicinal plants usage is a result of the many years of battles against various diseases because of which man learned to chase drugs in barks, seeds, fruit bodies, and other parts of the plants. Current science has proved their active role, and it has been added in modern pharmacotherapy a broad range of plant based drugs, known by earlier civilizations and used throughout the millennia. Culture of medicinal plants is thought to have started some 60,000 years ago, where pollen grains of several medicinal plants such as marshmallow (*Althaea*), yarrow (*Achillea*), ephedra and muscari were mentioned at burial sites at Shanidar in Iraq. This proves the use of medicinal plants by the Neanderthal Man. Medicinal plants were always of keen interest.

The ancient mentioned historical knowledge dates back to 2500 B.C. when Sumarian ideograms mentioned the use of medicinal plants like the poppy as the "the plant of joy" 1728 to 1686 B.C. in the Code of Hammurabi, the King of Babylon. Plants described mainly contained mint, henbane, senna and licorice. It is very tough to know at what point in time mankind first invented the therapeutic use of medicinal plants.

Plants are used medicinally in various countries and are source of many useful and important drugs (Mahesh and Sathish, 2008). Indian traditional medicine system *i.e. Ayurveda* is a medical system primarily adept in India that has been known for nearly 5000 years. Plants and their natural products constituents have a long history of use in modern ‘western’ medicine and in convinced systems of traditional medicine, and are the sources of important drugs such as atropine, codeine, digoxin, morphine, quinine and vincristine.

Initially phytochemical testing of plant is very useful for determination of the active constituents in different solvents and their yields. Most of the phytochemicals are found in alcoholic and aqueous extracts. Methanol is known to be one of the best solvents for extracting compounds such as phenolics and other polar materials in plants (Velioglu *et al*., 1998). The antimicrobial activity of the alcoholic extract can be attributed to the presence of naturally occurring antimicrobial phenolic compounds, like catecholes, oleoresins and secondary metabolites (Cordell and Shin, 1999; Goudgaon *et al*., 2003).

Arora *et al*. (2004) evaluated *in vitro* antibacterial activities of *Withania somnifera* extracts. The methanol extract of leaves showed the maximum activity against *Salmonella typhimurium* than *E. coli*, while in hexane extract of leaves showed moderate activity against *S. typhimurium* than *E. coli*. In 2010, Abubakar have reported the antibacterial potential of crude leaf extracts of *Eucalyptus camaldulensis* against some pathogenic bacteria. The least activity in terms of zones of growth inhibition was shown by aqueous extract against *E. coli*, while the highest activity was demonstrated in acetone extract of leaves.

Plants are major source of potentially useful structures for the development of new chemotherapeutic agents. The initial step towards this goal is the *in vitro* antibacterial activity assay (Tona *et al.*, 1998). Many reviews are available on the antiviral, antibacterial, antifungal, anthelmintic, antimolluscal and anti-inflammatory potency of plants (Samy and Ignacimuthu, 2000; Palombo and Semple, 2001; Govindarajan *et al.*, 2006). Some of these results have helped in identifying the active components responsible for such activities and in the developing drugs for the therapeutic use in human beings. Several researchers had reported that plants contain antimicrobial substances (Ibekwe *et al.*, 2000).

In the present study, two ethnomedicinal plant species *Aristolochia bracteolata* and *Ruellia patula* were screened for their antimicrobial quantification. Successive and serial extraction of these plants has been done in petroleum ether, chloroform, benzene, ethanol, methanol and water.

Methanolic and ethanolic extracts of stem of *Aristolochia bracteolata* and *Ruellia patula* showed the maximum activity against the test pathogens. The activity of these extracts may be due to the presence of flavonoids and other phenolic compounds which were dissolved in alcohols.

