Carrying Capacity Study of Teesta Basin in Sikkim

Volume - VIII

BIOLOGICAL ENVIRONMENT - FOOD RESOURCES

Commissioned by :

Ministry of Environment & Forests, Government of India

Sponsored by :

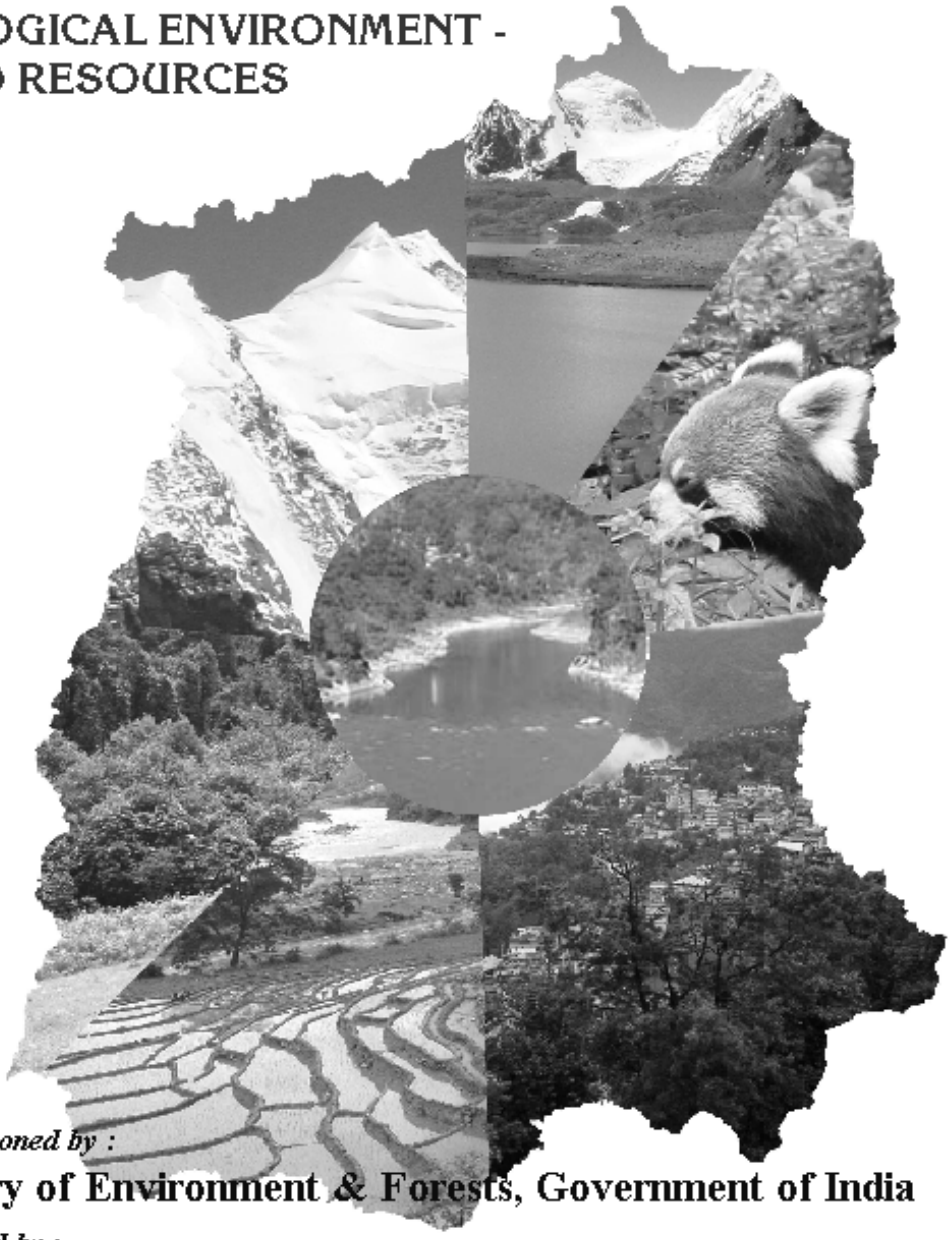
National Hydroelectric Power Corporation Ltd., Faridabad

CENTRE FOR INTER-DISCIPLINARY STUDIES OF
MOUNTAIN & HILL ENVIRONMENT
CISMHE UNIVERSITY OF DELHI, DELHI

Carrying Capacity Study of Teesta Basin in Sikkim

Volume - VIII

BIOLOGICAL ENVIRONMENT - FOOD RESOURCES



Commissioned by :

Ministry of Environment & Forests, Government of India

Sponsored by :

National Hydroelectric Power Corporation Ltd., Faridabad

CISMHE **CENTRE FOR INTER-DISCIPLINARY STUDIES OF MOUNTAIN & HILL ENVIRONMENT**
UNIVERSITY OF DELHI, DELHI
&
Department of Botany, Sikkim Government College, Gangtok

CARRYING CAPACITY STUDY OF TEESTA BASIN IN SIKKIM

EDIBLE WILD PLANTS AND ETHNIC FERMENTED FOODS






Food Microbiology Laboratory
Department of Botany
SIKKIM GOVERNMENT COLLEGE
GANGTOK 737102, SIKKIM

PARTICIPATING INSTITUTIONS

- **Centre for Inter-disciplinary Studies of Mountain & Hill Environment, University of Delhi, Delhi**

- **Centre for Atmospheric Sciences, Indian Institute of Technology, Delhi**

- **Centre for Himalayan Studies, University of North Bengal, Distt. Darjeeling**

- **Department of Geography and Applied Geography, University of North Bengal, Distt. Darjeeling**

- **Salim Ali Centre for Ornithology and Natural History, Anaikatti, Coimbatore**

- **Water and Power Consultancy Services (India) Ltd., Gurgaon, Haryana**

- **Food Microbiology Laboratory, Department of Botany, Sikkim Government College, Gangtok**

VOLUMES INDEX*

Volume – I
INTRODUCTORY VOLUME

Volume – II
LAND ENVIRONMENT - GEOPHYSICAL ENVIRONMENT

Volume – III
LAND ENVIRONMENT - SOIL

Volume – IV
WATER ENVIRONMENT

Volume – V
AIR ENVIRONMENT

Volume – VI
BIOLOGICAL ENVIRONMENT
TERRESTRIAL AND AQUATIC RESOURCES

Volume – VII
BIOLOGICAL ENVIRONMENT - FAUNAL ELEMENTS

Volume – VIII
BIOLOGICAL ENVIRONMENT - FOOD RESOURCES

Volume – IX
SOCIO-ECONOMIC ENVIRONMENT

Volume – X
SOCIO-CULTURAL ENVIRONMENT

EXECUTIVE SUMMARY

RECOMMENDATIONS

*For Volume-wise Detailed Index – Refer to the end of the report

ACKNOWLEDGEMENTS

The Report on “Edible Plants and Ethnic Fermented Foods” is one of the volumes of a mega project entiltled “**CARRYING CAPACITY OF TEESTA BASIN IN SIKKIM**” commissioned by the Ministry of Environment and Forests, Government of India and funded by National Hydroelectric Power Corporation Ltd. and coordinated through Centre for Inter-disciplinary Studies of Mountain & Hill Environment (CISMHE), University of Delhi. We are thankful to MoE&F. We also extend our sincere thanks to Prof. M.K. Pandit and Dr. Arun Bhaskar of CISMHE, University of Delhi for smooth running of the project and cooperation.

We thank all officials of the Government of Sikkim for their cooperation. We thank the Principal and staff of Sikkim Government College for technical support and constant encouragement.

The completion of this project is achieved through a team work- a spirit which we strongly believe. The team for this project:

Principal Investigator:	Dr. Jyoti Prakash Tamang
Co-investigator:	Dr. Madav Prasad Thapa
Research scholars:	Shri Rudra Mani Sharma
	Shri Arun Kumar Rai
	Ms. Paramita Rai
	Ms. Rita Dhakal

(Jyoti Prakash Tamang)
Principal Investigator/Senior Reader
Food Microbiology Laboratory
Department of Botany
Sikkim Government College
Gangtok 737102, Sikkim

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPER-1
INTRODUCTION

1.1 INTRODUCTION

Sikkim shows an important biological diversity mostly flora and fauna. More than 5000 species of angiosperms are found in the state-nearly one third of the total species of angiosperms found in the country. There are 4000 species of flowering plants, 3000 species of ferns, 500 species of orchids, 40 species of oaks, 30 to 40 species of primulas and bamboos, 154 species of mammals, 500 species of birds, over 700 species of butterflies and moths, 54 species of reptiles, 48 species of fishes and 30 species of amphibians. The forest area constituted 44.9 % of the total area of Sikkim.

Traditional foods have important bearing in the dietary habits of the people of Sikkim (Tamang, 2005). Food culture in the Sikkim Himalayas has been reflected in the pattern of food production in a mixed farming system. Depending on the altitudinal variation, the cereal crops are maize, rice, finger millet, wheat, buckwheat, barley; pulse crops are black gram, soybeans, green gram, garden peas; vegetable such as cabbage, cauliflower, leafy mustard *(rayo sag)*, young tendrils and fruits of squash (*iskus)*, brinjal, chili, cucumber, young tendrils and fruits of pumpkin, sponge gourd, tomato, tree tomato, etc.; tubers and rhizome crops are potato, sweet potato, cassava, colacasia, greater yam, ginger, turmeric, large cardamom; root crops are radish, carrot, etc. Seasonal fruits such as orange, banana, mango, papaya, guava, pear, peach, apple, fig, avocado, etc. are cultivated and eaten. Tea is also cultivated in Sikkim. Livestock mostly plays a subsidiary role in the

mixed farming system. The domestic livestock of Sikkim includes cattle, sheep, goats, pigs, yaks, poultry, etc. which is mainly used for meat, milk and milk products. Yaks (*Bos grunniens*) are reared mostly on extensive alpine and sub alpine scrub lands between 2100 m to 4500 m altitude for milk products and meat (Balaraman and Golay, 1991).

Wild plants play important roles in local diet of the Sikkim Himalayas. Preparation of wild edible plants including young edible bamboo shoots, ferns, stinging nettles, and their parts such as seeds, fruits, roots, leaves, flowers in local diet are important components of food culture. Varieties of wild mushrooms are also eaten. They also sell some common seasonal edible wild fruits and vegetables in nearby markets. Edible wild plants/fruits are in high demand in the local markets.

Food fermentation is probably one of the oldest 'biotechnological processes' from which development of fermented foods, based on trial and error, is rooted in the cultural history of human mankind (Geisen and Holzapfel, 1996). In absence of facilities for home refrigeration and freezing, it serves as affordable and manageable techniques for food preservation. It represents a distillation of knowledge and wisdom gained by experience and based on trial and error. People might not be able to explain what is going on during fermentation, but they certainly know what needs to be to get the desired products. The essential objective of food fermentation is to carry over supplies from the time of plenty to those of deficit. They knew how to culture the beneficial microorganisms for production of foods for their consumption. Only

scientific explanation and identity of these microorganisms were unknown to them. Till today, there are thousand of such fermented foods all over the world which are yet microbiologically explored. In the Indian sub-continent, mostly due to wide variation in agro-climatic conditions and diverse form of dietary culture of different ethnic groups of people, in most diverse types of microorganisms are associated with traditional fermented foods and beverages (Tamang and Holzapfel, 1999). Microorganisms bring about some transformation of the substrates during food fermentation such as enrichment of diet with improved flavour and texture, biopreservation of perishable foods, fortification of the products with essential amino acids, vitamins, minerals, etc., destruction of undesirable components, improvement of digestibility, and stimulation of probiotic function (Steinkraus, 1996; Stiles and Holzapfel, 1997). A variety of fermented products are prepared and consumed in the Sikkim Himalayas. These traditional products are usually prepared by rural women using their indigenous knowledge of fermentation.

Analysis of bioresources of Sikkim particularly the food security including the edible wild plants and ethnic fermented foods is the aim of this project. Some of the findings have been highlighted in this report.

1.1.1 Objectives

- To make a check-list of endangered flora and fauna in the Sikkim Himalayas.
- To make a list of edible wild plants in Sikkim.

- To document the indigenous knowledge of food fermentation.
- To analyse the nutritional value of edible wild plants.
- To anlayse (microbiology and nutritional aspects) of common ethnic fermented foods.
- To formulate the strategy for development of ethnic foods in Sikkim as alternative source of income in the proposed hydel-power sites in Teesta basin.

1.2 METHODOLOGY

1.2.1 Check list

Check list of plants and animals of Sikkim was prepared. The information presented on families of Angiosperms, Pteridophytes and Fungi was arranged in alphabetical order. Rarity of species like Endangered, Vulnerable, Rare, and Indeterminate & Extinct is based on Nayar and Sastry (1987, 1988 & 1990). The check list of animals was prepared using the Red Data Book. Update check list of edible wild plants of Sikkim was also prepared using references of Hara (1966), Bennet (1987), Sundriyal and Rai (1996), Rai *et al*. (1998), Gurung (2002) and Rai (2002).

1.2.2 Survey

A survey was conducted on the types of edible wild plants and ethnic fermented foods based on the method of the Indian Statistical Institute,

Kolkata (unpublished). Information on various types of edible wild plants and ethnic fermented foods produced and consumed by the people, their traditional methods of preparation, the ingredients used, the equipments used, mode of consumption, etc. were collected through interview or by perusal observation in randomly selected villages located in the Teesta basin areas of Sikkim.

1.2.3 Sample collection

Common seasonal edible wild plants were collected from their natural habitats located in Teesta basin areas of East, North and South districts of Sikkim. Samples were collected in sterile poly-bags and transported to laboratory for analyses. Samples of some common ethnic fermented foods (*kinema, gundruk, sinki, chhurpi, chhu, philu* and *gnuchi*) and beverages (*kodo ko jaanr*) were collected aseptically from different villages of Sikkim located in the Teesta basin, in pre-sterile bottles and bags kept in an ice-box from and transported to the laboratory for analyses.

1.2.4 Microbiological analysis

Ten g of sample were homogenised with 90 ml of 0.85% (w/v) sterile physiological saline in a stomacher lab-blender (400, Seward, UK) for 1 min and serially diluted in the same diluent. Lactic acid bacteria were isolated on MRS agar (HiMedia M641, India) supplemented with 1% $CaCO_3$, and incubated under anaerobic condition in an Anaerobic Gas-Pack system (HiMedia LE002, India) at 30°C for

48-72 h. Moulds and yeasts were isolated on potato dextrose agar (HiMedia M096, India) and yeast extract-malt extract agar (HiMedia M424, India), supplemented with 10 IU/ml benzylpenicillin and 12 μg/ml streptomycin sulphate, respectively, and incubated aerobically at 28°C for 72 h.

Purity of the isolates was checked by streaking again and subculturing on fresh agar plates of the isolation media, followed by microscopic examinations. Identified strains of lactic acid bacteria were preserved in MRS broth using 15 % (v/v) glycerol at −20 °C. Characterisation and identification of bacterial isolates were performed following the method of Harrigan (1998), and Wood and Holzapfel (1995). Characterisation and identification of yeasts and moulds were carried out following the methods of Kurtzman and Fell (1998), and Hesseltine (1991), respectively.

1.2.5 Analysis of nutritional value

Moisture content of sample was calculated by weight loss of 3 g of sample (in triplicate) at 135 ± 1°C for 2 h (AOAC, 1990). The ash content of sample was measured by heating at 550°C until the difference between two successive weighing was ≤ 1 mg (AOAC, 1990). The fat content was determined by ether extraction using a glass soxhlet (AOAC, 1990). The protein content of sample was determined by multiplying total nitrogen, estimated by standard Kjeldahl method, by 6.25 (AOAC, 1990). The carbohydrate content was calculated by

difference: 100 – (% protein + % fat + % ash) (Standal, 1963). Sodium, potassium and calcium of samples were estimated following the methods of Ranganna (1986) in a flame-photometer (CL361, Elico). Magnesium, manganese, copper, iron, zinc and sodium were estimated in an atomic absorption spectrophotometer (Model 2380, Perkin-Elmer, USA). Phosphorus was determined by colorimetric method (AOAC, 1990).

1.3 RESULTS AND DISCUSSION

1.3.1 Check-list of plants and animals

Check-list of plants of Sikkim was prepared, focusing on extinct, endangered, vulnerable, rare and indeterminate plants of North Sikkim (Annexure-I). Total numbers of plants of North Sikkim listed in Red Data Book of Indian Plants: Extinct- 3 angiosperms), 1 (Pteridophyta); Endangered - 10 (Angiosperms), 1 (Fungi); Vulnerable - 6 (Angiosperms), 1 (Pteridophyta); Rare -11 (Angiosperms), 2 (Pteridophytes); Indeterminate - 4 (Angiosperms), 1 (Pteridophyta)

Check-list of animal was also prepared (Annexure-II).

Mammals: As stated earlier, there are around 154 species of mammals in Sikkim belonging to 26 families. Of these, almost half are found in North Sikkim, but excepting moles, shrews, bats, some squirrels, rats and mice, most are listed in the Indian Wildlife (Protection) Act 1972 as amended up to 1993. Therefore, this shows the degree to which the mammals of Sikkim are endangered today. Unbelievably, all the wild

cats found in North Sikkim are listed in Schedule-I of the Act. Altogether, 16 species of mammals from north are listed under Schedule-I of the Act; more than 18 species are under Schedule-II; some are rare and 1 species viz. Sikkim stag is already extinct.

Birds: As mammals, most of the 500 types of birds found in Sikkim are resident in the North, and are also listed as protected under the Act. More than 15 species are already listed in Schedule-I of the Act; around 15 species under Schedule-II; more than 100 species under Schedule-IV and few are under Schedule-III of the Act. Birds protected under Schedule-I are Pheasants, Hornbills, Lammergeier, Black necked crane, White bellied sea Eagle, Falcons and Bazas.

Reptiles: Pythons are protected under Schedule-I of the Act, while Indian Cobras, Olive and Checkered keel backs, Russel's Viper and Monitor Lizards are protected under Schedule-II.

Amphibians: As far as Amphibians are concerned as of date no ecological or taxonomic work has been done other than sporadic collection by different authorities but all fresh water frogs are protected under Schedule-IV of the Act. *Ichthyophis sikkimensis* is listed as endemic to India i.e. it is not found anywhere else in the world.

Fishes: Till date 48 species of fish are found from riverine ecosystems of Sikkim. However, no ecological studies have been carried on. With the rapid ecological degradation of the river systems of the state it can be assumed that no fish species is common today. Even the introduced

Brown trout in the upper reaches seems as endangered today as is the famous 'game' fish Mahseer or Sahar. Strangely not a single fish features in the Wildlife (Protection) Act.

Butterflies: Almost 700 species and subspecies of butterflies are listed as occurring in Sikkim, which includes the north district. However most of the Papilionid and Nymphalid species seems to be endangered. Populations of many species are not as common today reason being the widespread use of insecticides and pesticides on food crops.

Other Invertebrates: Survey of available literature reveals that not much research has been done regarding invertebrates especially aquatic, in Sikkim. However, we have tried to list out some Moths, Trichopteras and Apterygota (Columbella) from the Sikkim Himalayas. Checklist of animals of North Sikkim is presented in Annexure-II.

1.3.2 Edible wild plants

1.3.2.1 *Check-list of edible wild plants*

An update check-list of edible wild plants was prepared (Annexure-III) using references of Hara (1966), Bennet (1987), Sundriyal and Rai (1996), Rai *et al*. (1998), Gurung (2002) and Rai (2002). Out of 128 edible wild plants listed in Annexure-III, which are reported from the various places of Sikkim, 63 wild plants are eaten as fruits, 22 as vegetables, 19 as pickles, rest as condiment, herbal materials, etc. Edible wild plants form important constituents of traditional foods in

Sikkim. Some people are economically dependent upon these plants. They sell in the local markets.

1.3.2.2 *Nutrional analysis of edible wild plants*

Leaves, inflorescences, flowers and fruits of eighteen common edible wild plants were collected from different places of Sikkim, mostly from the Teeta basin areas, and were analysed to know their nutritional composition (Table 1-18). The following edible wild plants were collected for the study:

Nasturtium officinale, Oxalis corniculata, Phlogacanthus thyrsiflorus, Rhododendron arboreum, Persicaria runcinata, Hottuynia cordata, Urtica dioica, Elaeagnus conferta, Ficus hookeriana, Fragaria nubicola, Ficus benjamina, Machilus fructifera, Aconogonum molle, *Diplazium esculentum, Campylandra aurantiaca, Choerospondias axillaries, Castanopsis hystrix* and *Docynia indica*.

This is the first report on the nutritional value of these common edible wild plants in Sikkim. Data showed that some of these plants have high nutritional value as well as high content of minerals particularly potassium.

Botanical name: *Nasturtium officinale* Brown.

Family: Brassicaceae

Local name (Nepali): Simrayo

English name: Water cress

Distribution: Throughout Sikkim upto 12, 000 ft.

Season: February-December

Taxonomic character:

Stems erect or spreading, copiously rooting at lower nodes. Leaves 0.5-2.5 cm, lateral leaflets elliptic, terminal leaflet ovate-cordate. Sepals oblong; petals obovate. Flower small, ebracteate racemes, white in colour.

Edible parts: Young twigs

Mode of consumption: Curry or soup

Table 1. Nutritional value of *Nasturtium officinale*

Moisture %	% on dry matter basis				mg/100g		
	Ash	**Fat**	**Protein**	**Carbohydrate**	Na	K	**Ca**
91.1 (90.7-91.6)	20.3 (17.7-22.8)	13.3 (11.4 - 15.2)	38.6 (37.9-39.3)	27.8 (27.1-28.5)	72.4 (69.6-76.4)	481.7 (467.9-505.5)	60.1 (59.0-61.5)

Number of samples (young twigs of water cress) = 4

Botanical name: *Oxalis corniculata* Linn.

Family: Oxalidaceae

Local name (Nepali): Chariamilo

English name: Clover sorrel/ Yellow sorrel/Indian sorrel

Distribution: East, South, West-districts of Sikkim upto 6000 ft.

Season: January- December

Taxonomic characters:

Stems prostrate, rooting at nodes with erect branches. Bulbs absent. Leaves alternate clustered; leaflets broadly obcordate. Stipules adnate to petiole. Peduncle axillary 1-5 flowered. Sepals linear to elliptic. Petals yellow spathulate, emarginate, puberculous.

Edible parts: Fruits and leaves

Mode of consumption: Raw leaves are eaten

Table 2. Nutritional value of *Oxalis corniculata*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
87.8 (87.4-88.2)	11.5 (11.5-11.5)	7.9 (6.5-8.6)	40.3 (39.7-41.0)	40.3 (39.7-41.0)	6.0 (5.9-6.1)	522.7 (517.8-527.8)	11.3 (11.0-11.5)

Number of samples (fruits) = 5

Botanical name: *Phlogacanthus thyrsiflorus* Nees.

Family: Acanthaceae

Local name (Nepali): Titay/Chua

Distribution: East, West, South-districts of Sikkim (2500-4000 ft.)

Season: February-April

Taxonomic characters:

Showy in early spring with its dense cylindrical spikes of brick-red velvety flower. Corolla broad tubular. Calyx lobes 6.8 mm, bristly haired. Bracts 6.0 to 12.0 mm long. Capsule cylindrical 4-angled, hairless. Seed disc like.

Edible parts: Inflorescence

Mode of consumption: Eaten as curry after sundry

Table 3. Nutritional value of *Phlogacanthus thyrsiflorus*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
79.1 (79.1-79.2)	10.4 (9.4-11.8)	3.8 (2.8-4.2)	7.1 (6.4-7.8)	78.7 (78.0-79.3)	2.9 (2.9-2.9)	722.9 (717.9-730.1)	105.0 (104.0-105.5)

Number of samples (inflorescence) = 4

Botanical name:	*Rhododendron arboreum* Smith.
Family:	Ericaceae
Local name:	Lali gurans (Nepali); Etok (Lepcha)
English name:	Rhododendron
Distribution:	North, South, and West-districts of Sikkim (6000-10,000 ft.)
Season:	March- June

Taxonomic characters:

Small tree, young shoot puberculous to tomentose. Leaves elliptic to oblanceolate, acute to acuminate, base cuneate, lower surface densely matted white, silvery or fawn tomentose. 10-20 flowered. Corolla tubular to campanulate, bright red, stamens 10 in number.