Recent reports of antibacterial, antiviral, antifungal, anti-oxidant, anti-inflammatory, antiallergenic, and hepatoprotective activities of flavonoids have generated interest in studies of flavonoids containing plants. Of these biological activities, anti-inflammatory capacity of flavonoids has long been utilized in Chinese medicine and the cosmetic industry as a form of crude plant extracts (Aguinaldo *et al*., 2005; Moon *et al*., 2006; Veitch, 2007; Wu *et al*., 1987; Chen and Jhang, 2014).

As is the case with several phytochemicals, phytosterols also exhibit anti-oxidant activity (Yoshida and Niki, 2003). Since many phytochemical displaying antioxidant activity, including extracts from spices, also possess antimicrobial activity (Dykes *et al*., 2003). Extracts of a primary phytosterol, B-sitosterol, from several herbs has been shown to exhibit antimicrobial activity against the organisms *Bacillus subtilis* (Beltrame *et al*., 2002) and *Candida albicans* (Moshi *et al*.,2004).

Biologically important metabolites contain an extraordinarily various assay of organic compounds and the carbohydrates are not only the first formed organic compounds in the plants as a result of photosynthesis but, also a major source of energy. Besides this, all the phytochemicals are directly or indirectly derived from them for the major framework or they also alter the physico-chemical properties of other groups of compounds by combining with them.

The phytochemicals of plants were found to be source of various bioactive compounds that could be directly used as intermediates for the synthesis of new medicines. Traditional medicine has important role in the present primary healthcare organization of the developing countries. The natural medicines are believed to be more satisfactory to the human body, when compare to modern medicines. Thus the most important feature needed is to derive the maximum profit from the traditional

system of medicine for providing adequate healthcare service to rural people (Ghani, 1990).

Infectious diseases induce morbidity and mortality globally. Multidrug resistivity is increasing day by day in microbes. This increase has been accredited to arbitrary use of broad spectrum antibiotics, immunosuppressive agents, intravenous catheters organ transplantation and ongoing epidermis of human immunodeficiency virus (HIV) infections. The outcome of multidrug resistant strain of many pathogens is a big threat and makes chemotherapy more difficult. However, the present cost of most of the chemotherapeutic agents is agonizing to the public especially in developing countries like India (Sarala *et al.*, 2010).Therefore attempts must be directed towards the development of effective natural, non-toxic drug for treatment and provided the thrust to the search for new antimicrobial substances from various source like medicinal plants.

The selection of plants usually involves various ethno botanical approach is one of the routine methods that are employed in choosing the plant for pharmacological study. Traditionally plant parts, extracts, infusions etc were used for treatment of various diseases. The data denotes that each plant extract shows different degree of ZOI (Zone of inhibition) against different clinical isolates (bacterial and fungal isolates). The physical parameters (like pH of the medium, period and temperature of incubation, volume of the well, concentration of plant extracts and size of inoculums) pose no much error in the results as they were fixed and standardized during research work. However, intrinsic factors might be accountable for variability in diffusion of extract which result in variable ZOI (Prasai *et al.*, 2004). Thus, the study conveys the value of plants used in *Ayurveda*, which could be of substantial interest to the development of new drugs. Results obtained from initial studies, indicated that, the plant extracts showed the strongest antimicrobial activity than the synthetic drugs.

The medicinal plants are integral part of the natural biodiversity and history of traditional knowledge of a country (Okigbo *et al*, 2008) and modern pharmacopoeia still contains about 25% drugs derived from plants and many others,

which are synthetic analogues built on prototype compounds isolated from plants. Interest in medicinal plants as a re-emerging health aid has been fuelled by the rising costs of prescription drugs, uncontrollable residual toxicity in the maintenance of personal health and the bioprospecting of new plant-derived drugs (Lucy and Edgar, 1999). Herbs are staging a comeback and herbal 'formulation' is happening all over the globe. The herbal products today indicate safety in contrast to the synthetics that are regarded as harmful to human and environment. Although herbs had been estimated for their medicinal, flavoring and aromatic qualities for centuries, the synthetic products of the modern age reduced their importance, for a while. However, the unwanted dependence on synthetics is over and people are returning to the naturals with hope of safety and security.