Edible parts:	Petals
Mode of consumption:	Eaten as such/ or fermented into alcoholic drink called *raksi*

Table 4. Nutritional value of *Rhododendron arboretum*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
88.2 (88.1-88.3)	7.6 (5.9-8.5)	7.6 (6.8-8.5)	16.3 (15.7-17.0)	68.5 (67.8-69.2)	4.8 (4.8-4.9)	171.5 (170.5-173.3)	2.5 (2.5-2.5)

Number of samples (petals) = 4

Botanical name: *Persicaria runcinata* (Buch-Ham ex D.Don) H.Gross.
Family: Polygonaceae
Local name (Nepali): Ratnaulo
Distribution: Throughout Sikkim (8000-11,500 ft.)
Season: February-December

Taxonomic characters:
Prostrate herb. Leaves runcinate- pinnatified, terminal lobe rhombic-ovate. Petioles usually rounded auriculate at base. Flowers in globose heads. Perianth white or pink. Stamens 5-8. Styles 3.

Edible parts: Young twigs
Mode of consumption: Eaten as such

Table 5. Nutritional value of *Persicaria runcinata*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
95.4 (95.2-95.6)	19.6 (17.6-19.6)	13.7 (13.7-13.7)	45.1 (44.4-45.8)	21.6 (20.9-22.3)	8.3 (8.0-8.5)	429.2 (427.7-432.7)	4.8 (4.5-5.0)

Number of samples (young twigs) = 4

Botanical name: *Hottuynia cordata* Thunb.
Family: Saururaceae
Local name (Nepali): Hilay jhar

Distribution: East, West, South-districts of Sikkim (upto 5500 ft.)

Season: February-September

Taxonomic characters:

Stems 12.0-45.0 cm. Leaves broadly ovate, acute or shortly acuminate, base cordate. Petioles 2-4 cm. Stipules oblong, adnate to petiole in lower half. Flowers spike, 1-2.5 cm. Basal bracts white, oblong or obovate, obtuse.

Edible parts: Whole plant is eaten

Mode of consumption: Eaten as curry and pickle

Table 6. Nutritional value of *Hottuynia cordata*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
88.3 (87.1-89.6)	14.5 (12.0-16.2)	6.8 (6.0-7.7)	35.0 (34.3-35.7)	43.7 (42.9-44.4)	6.9 (6.9-6.9)	801.4 (797.4-806.4)	11.3 (10.5-12.5)

Number of samples (whole plants) = 5

Botanical name: *Urtica dioica* Linn.

Family: Urticaceae

Local name: Lekh sishnu (Nepali); Sarong (Lepcha)

English name: Stinging nettle

Distribution: Throughout Sikkim (upto 7000 ft.)

Season: February-October

Taxonomic characters:

Plants 1.0- 1.5 m tall, monoecious, rarely dioecious, all parts bearing scattered white stinging hairs. Leaves ovate to lanceolate, acuminate, base rounded or cordate. Petioles 1-4 cm. Stipules lanceolate. Panicles long, male flowers 2 mm in diameter, perianth segments orbicular. Female flowers c 1.5 mm in diameter.

Edible parts: Inflorescence and young leaves
Mode of consumption: Eaten as soup

Table 7. Nutritional value of *Urtica dioica*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
84.6 (81.6-86.0)	15.6 (14.3-16.9)	4.5 (3.9-5.2)	30.6 (29.9-31.3)	49.3 (48.6-50.0)	11.7 (11.5-12.0)	911.0 (880.0-943.0)	102.5 (101.0-105.5)

Number of samples (young leaves) = 4

Botanical name: *Elaeagnus conferta* Roxb.
Family: Elaeagnaceae
Local name (Nepali): Muslendi
Distribution: East, North, South-districts of Sikkim
Season: March- April

Taxonomic characters:

Straggling shrubs; axillary branches sometimes spinose. Leaves elliptic- oblong, shortly acuminate, base rounded. Flowers in axillary clusters. Stamens inserted in throat. Fruits ellipsoid.

Edible parts: Fruits

Mode of consumption: Fresh fruits, and also processed into pickles

Table 8. Nutritional value of *Elaeagnus conferta*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
91.7 (89.9-94.0)	8.43 (7.2-10.8)	9.6 (8.4-10.8)	16.9 (16.2-17.6)	65.0 (64.3-65.7)	6.7 (6.5-7.0)	233.5 (230.5-235.0)	5.8 (5.5-6.0)

Number of samples (fruits) = 3

Botanical name: *Ficus hookeriana* Corner.

Family: Moraceae

Local name (Nepali): Nebara

English name: Fig

Distribution: East, West, South-districts of Sikkim (1950-5000 ft.)

Season: March- November

Taxonomic characters:

Tree, leaves broadly elliptic, bluntly apiculate, base rounded. Stipules linear, lanceolate. Figs obovoid, depressed at apex, 1.5-2.5 cm in diameter, basal bracts conspicuous.

Edible parts: Fruits

Mode of consumption: Fresh fruit

Table 9. Nutritional value of *Ficus hookeriana*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
89.0 (84.9-90.1)	10.9 (9.1-11.8)	8.2 (7.3-9.1)	24.5 (23.8-25.2)	21.6 (20.9-22.3)	12.8 (11.9-13.5)	736.1 (680.3-777.0)	38.1 (38.0-38.4)

Number of samples (fruits) = 5

Botanical name: *Fragaria nubicola* Lindl.

Family: Rosaceae

Local name (Nepali): Bhui aisenlu

English name: Straw berry/ Wild straw berry

Distribution: North, East, South-districts of Sikkim (6000-11,000 ft.)

Season: April- June

Taxonomic characters:

Prostrate herb with stout rootstock. Leaflets obovate or elliptic. Petioles pubescent. Scapes 2-10 cm with two median bracts 3-5 mm, 1-3 flowered.

Edible parts: Fruits

Mode of consumption: Fresh fruit

Table 10. Nutritional value of *Fragaria nubicola*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
93.1 (92.5-93.7)	8.7 (8.7-10.1)	16.0 (16.0-16.0)	21.7 (21.0-22.3)	53.6 (52.9-54.3)	8.2 (8.2-8.2)	160.5 (158.3-162.0)	8.0 (7.5-8.2)

Number of samples (fruits) = 3

Botanical name: *Ficus benjamina* Linn.

Family: Moraceae

Local name (Nepali): Kabra

Distribution: East, West, South-districts of Sikkim (4000-10,000 ft.)

Season: March -April

Taxonomic characters:

Small tree. Leaves elliptic to oblong, abruptly acuminate, base cuneate or rounded. Figs sub-globose, 12-15 mm, purplish when ripe. Basal bract 3, broadly ovate.

Edible parts: Leaf buds

Mode of consumption: Boiled and processed into pickles

Table 11. Nutritional value of *Ficus benjamina*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
94.5 (93.9-95.0)	7.3 (7.3-10.9)	18.0 (16.4-18.2)	34.5 (33.8-35.2)	40.2 (39.5-40.9)	9.2 (9.0-9.5)	222.0 (217.5-226.5)	11.7 (11.5-12.0)

Number of samples (leaf buds) = 4

Botanical name: *Machilus fructifera* Kostermans.

Family: Lauraceae

Local name (Nepali): Famphal

Distribution: East, West, South-districts of Sikkim (5000-8000 ft.)

Season: March-April

Taxonomic characters:

Tree upto 12 mm. Leaves obovate or oblanceolate, subacute, base attenuate. Perianth segments 4-5 mm, pubescent. Fruits globose c 4 cm in diameter.

Edible parts: Fruits

Mode of consumption: Fresh fruits

Table 12. Nutritional value of *Machilus fructifera*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
69.0 (69.0-69.1)	2.6 (2.6-2.6)	4.8 (4.8-4.8)	13.2 (12.5-13.9)	79.4 (78.7-80.1)	22.3 (20.7-23.6)	415.6 (386.3-430.7)	11.0 (10.0-12.3)

Number of samples (fruits) = 3

Botanical name: *Aconogonum molle* (D.Don)Hara

Family: Polygonaceae

Local name (Nepali): Thotnay

Distribution: Throughout Sikkim (4000-7000 ft.)

Season: March- October

Taxonomic characters:

Shrubs, leaves elliptic, acuminate, base cuneate, rounded or sub-cordate, appressed pubescent on both surfaces. Petioles upto 2.5 cm, ocreae 4-5 cm, membranous, lanceolate, pubescent. Perianth cream coloured.

Edible parts: Young shoots

Mode of consumption: Raw twigs are eaten

Table 13. Nutritional value of *Aconogonum molle*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
93.3 (93.3-93.4)	16.4 (16.4-16.4)	7.5 (5.9-8.9)	46.3 (45.7-47.0)	29.8 (29.1-30.5)	8.7 (8.4-8.9)	428.4 (422.8-427.8)	5.0 (4.5-5.5)

Number of samples (twigs) = 4

Botanical name: *Diplazium esculentum* (Retz) Sw.
Family: Athyriaceae
Local name (Nepali): Ningro
Distribution: Throughout Sikkim (4000-8000 ft.)
Season: March- December

Taxonomic characters:

Terrestrials. Rhizomes black, semierect, covered with much fibrous, stiff roots; scales broad lanceolate, toothed, dark brown. Stipe 65-70 cm, sparsely covered with deciduous scales, base flat ridged. Frond bipinnate, upto 1.5 cm tall; lamina spreading; secondary pinnae distant on the rachis, pinnatified at the base, serrate at apex. Veins forked, anastomosing between the opposite pairs of veinlets. Sori linear, short, parallel, on both sides of the veins. Indusium linear, margin entire, attached back to back, distal edges free. Sporangia sori stalked. Spores oval, dark, hyaline, exine papillate.

Edible parts: Young fronds

Mode of consumption: Vegetable Curry, mixed with chhurpi

Table 14. Nutritional value of *Diplazium esculentum*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
93.1 (92.3-93.9)	18.8 (17.4-18.8)	29.0 (18.5-19.6)	37.7 (36.7-38.7)	14.5 (14..0-15.2)	8.1 (7.4-8.4)	927.4 (871.5-968.0)	200.5 (200.0-201.0)

Number of samples (twigs) = 3

Botanical name: *Campylandra aurantiaca* Wall.

Family: Liliaceae

Local name (Nepali): Nakima

Distribution: Throughout Sikkim (4000-7000 ft.)

Season: August - October

Taxonomic characters:

Herbs with thick, creeping rhizomes. Leaves in rossete at apex of rhizome, parallel venation, elliptic to oblanceolate. Scape stout, leafless, bearing a dense terminal spike, with flowers each subtended by a herbaceous bract. Flowers fleshy, campanulate, with 6-8 free perianth lobes fused into broad tube below. Perianth lobes 4-6 x 3.5-5 mm; stamens 6-8 inserted on tube below lobes; anthers dorsifixed; filaments with lower parts expanded and fused to tube, upper part free, less

strongly recurved, divergent edges of fused(lower) parts conspicuously toothed. Fruit a globose berry, commonly one seeded.

Edible parts: Inflorescence
Mode of consumption: Curry and Pickle

Table 15. Nutritional value of *Campylandra aurantiaca*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
91.5 (91.5-91.5)	12.9 (11.8-14.1)	34.1 (33.6-34.7)	28.2 (27.7-28.8)	24.8 (24.2-25.4)	3.1 (3.0-3.4)	292.1 (259.2-314.5)	200.6 (200.4-200.9)

Number of samples (twigs) = 3

Botanical name: *Castanopsis hystrix* A.DC.
Family: Fagaceae
Local name (Nepali): Katush
Distribution: Throughout Sikkim (5000-9000 ft.)
Season: September- November

Taxonomic characters:

Tree 3-20 m. Leaves ovate lanceolate, 6-10 x 2-3 cm, acute, more or less entire; petioles 0.5-1.5 cm; spikes drooping to suberect; male flowers in clusters 2-3 mm across in axils of minute bracts. Female

flowers usually solitary, less tomentose; cupule globose, nut one per cupule, ovoid.

Edible parts: Fruits

Mode of consumption: Fresh nuts

Table 16. Nutritional value of *Castanopsis hystrix*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
55.2 (54.4-56.1)	2.0 (2.0-2.2)	2.2 (2.2-2.2)	8.0 (7.5-8.6)	87.8 (87.2-88.4)	2.9 (2.9-2.9)	911.6 (798.6-978.8)	199.0 (198.7-199.2)

Number of samples (twigs) = 4

Botanical name: *Choerospondias axillaris* (Roxb.) Burtt &Hill.

Family: Anacardiaceae

Local name (Nepali): Lapsee

Distribution: Throughout Sikkim (upto 5500 ft.)

Season: July- December

Taxonomic characters:

Tree. Leaves 6.5cm; petiole slender; leaflets petiolulate,pale beneath, not abruptly acuminate; nerves free, arching. Flowers solitary or subsolitary on the branches, long pedicelled ¼ in diameter, white calyx lobes acute. Petals elliptic subacute. Filaments short, subulate. Disc

annular 10- lobed. Ovary 5- celled with 5 short erect styles. Drupe rounded at the top, yellow. Stone 5- celled, quite small.

Edible parts: Fruits

Mode of consumption: Raw pulp are eaten or made into pickle

Table 17. Nutritional value of *Choerospondias axillaris*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
84.8 (83.6-86.0)	4.6 (3.9-4.7)	5.9 (5.2-6.6)	14.5 (14.0-15.1)	75.0 (75.0-75.0)	5.0 (5.0-5.0)	639.3 (577.6-659.9)	202.1 (201.9-202.4)

Number of samples (twigs) =4

Botanical name: *Docynia indica* (Wall.) Decaisne

Family: Rosaceae

Local name (Nepali): Mail

Distribution: East, West and South- districts of Sikkim (upto 5000 ft.)

Season: September- November

Taxonomic characters:

Tree 4-10m, branches sometimes spiny. Leaves ovate 9-15 x 3.5-6.0 cm acuminate, base rounded, margin entire or shallowly serrate, glabrous

above, densely white tomentose beneath at first becoming greyish pubescent later. Flowers fragrant. Calyx tube c. 8mm, lobes lanceolate, 8-15 mm, white tomentose. Petals white flushed pink, 1.5-3.0 x 2.0 cm, obovate. Pomes 2.5-4.0 x 2.5 cm, greenish yellow with red spots.

Edible parts: Fruits
Mode of consumption: Raw fruits are eaten or made into pickle

Table 18. Nutritional value of *Docynia indica*

Moisture %	% on dry matter basis				mg/100g		
	Ash	Fat	Protein	Carbohydrate	Na	K	Ca
85.1 (85.1-85.1)	4.0 (3.4 – 4.0)	6.7 (6.0-7.4)	32.2 (31.7-32.8)	57.1 (57.1-57.1)	15.3 (14.8-15.7)	202.8 (194.0-206.9)	200.5 (200.5-200.5)

Number of samples (twigs) = 3

1.3.2.3 *Market survey of edible wild plants*

Market survey of seasonal edible wild plants was conducted at Gangtok, Mangan, Singtam and Melli (Table 19). People usually collect the edible wild plants from their natural habitats and sell in local markets. In most cases, 100% profit is made out of selling the wild plants. However cost includes local transportation and other expenses. Profit is used fro livelihood and spend on children's education.

Table 19. Market survey of edible wild plants sold in local markets located in the Teesta basin of Sikkim

Edible Plants	Local name	Price in Rs. per kg		Profit (%)	Market	Source of buying/ collection	Seasons
		Buying (Collection)	Selling				
Urtica dioica (Inflorescence)	Gharia sishnu	33.3	41.6	25	Gangtok	32 mile, Marchak	Sep-Oct
Urtica dioica (Inflorescence)	Gharia sishnu		37.5	100	Mangan	Mangan, Sankalan	Sep-Oct
Urtica dioica (Bundles)	Gharia sishnu	17.5	23.0	31	Gangtok	Syari, Sichey, Bhusuk	July-Oct
Urtica dioica (Bundles)	Gharia sishnu		25.6	100	Mangan	Sankalan, Kodyong	July-Oct
Campylandra aurantiaca (Inflorescence)	Nakima		76.6	100	Gangtok	Kopibari, Lower syari	Aug-Oct
Zanthoxylum rhetsa (Fruits)	Siltimmur		58.3	100	Gangtok	Bhusuk	Aug-Oct
Diplazium esculentum (Fronds)	Ningro	6.6	8.5	29	Gangtok	Ranka, Lower syari	May-Oct
Diplazium esculentum (Fronds)	Ningro		9.7	100	Mangan	Mangan, Singik, Lingthem	May-Oct
Diplazium esculentum (Fronds)	Ningro	7.0	9.0	29	Singtam	Bermoik, Bumtar, Kajitar	Sep-Dec
Diplazium esculentum (Fronds)	Ningro	7.0	8.8	26	Melli	Sadam, Turuk	Sep-Dec

Nasturtium officinale (Young twigs)	Simrayo		8.4	100	Gangtok	Baluakhani, ICAR Tadong, Lower syari	July-Nov
Nasturtium officinale (Young twigs)	Simrayo		9.5	100	Mangan	Sankalan, Mangan	July-Dec
Nasturtium officinale (Young twigs)	Simrayo		9.3	100	Singtam	Pathing	June-Nov
Juglans regia (Fruits)	Okhar		21.6	100	Gangtok	Kabi, Ravangla, Pangthang	Sept-Dec
Juglans regia (Fruits)	Okhar		21.6	100	Mangan	Chowang, Mangan, Singik	Sept-Dec
Juglans regia (Fruits)	Okhar		10.0	100	Singtam	Bermoik, Pathing	Oct-Nov
Juglans regia (Fruits)	Okhar		10.8	100	Melli	Sadam	Oct-Nov
Choerospondias axillaris (Fruits)	Lapsee		10.0	100	Gangtok	Lower syari, Ranka	Sept-Dec
Choerospondias axillaris (Fruits)	Lapsee		10.6	100	Mangan	Chowang, Sankalan	Sept-Dec
Choerospondias axillaris (Fruits)	Lapsee	7.3	9.3	27	Melli	Turuk, Sadam	Oct-Dec
Docynia indica (Fruits)	Mail	7.7	9.3	21	Singtam	Jholungay, Bermoik	Oct-Dec
Heracleum wallichi (Inflorescence)	Chimphing	220.0	253.3	15	Gangtok	Lekh	Oct-Nov
Heracleum wallichi (Inflorescence)	Chimphing		220.6	100	Mangan	Sankalan, Mangan	Oct-Nov
Heracleum wallichi (Inflorescence)	Chimphing	245.2	276.2	13	Singatam	Lekh	Sept-Dec

1.3.3 Ethnic fermented foods

Ever since ethnic people inhabited in the Himalayan regions ranging from the foothills to alpine, gathering and utilization of available plants, animals and their products for consumption started and generally emerged as ethnic food culture of the present day. Food culture has been evolved as a result of traditional wisdom and empirical experiences of generations over a period of time, based on agro-climatic conditions, ethnic preference, socio-economic development status, religion and cultural practices of the region. Nature has given ability and opportunity to human being to select his food from a wide range. More than 30 varieties of ethnic fermented foods and more than 9 types of ethnic fermented beverages are prepared and consumed in the Sikkim Himalayas for centuries (Table 20 & 21). About 20 % of the total daily food consumed in local diet represents fermented foods (Yonzan and Tamang, 1998). Women play important roles with their indigenous knowledge of food fermentation. Their participation spans from cultivation to harvest, fermentation to culinary skills and production to marketing. Rural women also sell the food products in local markets and earn their livelihood.

Ethnic fermented food products have always been an important component of the Sikkimese culture (Tamang, 2001). *Bhat-dal-tharkari-achar* (rice-legume soup-curry-pickle) is the basic diet of the Sikkimese meal. The early morning starts with a full mug of tea with sugar or salt with or without milk, with a pinch of hot black pepper. The first meal eaten in the morning is a simple *bhat-dal-tharkari-achar* (rice-legume

soup-curry-pickle) corresponding to cooked rice, *dal,* vegetable mixed with potatoes, meat or milk products and pickles. It is followed by light refreshment with mostly traditional snacks and tea in the afternoon. The second meal is dinner around early evening, which consists of the same *bhat-dal-tharkari-achar*. Bhutias and Lepchas usually eat thug-pa, noodles in soup. People of Sikkim are mainly rice eaters. In high altitudes of Sikkim, people usually eat boiled potatoes, drink *pheuja* (butter tea prepared from yak milk). In the rural areas, people mostly eat cooked maize-rice as a staple food, popularly known as *dheroh*.

The Sikkimese food is less spicy and prepared in *gheu* or *maa* (butter), but now commercial edible oil is being used. The Bhutias and the Lepchas are non-vegetariasns and prefer beef and pork. Some Nepalis are vegetariasns. Some Nepalis are vegetarians. Now-a-days, the vegetarian diet is becoming popular among the difference ethnic groups due on grounds of health, religion and personal preference. Non-vegetarians eat chicken, mutton, lamb and pork. Beef is taboo to a majority Nepalis except Tamangs, Sherpas and Yolmos. Newars prefer to eat buffalo meat. Cooking is usually done by women. Elders and male members are served the meals first and women eat afterwards in the kitchen (Tamang, 2005).

Some common ethnic fermented foods, their methods of preparation, mode of consumption, economy, functional microorganisms and nutritional value have been mentioned below.

Table 20. Ethnic fermented foods of Sikkim

Product	Major ingredient(s)	Nature and Use	Major consumer
Kinema	Soybean	Sticky soybeans; curry	Non-Brahmin Nepalis
Maseura	Black lentil	Dry, ball-like; condiment	Newar
Gundruk	Leafy vegetable	Dried, sour; soup/ pickle	All
Sinki	Radish tap root	Dried, sour; soup/ pickle	All
Khalpi	Cucumber	Sour; pickle	Bahun-Chettri
Goyang	Green vegetable	Curry	Sherpa
Mesu	Bamboo shoots	Sour; pickle	All
Selroti	Rice-wheat flour	Round, deep fried; bread	Nepalis
Chhurpi (soft)	Cow/yak milk	Soft, cheese-like, curry/pickle	All
Chhurpi (hard)	Cow/yak milk	Hard-mass; masticator	All
Chhu/Sheden	Cow/yak milk	Soft; strong-flavoured, dish	Bhutias, Sherpa, Lepchas
Philu	Cow/yak milk	Cream; fried curry with butter	Bhutias, Sherpa
Somar	Cow/yak milk	Paste, flavoured; condiment	Sherpa
Dahi/Shyow	Cow/yak milk	Curd; savory	All
Mohi	Cow milk	Butter-milk	All
Gheu	Cow milk	Butter	All

Maa	Yak milk	Butter	Bhutias
Sidra	Fish	Dried fish; curry	Non-Brahmin Nepalis
Sukuti	Fish	Dried, salted	Non-Brahmin Nepalis
Sukako maacha	River fish	Dried/Smoked	Non-Brahmin Nepalis
Gnuchi	River fish	Smoked fish; curry	Lepchas
Shakampo	Beef/Yak/Pork	Smoked meat; curry	Bhutias, Lepchas
Sukula	Buffalo meat	Dried meat; curry	Newar
Sukako masu	Mutton/Pork	Smoked meat; curry	Non-vegetarian Nepalis
Kargyong	Beef/Yak/Pork	Sausages; curry	Bhutias, Lepchas
Kheuri	Beef/Yak/Pork	Sausages; curry	Bhutias, Lepchas
Chilu	Beef/Yak/Sheep	Meat fat; used as edible oil	Bhutias
Satchu	Beef/Yak	Dried, smoked meat; curry	Bhutias