The present study has shown a spectrum of antimicrobial activities, which provides a support to some traditional uses of selected medicinal plants. But the effective biomolecules which act as antimicrobial have to be identified, isolated and subjected to extensive scientific and pharmacological screening that can be used as sources for new drugs.

Table 7.1: Showing zone of inhibition of different extracts of *A. bractoeolata* (leaves) against selected pathogens.

Extracts	***Streptomyces griseus***		***Pseudomonas aeruginosa***		***Staphylococcus aureus***		***Escherechia coli***	
	Zone of Inhibition Mean of Bacteria (mm)	Activity index-	Zone of Inhibition Mean of Bacteria (mm)	Activity index-	Zone of Inhibition Mean of Bacteria (mm)	Activity index-	Zone of Inhibition Mean of Bacteria (mm)	Activity index-
Pet. ether	NA	-	NA	-	NA	-	NA	-
Chloroform	NA	-	NA	-	4	0.2	NA	-
Benzene	NA	-	NA	-	NA	-	NA	-
Ethanol	NA	-	NA	-	NA	-	NA	-
Methanol	6	0.3	NA	-	NA	-	NA	-
Aqueous fraction	NA	-	10	0.5	NA	-	4	0.2
Standard	20	-	20	-	20	-	20	-

NA-no activity
AI- sample zone /standard zone

Table 7.2: Showing zone of inhibition of different extracts of *A. bractoeolata* (stem) against selected pathogens.

Extracts	*Streptomyces griseus*		*Pseudomonas aeruginosa*		*Staphylococcus aureus*		*Escherechia coli*	
	Zone of Inhibition Mean of Bacteria (mm)	**Activity index-**	**Zone of Inhibition Mean of Bacteria (mm)**	**Activity index-**	**Zone of Inhibition Mean of Bacteria (mm)**	**Activity index-**	**Zone of Inhibition Mean of Bacteria (mm)**	**Activity index-**
Pet. ether	NA	-	NA	-	NA	-	NA	-
Chloroform	NA	-	NA	-	NA	-	NA	-
Benzene	NA	-	NA	-	NA	-	NA	-
Ethanol	8	0.4	NA	-	8	0.4	8	0.4
Methanol	12	0.6	NA	-	12	0.6	10	0.5
Aqueous fraction	NA	-	NA	-	NA	-	NA	-
Standard	20	-	20	-	20	-	20	-

NA-no activity
AI- sample zone /standard zone

Table 7.3 Showing zone of inhibition of different extracts of *R. patula* (leaves) against selected pathogens.

Extracts	***Streptomyces griseus***		***Pseudomonas aeruginosa***		***Staphylococcus aureus***		***E. coli***	
	Zone of Inhibition Mean of Bacteria (mm)	Activity index-	Zone of Inhibition Mean of Bacteria (mm)	Activity index-	Zone of Inhibition Mean of Bacteria (mm)	Activity index-	Zone of Inhibition Mean of Bacteria (mm)	Activity index-
Pet. ether	NA	-	NA	-	NA	-	NA	-
Chloroform	NA	-	NA	-	4	0.2	NA	-
Benzene	NA	-	6	0.3	NA	-	8	0.4
Ethanol	NA	-	NA	-	NA	-	4	0.2
Methanol	NA	-	12	0.6	NA	-	NA	-
Aqueous fraction	NA	-	NA	-	NA	-	NA	-
Standard	20	-	20	-	20	-	20	-

NA-no activity
AI- sample zone /standard zone

Table 7.4: Showing zone of inhibition of different extracts of *R. patula* (stem) against selected pathogens.

Extracts	*Streptomyces griseus*		*Pseudomonas aeruginosa*		*Staphylococcus aureus*		*E. coli*	
	Zone of Inhibition Mean of Bacteria (mm)	**Activity index-**	**Zone of Inhibition Mean of Bacteria (mm)**	**Activity index-**	**Zone of Inhibition Mean of Bacteria (mm)**	**Activity index-**	**Zone of Inhibition Mean of Bacteria (mm)**	**Activity index-**
Pet. ether	NA	-	NA	-	NA	-	NA	-
Chloroform	4	0.2	NA	-	NA	-	NA	-
Benzene	NA	-	NA	-	NA	-	NA	-
Ethanol	NA	-	12	0.6	12	0.6	NA	-
Methanol	4	0.2	NA	-	12	0.6	NA	-
Aqueous fraction	NA	-	NA	-	4	0.2	NA	-
Standard	20	-	20	-	20	-	20	-

NA-no activity
AI- sample zone /standard zone

CHAPTER 8
SUMMARY AND CONCLUSION

SUMMARY

The term 'Biodiversity' generally refers to the variety of living organisms on this earth. It came under serious threat as a result of various human activities. It is mainly due to habitat loss, over-exploitation of natural resources, pollution and introduction of exotic species. Excessive and uncontrolled biotic interferences have also resulted in depletion of biodiversity. Loss of biodiversity may trigger large unpredictable change in an ecosystem. There is an urgent need to conserve the biodiversity before the treasure is lost. The conservation of species in their natural environment i.e. *in-situ* conservation is considered as the most appropriate way of conserving the biodiversity.

Conservation reserves are the essential part of any comprehensive biodiversity conservation strategy. The main aim of conservation reserves are for the protection of existing forests and restoration of the degraded forests in ecological sensitive areas. Based on the floristic wealth and existing threats, certain forest areas have been prioritized and brought under long term conservation programmes. In this context Government of Rajasthan declared 1047.48 hectare forest area as Beer Jhunjhunu Conservation Reserve of district Jhunjhunu for protecting landscapes, flora, fauna and their habitats.

Jhunjhunu district, a part of Shekhawati region of Rajasthan, is located in the north-eastern part of the state. The Aravali ranges are embracing the souh-eastern part of the district. These ranges have immense influence on the vegetation of the area. Most part of the district is semi-arid. The study area, Beer Jhunjhunu Conservation Reserve is a protected forest area and considered as important in terms of biodiversity. The area harbours rich flora, wild animals, birds, natural surroundings and Baba Khetanath Ashram. It is almost plain area including sand-dunes with little slopes at some places.The vegetation of the area is composed of Tropical thorn forest and dry deciduous forest type.

Floristic Diversity

Floristic composition and structure was the main components of the any specific area. The present study provides baseline information about the floristic composition of the area. Based on the extensive field work undertaken at different study sites, a total of 453 plants taxa (including variety) belonging to 452 species under 289 genera and 79 families have been recorded in the Beer Jhunjhunu Conservation Reserve. Among them 350 were dicots and 101 belonging to monocots and only one species of gymnosperm was recorded. The study revealed that herbs and grasses are dominated in the area with 288 species contributing 63% of plant species. It is followed by trees (52), climbers (50), shrub (41) and undershrubs (22) representing 11.43%, 11.04%, 9.05% and 4.86% respectively. Poaceae was the most dominant family in the present study followed by Fabaceae and Asteraceae.

Salvadora oleoides-Capparis decidua forms the dominant community of the area. The other common trees are: *Salvadora persica, Acacia nilotica, A. senegal, A. leucophloea, Zizyphus mauritiana, Ficus religiosa, F. benghalensis, Prosopis cineraria, P. juliflora, Maytenus emarginata, Tecomella undulata* and *Balanites aegyptiaca*. The common shrub species includes: *Capparis decidua, Zizyphus nummularia, Lycium barbarum, Calotropis procera, Mimosa hamata, Nerium indicum, Thevetia peruviana* and *Lawsonia inermis*. In addition, undershrubs and herbs like *Crotalaria burhia, C. medicaginea, Leptadenia pyrotechnica, Tephrosia purpurea, Aerva persica, A. pseudotomentosa, Clerodendrum phlomiidis, Indigofera cordifolia, Farsetia hamiltonii, Heliotropium strigosum, Abutilon indicum, Artemisia scoparia, Sida cordifolia* and *Ipomoea sindica* were observed in the study area.