Table 21. Ethnic fermented beverages of Sikkim

Product	Substrate	Nature and use	Major consumer
Marcha/Khesung/ Phab/Buth	Rice, wild herbs, spices	Starter culture to ferment alcoholic beverages	*Major producers*: Limboo, few Rai and Lepcha women
Kodo ko jaanr/	Finger millet	Mild-alcoholic, slightly	Non-Brahmin

Chyang/Chee		sweet-acidic; beverage	Nepalis, Bhutias, Lepchas
Bhaati jaanr	Rice	Mild-alcoholic, sweet-sour, food beverage; paste	Non-Brahmin Nepalis, Bhutias, Lepchas
Makai ko jaanr	Maize	Mild-alcoholic, sweet-sour, food beverage; paste	Non-Brahmin Nepalis, Bhutias, Lepchas
Gahoon ko jaanr	Wheat	Mild-alcoholic, slightly acidic, beverage	Non-Brahmin Nepalis, Bhutias, Lepchas
Simal tarul ko jaanr	Cassava tuber	Mild-alcoholic, sweet-sour, food beverage; paste	Non-Brahmin Nepalis, Bhutias, Lepchas
Jao ko jaanr	Barley	Mild-alcoholic, slightly acidic, beverage	Non-Brahmin Nepalis, Bhutias, Lepchas
Faapar ko jaanr	Buck wheat	Mild-alcoholic, slightly acidic, beverage	Non-Brahmin Nepalis, Bhutias, Lepchas
Raksi/Arak	Cereals	Clear distilled liquor; high alcohol content drink	Non-Brahmin Nepalis, Bhutias, Lepchas

1.3.3.1 *Fermented soybean*

1.3.3.1.1 *Kinema*

Kinema is a soybean-based fermented sticky, slightly alkaline product with slight ammoniacal flavour produced by bacterial fermentation. Kinema is an inexpensive, high plant protein food in the local diet. Soybean, locally known as 'bhatmas' is traditionally used to prepare fermented and non-fermented recipes in the Eastern

Himalayan regions of Nepal, India and Bhutan for centuries. Soybean is a summer leguminous crop grown under rainfed conditions in upland terraces as a sole crop as well as mix-crop with rice and maize up to an altitude of 1500 m. Two indigenous local varieties of soybeans (*Glycine max*) 'yellow cultivar' and 'dark brown cultivar' are sown in May to June, and are harvested in November. Most of the soybeans produced in these regions are consumed locally (Tamang, 1996).

During preparation of kinema (Fig. 1), yellow variety of small-sized (~ 6 mm) soyabeans are soaked overnight in water and cooked by boiling until they are soft. Excess water is drained off and cooked soybean seeds are cracked lightly by a wooden pestle (locally called *muslo*) in a wooden mortar (locally called *okhli*) to split the cotyledons, probably to accelerate the fermentation. About 1 % of firewood ash is added to soybeans to maintain the alkaline condition of the product. Soybean grits are placed in a bamboo-basket lined with locally grown fresh fern (*Glaphylopteriolopsis erubescens*) leaves, and covered in a jute-bag and left to ferment naturally at ambient temperatures (25-40^0 C)

for 1-2 days above earthen-oven kitchen. In eastern Nepal, dark-brown varieties of soybean are used to make kinema. Instead of fern leaves, *Ficus* (fig) and banana leaves are used as wrapping materials. Other methods remain same. Completion of fermentation is indicated by appearance of white viscous mass and typical kinema flavour with slight ammonia odour.

Shelf-life of fresh kinema is 2-3 days during summer and a maximum of one week in winter without refrigeration. Shelf-life of kinema is prolonged by drying it in the sun for 2-3 days. Dried kinema

is stored for several months at room temperature. Preparation of kinema varies from place to place and is still restricted to household level. It is interesting to note the mountain women using their indigenous knowledge of food production prepare kinema. This unique indigenous knowledge of kinema-making has been protected as hereditary right and passes from mother to daughter, mostly among the Limboo women.

Soybean (100 g)

↓

Cleaned and washed

↓

Soaked in water overnight

↓

Drained off; clean water added

↓

Cooked by boiling

↓

Drained off excess water

↓

Lightly cracked in wooden mortar by a wooden pestle

↓

←Dusted wood ash (~1 %)

↓

Wrapped in fern leaves, kept in a bamboo basket

↓

Fermented (25-40^0 C, 1-2 days)

↓

Kinema (~230 g)

Fig.1 Flow sheet of traditional method of kinema

Kinema is eaten as curry with boiled rice. Delicacy of kinema can be perceived by its appealing flavour and sticky texture. Fresh kinema is fried in vegetable oil, and chopped onions, tomatoes and turmeric powder are added and fried for 2 min. Then salt and sliced green chilies are added and fried for 3-5 min. A little water is added to make thick gravy, and cooked for 5-7 min. Kinema curry is ready for serving with boiled rice (Tamang and Tamang, 1998). Dried kinema is sometimes mixed with leafy vegetable to make mixed curry. Kinema production is done at individual or household level by rural women. Some people are economically dependent on this product. Kinema is sold in local markets called ‘haats’. It is sold in amount equivalent to weights of 150-200 g

packages of kinema, usually packed in *nevara* (fig plant) leaves and tied loosely by straw. The 100 g of kinema cost about Rs.5/-. Daily 3-5 kg of kinema is sold by each seller in market who produces kinema for commercial purpose. About 40 % of profit can be made out of selling kinema. The 60 % expense includes cost of raw soybeans, fuel for cooking, transportation from village to town, etc. This little profit they spend on children's education and procuring of essential commodities not locally available, and also on domestic expenses. This trade has been protected as hereditary right and passes from mother to daughter (Tamang, 2000a).

Kinema production is an income-generation for some families. Though there is a good market for kinema, and some village women are involving in this income generation, kinema processing has not been included in loan-scheme of public sector banks or financial institutions, neither incorporated in the rural development programme and small-cottage industry scheme of the government.

Bacillus subtilis, Enterococcus faecium, Candida parapsilosis and *Geotrichum candidum* are associated with kinema (Sarkar *et al.*, 1994). However, *Bacillus subtilis* is the dominant functional microorganism in kinema fermentation (Sarkar and Tamang, 1994; Tamang and Nikkuni, 1996). It is observed that rich microbial diversity in various sources particularly soybean, equipment and leaves as wrapping materials harness indigenous microbiota for spontaneous fermentation of kinema (Tamang, 2000b). Practice of not cleaning up the mortar and pestle, and using fresh leaves as wrapping materials by rural people, significantly

correlate their indigenous knowledge of 'microbiology' to preserve and supplement microorganisms for spontaneous fermentation of kinema without using starter cultures (Tamang, 2003).

On a protein cost per kilogram basis, kinema is the cheapest source of plant protein than animal and dairy products. During kinema production, soya-proteins, which have been denatured by cooking process, are hydrolyzed by proteolytic enzymes produced by *Bacillus subtilis* into peptides and amino acids enhancing digestibility (Tamang and Nikkuni, 1998). Remarkable increase in water-soluble nitrogen and trichloroacetic acid (TCA)-soluble nitrogen contents were observed during kinema fermentation (Sarkar and Tamang, 1995). Total amino acids, free amino acids and mineral contents (Table 22) are increased during kinema fermentation, and subsequently enriched the nutritional value of the product (Tamang, 1995). Kinema is highly nutritious food containing (per 100 g dry matter) Protein 48 g, Fat 17 g, Carbohydrate 28 g and Calorie 2 MJ.

Kinema is similar to fermented non-salted sticky soybean foods of other regions: turangbai of Meghalaya (India); hawaijar of Manipur (India); aakhoni of Nagaland (India); bekhang-um of Mizoram (India); natto of Japan; chungkok-jang of Korea; thua-nao of Thailand; pe-poke of Myanmar; douchi of China.

Table 22. Nutritional value of kinema

Parameters	Soybean	Kinema
Protein (g on dry matter)	47.1	47.7
Fat (g on dry matter)	22.1	17.0
Carbohydrate (g on dry matter)	25.8	28.1
Ash (g on dry matter)	5.0	7.2
Fe (mg/100 g)	8.7	17.7
Mn (mg/100 g)	2.7	5.4
Zn (mg/100 g)	3.8	4.5
Na (mg/100 g)	1.7	27.7
Ca (mg/100 g)	186.0	432.0
Total amino acids (mg/100 g)	43654	46218
Free amino acids (mg/100 g)	472	5129
Water soluble nitrogen (% of TN)	15.4	62.0
Formol nitrogen (% of TN)	1.5	7.0
Energy (MJ/100 g dry matter)	2.1	2.0

1.3.3.2 *Fermented vegetables*

1.3.3.2.1 *Gundruk*

Gundruk is a non-salted fermented acidic vegetable product indigenous to the Himalayas, commonly prepared during winter when perishable leafy vegetables are plenty. In the time of plenty that is particularly in October-December large quantities of leaves of mustard, ‘rayo-sag’, radish, etc. pile up, much more than people could consume fresh. That is the time when gundruk is prepared.

During fermentation of gundruk (Fig. 2), fresh leaves of '*rayo-sag'* (*Brasicca rapa* sub-species *campestris* variety *cuneifolia*), mustards (*Brasicca juncea*), cauliflowers (*Brasicca oleracea* variety *botrytis*) are wilted and shredded using a sickle or knife. The shredded leaves are crushed mildly and pressed into a container or earthen jar, made air tight and fermented naturally for about 7-10 days. The jar is kept in a warm place. After 7-10 days, a mild acidic taste indicates the completion of the fermentation and gundruk is removed from jar and sun dried for storage.

Fresh leafy vegetable

↓

Wilted (1-2 d)

↓

Crushed mildly

↓

Soaked briefly in warm water

↓

Packed into a pot, pressed tightly, fermented (7-10 d)

↓

Sun-dried

↓

Gundruk

Fig.2 Flow sheet of traditional method of gundruk preparation

Gundruk is eaten as soup or pickle. Gundruk soup is made by soaking it in water for 10 min, squeezed, fried in oil with chopped onions, tomatoes, chilies, turmeric powder and salt, water is added. Boil for 10 min, and serve hot with cooked rice. Gundruk pickle is also made and served as *achar.* Gundruk is a good appetizer in a bland, starchy diet. Gundruk is sold in all local periodical markets. One kg of gundruk costs about Rs. 100/- or more in markets.

During gundruk fermentation, *Lactobacillus fermentum* initiates the fermentation and is followed by *Pediococcus pentosaceus*, *Lactobacillus paracasei*, and finally *Lactobacillus plantarum* (Tamang *et al*., 2005). These bacteria produce lactic acid and acetic acid which lower the pH of the substrates making the products more acidic in nature. Due to low pH (3.3-3.8) and high acid content (1.0-1.3 %), gundruk can be preserved for longer periods without refrigeration. This can be cited as an example of biopreservation of perishable vegetable which are plenty during winter season in the Himalayan regions.

Gundruk is similar to fermented acidic vegetable products of other regions, with one important difference, unlike gundruk these fermented vegetable products are salted, such as kimchi of Korea; sauerkraut of Germany and sunki of Japan.

1.3.3.2.2 *Sinki*

Sinki, a non-salted fermented radish tap root food, is prepared by “pit fermentation”, which is a unique type of biopreservation of foods by lactic acid fermentation. It is usually prepared during winter when

perishable radish tap roots are plenty. When the leaves of radish are fermented it is gundruk and when the tap root of radish is fermented, it is called sinki.

The method of preparation of sinki is same as gundruk. However, 'pit fermentation' is commonly practiced to produce large

quantities of sinki in villages. During sinki production, 2-3 ft pit is dug in dry place and is warmed by burning. The pit is lined with bamboo bract sheaths and rice-straw (Fig. 3). Fresh tap roots of radish are cleaned and wilted by sun-drying for 2-3 days until they become soft. Then they are shredded using a sickle. The shredded radish tap roots are crushed and pressed tightly into a pit, covered with dry leaves and rice straw. The top of the pit is plastered with mud. The pit is weighted down by heavy stones and left to ferment for a month. Fermented mass is taken out and sun-dried. Sinki can be shelved for about a year or more by keeping it in the sun from time to time.