Most of the trees and shrubs of the Beer Jhunjhunu were often covered with a large number of climbers and ramblers.In the south segment of Beer area, some plants showed resemblance with hilly tract vegetation. These includes: *Hibiscus ovalifolius, Barleria prionitis, B. acanthoides, Lindenbergia indica, Triumfetta rhomboidea, Dipteracanthus patulus, Lepidagathis bandraensis, Rhynchosia minima, Ceropegia bulbosa, Sarcostemma viminale* and *Securinega leucopyrus*. It may be due to the influence of presence of offshoots of Aravalli hills in the south-

eastern part of the district. During the rainy season, the area gets covered with green carpet of grasses and herbs.

An extensive survey of the study area revealed that the area was luxuriant in vegetation and enriched with many medicinal, rare and threatened plants. 35 plant species were reported as rare, endemic and threatened from the area. *Calligonum polygonoides*, *Sarcostemma viminale*, *Leptadenia reticulata*, *Indigofera caerulea*, *Ceropegia bulbosa* var. *bulbosa* and *C. bulbosa* var. *lushii* were observed as endangered in the study area and require immediate attention for their conservations.

Ethnobotany

Since time immemorial, plants served as the first source of medicine to treat various ailments. Man learnt about the therapeutic use of plants through trials and errors. This knowledge was orally passed from generation to generation leading to the development of the traditional healthcare system.

The present study indicated that the flora of Beer Jhunjhunu, is quite rich in medicinal plant species in spite of being located in the arid zone of country. A total of 120 plant species were recorded, which are being exploited by the local people for curing various ailments. Present observations revealed that plants are used in many health problems such as skin diseases, rheumatism, asthma, urinary disorders, dental caries, kidney stone, debility and gynecological disorders in women. The study revealed that these medicinal plants were used as simple drugs and also in the form of decoction, powder, juice or paste.

The role of ethnoveterinary medicine in livestock development is beyond dispute. 64 plant species of ethnoveterinary uses belonging to 36 families were also recorded in the present study. It has been observed that ethnomedicinal plants were safe, efficacious and affordable for the rural people of the study area.

The plants are commonly used in traditional art and technology, construction of traditional huts and agricultural implements. The people inhabiting the Shekhawati region of Rajasthan were known for their love for music. *Chang* or

Dhap is commonly played by thumping ones hands on the same and providing beats during festivals.

Phytochemical analysis of selected plant species

In recent times, ethnomedicinal and traditional pharmacological approaches are achieving great appreciation in modern medicinal system. The use of medicinal plants in the treatment and prevention of infectitious diseases has attracted the attention of scientists all over the world. The importance of medicinal plant lies in their biological active principles, which are the real healer in the process of medication. In the present investigations, two common ethnomedicinal plant species *Aristolochia bracteolata* Lam. and *Ruellia patula* Jacq., widely used by the rural and tribal people to treat various ailments, were considered suitable for detailed study. These plants species are further screened for isolation of active compounds and observing their antimicrobial activity.

Phytochemicals are chemical compounds produced by plants. These phytoconstituents confer specific characteristics and properties of the plants. Thin Layer Chromatography (TLC) and Preperative Thin Layer Chromatography (PTLC) studies were carried out to isolate the principal components that were present in extracts of plant parts of *Aristolochia bracteolata* Lam. and *Ruellia patula* Jacq. TLC and PTLC studies were carried out for different extracts on silica gel. The different solvent systems of different polarities were prepared and TLC and PTLC were carried out to select the suitable solvent system.

The Phytochemical screening of different extracts of the stem and leaves of *Aristolochia bracteolata* Lam. and *Ruellia patula* Jacq. indicated the presence of important bioactive compounds like flavonoids, alkaloids, phenols and sterols. After quantification, it was observed that maximum amount of flavonoids were observed in leaves of *Aristolochia bracteolata* Lam. and *Ruellia patula* Jacq. as compared to stem. The maximum amount of phytosterol was observed in the stem of both plant species as compared to leaves.