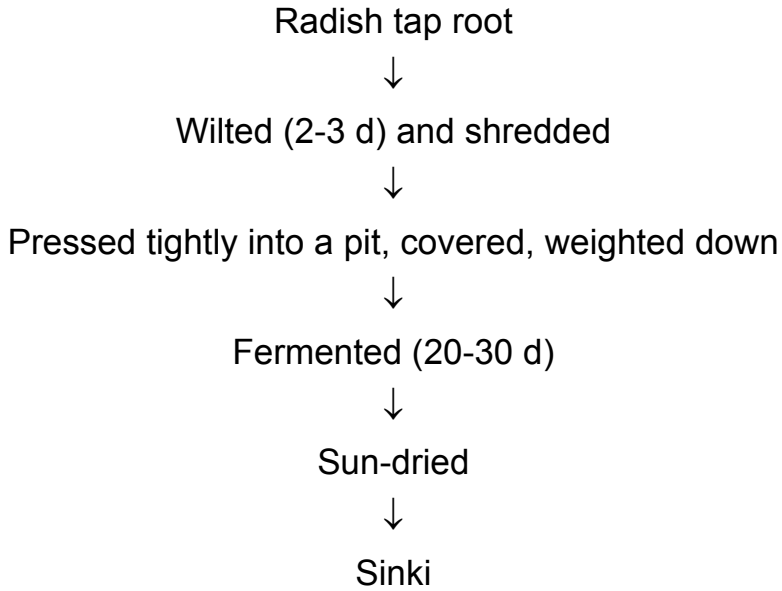


Fig.3 Flow sheet of traditional method of *sinki* preparation

Sinki, with a highly acidic flavour, is typically used as a base for soup and as pickle. The soup is made by soaking sinki in water for about 10 min, squeezing out the liquid and frying along with chopped onion, tomatoes and green chilies and salt. Soup is served hot along with meals. It is said to be a good appetizer, and people use it for remedies for indigestion.

Pickle is prepared by soaking sinki in water, squeezing and mixing with salt, mustard oil, onion and green chilies.

Sinki is also sold in all local periodical markets. One kg of sinki costs about Rs 100/- or more. Some people are economically dependent upon gundruk and sinki production.

Sinki is a naturally fermented product. *Lactobacillus fermentum* initiates the fermentation in *sinki* production, followed by *Lactobacillus brevis* and *Lactobacillus plantarum*. During fermentation pH dropped from 6.7 to 3.3 with increase in acidity (Tamang and Sarkar, 1993).

The nutritional composition of sinki is: moisture 22%, pH 4.4, acidity 0.8%, protein 14.6 g DM (dry matter basis), fat 2.5 g DM, ash 11.5 g DM, Ca 120.5 mg/100 g DM, K 443.1 mg/100 g DM, Fe 18 mg/100 g DM (Tamang, 1992; Tamang and Sarkar, 1993). Sinki contains high amount of organic acids which are good appetizers (Tamang, 1992). Due to low pH and high acids, sinki can be preserved for several months for consumption.

1.3.3.3 *Fermented milk products*

Consumption of milk and milk products are the dietary culture of ethnic people living in the Sikkim Himalayas. Cow milk is popular. In the high altitude (>2100 m), mostly in north Sikkim, yak rearing is common practice for milk, meat, skin and hair. Prodcution of ethnic fermented milk products is mainly confined to the unorganized sector as well as individual household level in Sikkim. Based on the survey (Dewan, 2002), annual production and per capita consumption of different indigenous fermented milk products in the four districts of Sikkim was calculated (Table 23 and 24).

Table 23. Annual production of ethnic fermented milk products in each household of Sikkim

(kg per household)

Product						
Dahi	*Gheu*	Soft *chhurpi*	*Chhu*	*Somar*	*Philu*	*Mohi*[a]
76.2 ± 7.7	14.2 ± 28.5	5.0 ± 13.3	4.0 ± 12.3	0.1 ± 1.2	0.2 ± 1.0	125.4 ± 171.0

[a] Litre per household

Data represent the means SD± 228 of households.

Table 24. Per capita consumption of ethnic fermented milk products of Sikkim

Product	Per capita consumption (g per day)				
	District				
	North[a]	South[b]	East[c]	West[d]	Sikkim[e]
Dahi	29.9 ± 54.4	28.8 ± 35.5	46.2 ± 48.1	19.2 ± 19.2	33.0 ± 38.8
Gheu	10.3 ± 12.7	4.4 ± 4.8	9.8 ± 21.3	1.7 ± 2.0	7.1 ± 14.5
Soft *chhurpi*	5.0 ± 7.5	4.5 ± 9.9	1.6 ± 5.0	0.7 ± 1.7	2.8 ± 6.7
Chhu	3.4 ± 5.9	3.5 ± 9.9	0.3± 0.40.9	0.4 ± 1.8	1.7 ± 5.6
Somar	0.1 ± 0.9	0.003 ± 0.017	0.1 ± 0.2 1.0	0.02 ± 0.012	0.14 ± 0.7
Philu	0.4 ± 0.8	0.08 ± 0.31	0.006 ± 0.040	0.03 ± 0.13	0.1 ± 0.4
Dudh *chhurpi*	0.0005 ± 0.0009	0.001 ± 0.007	0.005 ± 0.026	0	0.002 ± 0.016
	Per capita consumption (ml per day)				

Mohi	22.7 ± 32.9	52.5 ± 56.7	68.6 ± 89.9	53.8 ± 57.5	51.2 ± 68.1

Products included both cow and yak fermented milk products.

Data represent the means of households[a] SD ± 54; households[b] SD ± 48; households[c] SD ± 78; households[d] SD ± 48; households[e] SD ± 228.

1.3.3.3.1 *Chhurpi*

Soft-variety of chhurpi is a cheese-like fermented milk product. It has a rubbery texture with slightly sour taste and excellent aroma when it is fresh. Soft chhurpi is used to prepare various dishes and its popularity is increasing as it provides a different taste to food.

During traditional method of preparation of chhurpi, dahi (curd) is churned in a bamboo or wooden vessel, with the addition of warm or cold water, to produce gheu and mohi. Mohi (butter milk) is cooked for about 15 minutes till a soft, whitish mass is formed. This mass is sieved out and put inside a muslin cloth, which is hung by a string to drain out the remaining whey. The product is called soft-variety of chhurpi (Fig. 4).

Milk

↓

Dahi

↓

Churned in bamboo or wooden vessel (30-45 min)

with addition of warm or cold water

↓

→ Gheu(butter)

↓

Mohi (buttermilk)

↓

Cooked for 15 min

↓

Solid, white mass sieved out

↓

Whey squeezed out with a muslin cloth

↓

Soft Chhurpi

Fig.4 Flow sheet of soft chhurpi preparation

Soft chhurpi is consumed as an excellent source of protein and as a substitute for vegetables. Soft chhurpi is prepared into a curry by cooking it in oil along with onions, tomato and chilies. The curry is also prepared with edible ferns, locally called 'sauney ningro' (*Diplazium polypodiodes*) and 'kali ningro' (*Diplazium* sp.). This curry is eaten with rice. It is also used to prepare 'achar' or pickle by mixing it with chopped cucumber, radish, chilies, etc (Tamang and Tamang, 1998). Soup prepared from soft chhurpi can be consumed as a substitute for dal along with rice. Chhurpi is sold in all local periodical markets by rural

women. It is packed in the leaves of fig plant and then tied loosely by straw. One kg of chhurpi costs about Rs.60/- or more.

Chhurpi is characterized by lactic acid bacteria fermentation. The predominant lactic acid bacteria are *Lactobacillus plantarum, Lactobacillus curvatus, Lactobacillus fermentum, Lactobacillus paracasei* subsp. *pseudoplantarum, Lactobacillus alimentarius, Lactobacillus kefir, Lactobacillus hilgardii*, *Enterococcus faecium* and *Leuconostoc mesenteroides* (Tamang *et al.*, 2000; Dewan, 2002). These strains of lactic acid bacteria showed the probiotic properties as well as antimicrobial properties in chhurpi (Dewan, 2002).

For the first time, Tamang *et al. (*2000) reported the probiotic properties of microorganisms isolated from chhurpi samples from the Himalayan fermented foods. The lactic acid bacteria present in chhurpi showed the probiotic properties advocating the chhurpi as functional or health-food.

The nutritional composition of chhurpi is: moisture 73.8%, pH 4.2, acidity 0.61%, ash 6.6% DM, fat 11.8% DM, protein 65.3% DM and carbohydrate 16.3% DM; minerals (mg/100g): Ca 44.1, Fe 1.2, Mg 16.7, Mn 0.6 and Zn 25.1 (Dewan, 2002).

1.3.3.3.2 *Chhu*

Chhu is an indigenous cheese-like fermented yak or cow milk product consumed mostly by the Bhutias and Lepchas in Sikkim. Initially

it has a rubbery texture with slightly sour taste when fresh, after further fermentation it becomes creamish to pale yellow coloured and develops a strong flavour. Shyow (curd) is prepared from boiled or unboiled milk of yak or cow. Shyow is churned in a bamboo or wooden vessel, with addition of warm or cold water to produce maa and kachhu. Kachhu is cooked for 15 minutes till a soft, whitish mass is formed. This mass is sieved out and put inside a muslin cloth, which is hung by a string to drain out the remaining whey. The product is called chhu (Fig. 5). Chhu is placed in a closed vessel and kept for several days to months to ferment the product further after which it is consumed.

Shyow

↓

→ Maa

↓

Kachhu

↓

Cooked for 1-2 h

↓

Solid, white mass sieved out; whey squeezed out with a muslin cloth

↓

Further fermentation

↓

Chhu

Fig.5 Flow sheet of chhu preparation in East Sikkim

It is prepared into a curry by cooking it in maa along with onions, tomato and chilies and is consumed with boiled rice. Soup prepared from strong-flavoured chhu is also consumed by the Bhutia. It has a sour taste with strong aroma and is used as appetizer.

Microorganisms present in chhu are *Lactobacillus farciminis, Lactobacillus brevis, Lactobacillus alimentarius* and *Lactococcus lactis* subsp. *cremoris*. Proximate composition of *chhu* is: moisture 75.5%, pH 6.3, acidity 0.15%, ash 1.9% DM, fat 5.8% DM, protein 58.4% DM and carbohydrate 33.9% DM; mineral (mg/100 g): Ca 111, Fe 4.5, Mg 64.3, Mn 3.1 and Zn 87.6.

1.3.3.3.3 *Philu*

Philu is a typical indigenous fermented butter-like milk product obtained from cow or yak milk, with an inconsistent semi-solid texture. It is commonly eaten by the Bhutias and Sherpa. Sherpa calls it philuk.

During philu preparation, fresh milk, collected in cylindrical bamboo vessels (locally called ‘dzydung’ by the Bhutia) or in wooden vessels (called ‘yadung’) is slowly swirled around the walls of these vessels by rotating these vessels for a few minute. Sometimes a thick mesh of dried creeper is kept inside the vessel to increase the surface area for the philu to stick. A creamy mass sticks to the walls of the vessels and around the creeper. The milk is then poured off and utilized elsewhere. The vessel is then kept in an upside down position to drain out the remaining liquid. This process is repeated daily for about 6-7

days until a thick, white cream-layer is formed on the vessel walls and the creeper surface (Fig. 6). This soft mass as philu, is scraped off and stored in dry place for later consumption. Philu obtained from yak milk has a cream-white colour with an inconsistent semi-solid texture. Philu is consumed as a side dish with rice. Philu is cooked with butter and little salt is added. Rich gravy is prepared and consumed along with boiled rice.

Milk (unboiled)

↓

Collected in bamboo or wooden vessels

↓

Rotated and swirled in the vessel

↓

Milk poured off, vessel upturned

↓

Process repeated until thick, layer formed on vessel wall and creeper mesh,
fermentation of the creamy mass continues throughout the entire period

↓

Scraped off whitish layer of cream from vessel walls and creeper

↓

Philu

Fig.6 Flow sheet of philu preparation.

Philu is a high-priced traditional milk product sold in local markets in the Sikkim Himalayas. It costs about Rs. 200 per kg in Gangtok market. Few rural people are dependent on this product for their livelihood. In North Sikkim, philu is produced mostly from yak milk and is produced and consumed at the household level by the Bhutias.

Microorganisms in philu are *Lactobacillus casei* subsp. *casei, Lactobacillus bifermentans* and *Enterococcus faecium*. The nutritional composition of *philu* is: moisture 38.2%, pH 4.3, acidity 0.61%, ash 3.6% DM, fat 32% DM, protein 52% DM and carbohydrate 12.5% DM; minerals (mg/100 g) Ca 34.9, Fe 0.8, Mg 16.9, Mn 0.9 and Zn 27.1 (Tamang *et al*., 2004; Dewan, 2002).

1.3.3.4 *Traditionally processed fish products*

The people of the Sikkim Himalayas consume different types of traditionally processed smoked/sun-dried fish products (Thapa, 2002). Some of the fish products are prepared using indigenous knowledge of the rural people for fish preservation. Such fish processing technique has been still present in those regions or villages, which are located near water bodies with plenty of freshwater fishes. Some villagers sell them in the market area. As the products are manufactured by the rural people during appropriate season, they are regarded as a special dish for them. The fish products also seem to be an important source of protein in the local diet. According to some old people of the villages in these regions, interviewed during the survey, sukako maacha was produced in bulk in most of the places near the river-sites, even in the

low-altitudes of rivers like Teesta and Rangit in Sikkim till seventies. Now-a-days, production of these traditional processed fish products is confined to limited areas and is hardly seen in the local markets due to decline in the fish population in the hill rivers. The study reveals that decline in the fish population in the Teesta and Rangit River is mainly due to hydropower project activities leading soil erosion, siltation, water pollution by growing industries, sewage and pesticide.

Consumption of fish products in the local diet, though, is important diet, is comparatively less than other fermented products such as vegetable and dairy products in the Sikkim Himalayas. This may be attributed by pastoral system of agriculture and the consumption of dairy products in these regions.

1.3.3.4.1 *Gnuchi*

Gnuchi is a typical smoked and dried fish product commonly eaten by the Lepcha. The word ‘gnuchi’ means smoked fish in the Lepcha language.

During traditional method of preparation of gnuchi, fish are caught early in the morning from the river because it is believed that during this time they come near the banks. This make it easier to catch the fish using fishing net locally called ‘sangli’. Fish are collected in a bamboo basket locally called ‘tamfyok’, which is woven by bamboo strips and is properly tied around the waist of the fisherman while fishing. Fishe

captured includes *Schizothorax richardsonii* Gray, *Labeo dero* Hamilton, *Acrossocheilus* spp., *Channa* sp., etc.

Fish are kept on a big bamboo tray called ‘sarhang’ to drain off water, degutted, mixed with salt and turmeric powder. Fish are separated according to their size. The bigger sized fish is selected and spread in an upside down manner on ‘sarhang’ and is kept above the earthen-oven in kitchen. The small sized fish are hung one after the other in a bamboo stripe above the earthen-oven for 10-14 days, after which gnuchi is ready to be consumed (Fig. 7). Gnuchi can be kept at room temperature for 2-3 months.

Gnuchi is eaten as curry with boiled rice by the Lepcha. It is also cooked with vegetable.

Fish

↓

Caught from river, degutted and washed

↓

Mixed with turmeric powder and salt

↓

Sieved in a bamboo tray and spread thoroughly

↓

Smoked above the earthen-oven for 10-14 days

↓

Gnuchi

Fig.7 Flow sheet of gnuchi preparation

Functional microorganisms were isalated from samples of gnuchi and were identified as *Enterococcus faecium*, *Pediococcus pentosaceus*, *Bacillus subtilis* and *Micrococcus* sp. (Thapa *et al*., 2005).

The nutritional value of gnuchi is: moisture 14.3%, ash 16.9%, fat 14.5% and protein 21.3%; minerals (mg/100 g): Ca 38, Fe 1.1, Mg 8.8, Mn 1.1 and Zn 7.5 (Thapa, 2002).

1.3.4 Ethnic fermented beverages

Ethnic fermented beverages (Table 21) constitute an integral part of dietary culture and have strong ritual importance among the ethnic people in the Sikkim Himalayas where social activities require provision and consumption of appreciable quantities of alcohol (Tamang *et al.*, 1996). Making and use of fermented beverages are of widespread interest enhancing the pleasure of consumption. It has also nutritional significance. Alcoholic beverages are exclusively prepared from locally grown cereal-grains using traditionally prepared mixed inocula or starter called marcha. These alcoholic beverages are considered as nutritious. Traditional alcohol brewing is a home-based industry mostly done by rural women using their indigenous knowledge of alcohol fermentation.

1.3.4.1 *Kodo ko Jaanr or Chyang*

Kodo ko jaanr or chyang is the most common fermented alcoholic beverage prepared from dry seeds of finger millet (*Eleusine coracana*), locally called ‘kodo’. Jaanr is common name for all alcoholic beverages

in Nepali. Different ethnic groups call it by their own dialect such as *mandokpenaa thee* by Limboo, *sampicha ummaak* by Rai, *naarr paa* by Gurung, *saangla chi* by Tamang, *chirs shyaabu* by Sunwar, *paadaare haan* by Magar, *gyaar chyang* by Sherpa, *minchaa chyang* by Bhutia, and *mong chee* by Lepcha. Description of alcohol-drinking custom in the Sikkim Himalayas has been cited in some historical documents (Hooker, 1854, O'Malley, 1907; Risley, 1928). Risley (1928) writes "*marwa, chang*, is a kind of beer brewed by everyone in Sikkim, and might be called their staple food and drink".

During preparation, seeds of finger millet are cleaned, washed and cooked for about 30 min in an open cooker. Excess water is drained off and cooked millets are spread on a bamboo-mat called 'mandro' for cooling. About 1-2% of powdered *marcha* is sprinkled over cooked seeds, mixed thoroughly and packed in a bamboo basket lined with fresh fern, locally called 'thadre unioon' *(Thelypteris erubescens*) or banana leaves, then covered with sack clothes, and kept for 2-4 days at room temperature for saccharification. During saccharification sweet aroma is emitted out and the saccharified mass is transferred into an earthen pot or into specially made bamboo basked called 'septu' and made it air-tight and fermented for 3-4 days during summer and 5-7 days in winter at room temperature (Fig. 8).

Finger millets

↓

Cleaned and Washed

↓

Cooked; excess water drained off

↓

Cooked seeds are spread on bamboo-mat for cooling (20 –25° C)

↓

← Added marcha (~ 1-2 %)

↓

Mixed; packed in heaps and saccharified for 2-4 d

↓

Transferred into a closed earthen pot

↓

Fermented (25-30° C, 3-7 d)

↓

Kodo ko Jaanr or Chyang

↓

← Added lukewarm water

↓

Kept in toongbaa for 10-20 min

↓

Sipped the extract of kodo ko jaanr through pipsing

Fig.8 Flow sheet of kodo ko jaanr preparation in East Sikkim

Good quality of jaanr has sweet taste with mild alcoholic flavour. Prolonged fermentation makes the product bitter in taste and more alcoholic. Sour taste and unpleasant flavour of jaanr is unacceptable to consumers. Kodo ko jaanr is consumed in a unique way in the Sikkim

Himalayas. About 200-500 g of jaanr is put into a vessel called toongbaa and lukewarm water is added up to the edge of it. After 10-15 min, milky white extract of jaanr is sipped through a narrow bamboo straw called pipsing having a hole in a side near the bottom to avoid passing of grits. Water can be added 2-3 times after sipping up the extract. Guests are served with toongbaa along with fried meat or pickles. Alternately, thick milky white liquid pressed from the kodo ko jaanr is filtered under pressure using a filter called 'chhapani'. Such liquor is believed to be good tonic for ailing persons and post-natal women. After consumption, grits of kodo ko jaanr are used as fodder for pigs and cattle. This is a good example of total utilization of substrate as food and fodder. Some people are economically dependent on chyang. Kodo ko jaanr is commonly available in liquor shops or locally called 'ghaddi', restaurants and hotels.

Equipment used for jaanr production

Septu: It is a container made up of bamboo stripes or woods to store jaanr. It is commonly used in marriages.

Chhapani: It is a filter made up of bamboo stripes used to filter the fermented mass.

Mandro: It is a mat made up of bamboo used for cooling the cooked substrates before fermentation. Size of mandro varies from 1 m to 2 m.

Toongbaa or dhungro: It is a vessel in which fermented millet-seeds are placed and warm water is added, and extract is sipped through a narrow

bamboo straw called pipsing. Toongbaa is made up of wood or bamboo or earthenware. Usually wooden toongbaa is decorated with silver lining and is provided with a lid.

Pipsing: It is a narrow straw, made up of bamboo having a hole in opposite sides at the one end of the straw to avoid passing of grits during sipping of jaanr from toongbaa

Microorganisms necessary for fermentation of finger millets into kodo ko jaanr are supplemented by marcha, a starter culture. The nutritional composition of finger millet and kodo ko jaanr is presented in (Table 25). Alcohol content of kodo ko jaanr is around 6%. It is high calorie food beverage. Remarkable increase in mineral contents such as calcium, magnesium, manganese, iron, potassium and phosphorous have been observed in jaanr during fermentation. Kodo ko jaanr, thus, contributes to the mineral intake in daily diet of the local people. Because of high calorie, ailing persons and post-natal women consume the extract of kodo ko jaanr to regain the strength.

Table 25. Nutritional composition of kodo ko jaanr

Parameter	Finger millet	Kodo ko jaanr
pH	6.4	4.0
Moisture (%)	66.0	68.7
Acidity (%)	0.01	0.28
Alcohol (%)	0	6.0
Ash (% DM)	4.9	4.9
Fat (% DM)	2.4	2.0

Protein (% DM)	10.0	9.0
Crude fibre (% DM)	6.7	7.7
Carbohydrate (% DM)	82.7	84.2
Energy (Kcal/100g DM)	375.0	395
Minerals (mg/100 g dry matter):		
Calcium	206	281
Magnesium	76	118
Manganese	3.6	9.0
Copper	0.8	2.2
Iron	8.7	24
Zinc	1.0	1.2
Sodium	28	39
Potassium	252	398
Phosphorus	228	326

Data represent the means of 10 samples.

% DM, percentage on dry matter basis.

1.4 CONCLUSION

Ethnic food culture harnesses the cultural history of particular community, their worth indigenous knowledge of food production, vast nutritious qualities, microbial diversity associated with fermented foods as genetic resources, source of income-generation related to tourism and enjoyment of dining. The concept of 'ethnic food tourism" may have relevance in present days due to increase in tourist industry in the Himalayas. Movement and interaction of people, sense of respect to traditional value and culture will serve to intricately link the enjoyment of dining to locale, making this the standard of food culture of the region. Finding enjoyment in eating the produce of the region while in that region – herein lies the essence of a food culture that gives confidence

in life, pride to the people of the region and ultimately, enjoyment and friendship. Further, it imparts meaning to the act of travel and bestows happiness upon the traveler. The promoters have to focus on the specific food culture of a region in a presentable form where tourists can find local cuisine in menu, signifying the food culture of a region.

Food industry is a sunrise industry with emphasis on culture, tradition, cost-effectiveness as well as the interface between health and nutrition. The most important role that is played in the kitchen is the tradition and innovativeness. When we look at the ethnic popularity certain foods are more preferred than the others, example 'fried vegetable' is more preferred in one ethnic group whereas the same vegetable in 'boiled form' is preferred by other ethnic population. When we think to globalization of the traditional foods, we should combat these preferences to give the best traditional foods to consumers. For example, kinema is high plant protein food with low fat and rich in essential amino acids, and is less-expensive, but is confined to particular consumers, mostly because of its flavour and sticky texture. The typical flavour is the characteristic to kinema developed due to proteolytic activities. Most of non-consumers, who are not familiar, do not prefer to eat kinema. Flavourless kinema cannot be developed, and if developed it will be a new product with distinct characters, different from kinema.