Antibacterial activity of selected plant species

Since ancient times, natural products have been used in folklore preparations all over the world. The study of biologically active compounds from plants has been novel resources of useful drugs for treating many infectitious diseases. There is need to develop alternative antibacterial drugs. One such approach is to screen local medicinal plants which reprsents a rich source of novel antimicrobial agents. In the present study, plant parts such as stem and leaves of *Aristolochia bracteolata* Lam. and *Ruellia patula* Jacq. were selected for their antibacterial activity of different extracts and isolation of active fractions from the plants showing best antimicrobial activity against the selected pathogens.

The present investigations observed the antimicrobial activities of the various extracts of the leaves and stem of *Aristolochia bracteolata* Lam. and *Ruellia patula* Jacq., using agar well diffusion method against human pathogenic bacteria such as *Escherechia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Streptomyces griseus*. In *Aristolochia bracteolata* Lam., leaves showed maximum activity in aqueous fraction against *P. aeruginosa* while in stem, maximum activity was observed in methanol fraction against *S. griseus* and *S. aureus*. Further, maximum activity in leaves extracts of *R. patula* was observed in methanol fraction against *P. aeruginosa*, while in stem of *Ruellia patula* Jacq., maximum activity was observed in both methanol and ethanol fractions against *S. aureus* which was at par with ethanol fraction against *P. aeruginosa*. The present study supported the folklore claims of using these plant species for treating ailments.

Conclusion

Understanding the floristic diversity of an area is prerequiste for proper conservation efforts. Species need to be conserved along with their habitats. The present observation showed that the Beer region of Jhunjhunu harbours a rich array of floristic wealth which represents medicinal, religious, environmental, ecological and economical values.

The present work provides a detailed account of ethnobotany of Beer Jhunjhunu Conservation Reserve. The study can lead to strengthening of cultural

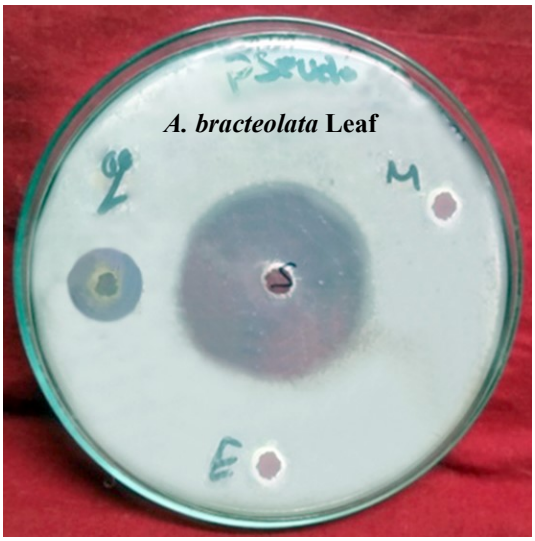
diversity and conservation, greater sustainability in exploration of plant resources. The study will help in recording and documentation of traditional knowledge about the empirical uses of plants, which is widely disappearing now. It can be observed from the present study that through such investigations, more new plant drugs can be obtained from the hidden knowledge of the traditional communities.

Presence of ethnobotanically important species makes the area more important and concerned for conservation in terms of resource supply for sustainable utilization. Many rare, endemic and threatened taxa were reported from the study area. Such diverse, rich and valuable vegetation of the area signifies the need of proper conservation and management of the Beer Jhunjhunu Conservation Reserve.

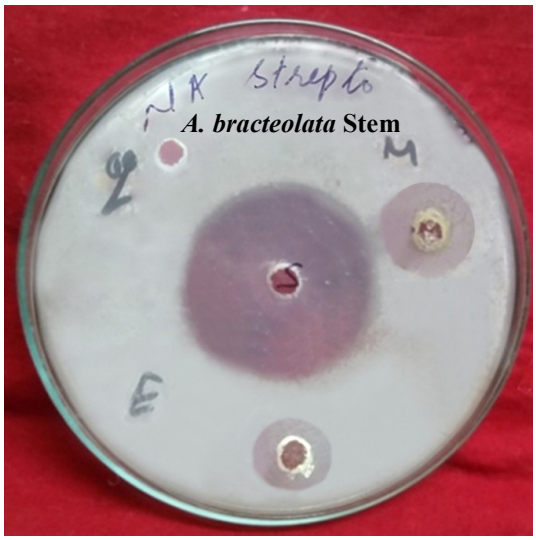
The present study indicated that the selected plant species *Aristolochia bracteolata* Lam. and *Ruellia patula* Jacq. possess different bioactive compounds. They can be used as phytomedicine as they showed antimicrobial activities. So the plant species can be further tested to discover the new dimensions of pharmaceuticals.

The natural resources of this area have been depleting fast during the last few decades due to destruction of habitats. The region is subjected to enormous anthropogenic pressure such as habitat fragmentation, illegal harvesting, smuggling of plants, over-exploitation of economically important plants, encroachment by nearby community, alien species invasion, unchecked grazing, deforestation, unplanned developmental activities and pollution due to sewage and dumping of solid wastes. Many plant species were facing threats for the existence. Conservation of the species in their natural habitat would be the best way to recover the species from getting extinction.

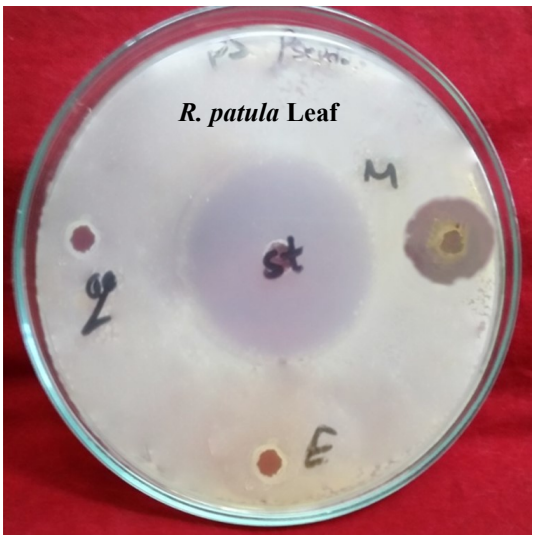
PLATE 7. 1: ANTIBACTERIAL ACTIVITY OF SELECTED MEDICINAL PLANTS



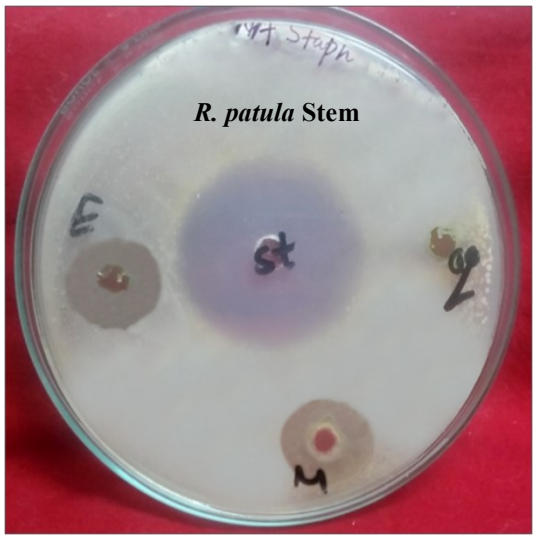
(A)The effect of *A. bracteolata* (leaves) extract against *P. aeruginosa*



(B)The effect of *A. bracteolata* (stem) extract against *S. griseus*



(C)The effect of *R. patula* (leaves) extract against *P. aeruginosa*



(D)The effect of *R. patula* (stem) extract against *S. aureus*

ABBREVIATION: Std.= Standard; E= Ethanol; M= Methanol; Pt= Petroleum ether; B= Benzene; Ch= Chloroform; Aq= Aqueous

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