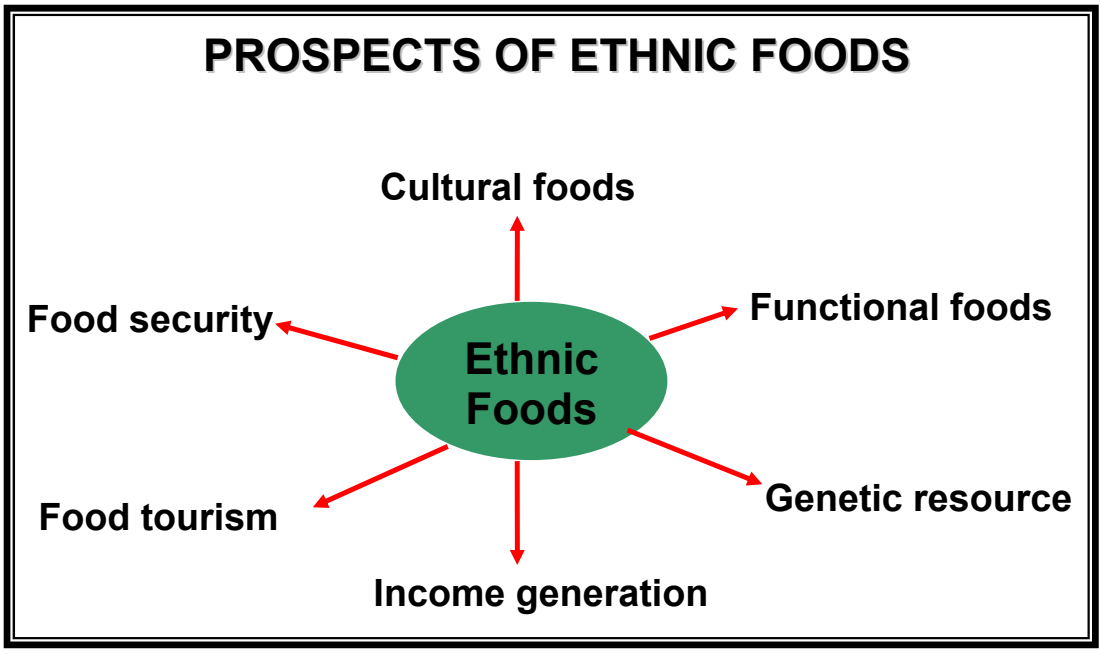
Three potential avenues for product development from traditional foods are: Re-creation of authentic food products; benefit of culinary and/or functional properties; and exploitation of technology. Many commercial products have been developed using the characterization of

food fermentations as a basis. Technical parameters contribute to only one part of the equation in the successful commercialization of traditional food products or processes. Where and how these new products fit into a given market will largely define business success if and when such processes are industrialised. Availability and consistent supply of raw materials, basic infrastructure, administrative policy, cost of capital, legislation and trade issues, and import/export restrictions are all necessary for considerations for industrialization of traditional foods.

Some traditional foods such as sishnu, silam, chinday and many edible wild plant foods have medicinal values. Though clinical study of these foods has not been done yet, people strongly believe to have certain therapeutic values. Such foods if studied properly may be projected in the global markets. The R & D Centre for the traditional foods of the Sikkim Himalayas should be set up to open the way for industrialization of some traditional food production with consequent benefit to the regional economy and employment.

The art of tradition and culture of making the foods at household level has to synergise with regulatory standards. It is important to interface traditional foods with health, safety, nutrition and cost. Value addition to traditional foods through interface of food science and technology for better products is the need of the day. We need to have a much larger perspective plan for ethnic foods of Sikkim with a global approach. Traditional food has to be traditional and has to be promoted keeping in view of the fact of ethnic demand and cultural interface, and

also respect of skill and expertise of ethnic people for building up a global approach of traditional foods.



1.5 SUMMARY AND RECOMMENDATIONS

1) The Sikkim Himalayas is a home of many endangered species of flora and fauna. The diversity should not be disturbed.

2) The most crucial step to be taken is the protection, conservation and regeneration of flora and fauna. People have to be made aware of the implications of further destroying species already endangered.

3) More than 30 varieties ethnic fermented foods and 150 types of non-fermented traditional foods including edible wild plants are consumed in Sikkim.

4) Analysis of bio-resources of Sikkim particularly the food security including some common ethnic fermented foods (*kinema, gundruk, sinki, chhurpi, chhu, philu, gnuchi* and *kodo ko jaanr*) and eighteen common edible wild plants was one of the aims of this study.

5) Microorganisms enhancing the functional properties and nutrittonal value of fermented foods, were isolated, characterised and identified including species of lactic acid bacteria, *Bacillus* and alcohol-producing yeasts and moulds, and preserved at -20^{o} C.

6) Biopreservation of foods: *gundruk;* Bioenrichment of nutritional value: *kinema;* Protective properties such as probiotics: *chhurpi chhu*; Production of enzymes: *kinema;* High Caloric food beverage mostly for ailments and post-natal care, and also contributes to mineral intake: *kodo ko jaanr.*

7) The entire Teesta basin in Sikkim mostly north and east districts is rich in edible wild plants. Some ethnic people sell the seasonal wild plants in local markets, and economically dependant upon these products.

8) Out of 128 edible wild plants recorded from Sikkim, 63 plants are eaten as fruits, 22 as vegetables, 19 as pickles, rest as condiment, herbal materials, etc. Some people are economically dependent upon these plants. They sell in the local markets.

9) Most of the edible wild plants have high nutritional value, particularly, rich in minerals, contributing the low-cost nutritional supplement.

10) People usually collect the edible wild plants from their natural habitats and sell in local markets.

11) In most cases, 100% profit is made out of selling the wild plants. However, cost includes local transportation and other expenses. Profit is used for livelihood.

12) No step has been taken up yet from any side to commercialize these edible wild plants and their products or domestication of these products in mass–scale production using modern agricultural practices.

13) Our findings suggest that some of these wild plants may be domesticated and may contribute significant nutritional value in local diet. Edible wild plants are no doubt, food security of the region, in scarce of domesticated seasonal products.

14) The R & D Centre for the ethnic traditional foods should be set up to open the way for industrialization of some traditional food production with consequent benefits to the regional economy and employment.

15) Gene Bank may be set up to deposit important microorganisms involving in traditional foods preservation, which may ensure to conserve microbial diversity of food eco-system.

16) Institutional mechanisms should be developed to commercialize the ethnic fermented foods, and also develop food entrepreneurship in Sikkim. Popularization of Ethnic Foods of Sikkim has been conceptualized in the line of “Ethnic Food Tourism” for income generation and cultural aspects.

17) Some common foods have therapeutic values, if studied properly may be projected in the global markets.

BIBLOGRAPHY

BIBLIOGRAPHY

AOAC (1990). *Official Methods of Analysis,* 15th Edition. Association of Official Analytical Chemists, Virginia.

Balaraman, N. and Golay, M.M. (1991). *Livestock Production in Sikkim*. Sikkim Science Society, Gangtok.

Bennet, S.S.R. (1987). *Name Changes in Flowering Plants*. Triseas Publications, Dehradun, India, 772.

Dewan, S. (2002). *Microbiological evaluation of indigenous fermented milk products of the Sikkim Himalayas*. Ph.D. Thesis, Food Microbiology Laboratory, Sikkim Government College (affiliated to North Bengal University), Gangtok, India.

Geisen, R. and Holzapfel W.H. (1996). Genetically modified starters and protective cultures. *International Journal of Food Microbiology* 30: 315-324.

Gurung, B. (2002). *The Medicinal Plants of Sikkim Himalaya*. Maples Chakung, West Sikkim, 1-469.

Hara, H. (1966). *The Flora of Eastern Himalaya*. University of Tokyo, Japan, 744.

Harrigan, W.F. (1988). *Laboratory Methods in Food Microbiology*. 3rd edn. Academic Press, London.

Hesseltine, C.W. (1991). Zygomycetes in food fermentations. *Mycologist* 5(4): 162-169.

Hooker, J.D. (1854). *Himalayan Journals: Notes of a Naturalist in Bengal, the Sikkim and Nepal Himalayas, the Khasia Mountains* John Murray, London.

Kurtzman, C.P. and Fell, J.W. (1998). *The Yeast, A Taxonomic Study*. 4th edn. Amsterdam: Elsevier. O' Malley, L.S.S. (1907) *Darjeeling District Gazetteer.* Gyan Publishing House, New Delhi.

Nayar, M.P. and Sastry, A.R.K. (1987, 1988, 1990). Red Data Book of Indian Plants, Vol. I, II, III, Botanical Survey of India, Kolkata.

O' Malley, L.S.S. (1907) *Darjeeling District Gazetteer.* Gyan Publishing House, New Delhi.

Rai, A. (2002). *Some Edible Wild Plants of Darjeeling Hills*. M.Sc. Dissertation, Darjeeling Government College, Darjeeling.

Rai, P.C., Sarkar, A., Bhujel, R.B. and Das, A.P. (1998). Ethnobotanical studies in some Fringe Areas of Sikkim and Darjeeling Himalayas. *Journal of Hill Research*, 11(1): 12-21.

Ranganna, S. (1986). *Handbook of Analysis and Quality Control for Fruit and Vegetable Products, 2nd Edition*, Tata McGraw-Hill Publishing Company Limited, New Delhi pp. 127-130.Risley, H.H. (1928) *The Gazetteer of Sikkim.* D. K. Publishing Distributors (P) Ltd., New Delhi.

Risley, H.H. (1928). *The Gazetteer of Sikkim.* D. K. Publishing Distributors (P) Ltd., New Delhi.

Sarkar, P.K. and Tamang, J.P. (1994). The influence of process variables and inoculum composition on the sensory quality of kinema. *Food Microbiology* 11: 317-325.

Sarkar, P.K. and Tamang, J.P. (1995). Changes in the microbial profile and proximate composition during natural and controlled fermentations of soybeans to produce kinema. *Food Microbiology* 12: 317-325.

Sarkar, P.K., Tamang, J.P., Cook, P.E. and Owens, J.D. (1994). Kinema – a traditional soybean fermented food: proximate composition and microflora. *Food Microbiology* 11: 47-55.

Standal, B.R. (1963). Nutritional value of proteins of oriental soybean foods. J. Nutr. 81:279-285.

Steinkraus, K.H. (1996). *Handbook of Indigenous Fermented Foods*, second edition. Marcel Dekker, New York.

Stiles, M.E. and Holzapfel, W.H. (1997). Lactic acid bacteria of foods and their current taxonomy. *International Journal of Food Microbiology* 36: 1-29.

Sundriyal, M. and Rai, L.K. (1996). Wild edible plants of Sikkim Himalaya. *Journal of Hill Research* 9(2): 267-278.

Tamang, J.P. (1992). *Studies on the microflora of some traditional fermented foods of the Darjeeling hills and Sikkim,* Ph. D. Thesis, North Bengal University, Darjeeling, India.

Tamang, J.P. (1995) *Study of traditional fermented foods production in Darjeeling hills and Sikkim, with emphasis on Kinema.* Post-doctoral Thesis, National Food Research Institute, Tsukuba (Japan). Under the United Nations University Post-doctoral Fellowship.

Tamang, J.P. (1996). Fermented soybean products in India. In: *The Proceedings of the Second International Soybean Processing*

and Utilization Conference, Bangkok, Thailand, January 8-13, 1996 (Ed: A. Buchanam), 189-193.

Tamang, J.P. (2000a). *Case study on socio-economical prospective of kinema, a traditional fermented soybean food.* In: *The proceeding of the 1997 International Conference on Traditional Foods*, March 6-8, 1997 (ed. Director, CFTRI), CFTRI, Mysore, India, 180-185.

Tamang, J.P. (2000b). Microbial diversity associated with natural fermentation of *Kinema*. In: *Proceedings of the Third International Soybean Processing and Utilization Conference*, Tsukuba, Japan, October 15-20, 2000 (ed. K. Saio), 713-717.

Tamang, J.P. (2001). Kinema. *Food Culture* 3: 11-14.

Tamang, J.P. (2003). Native microorganisms in the fermentation of *kinema*. *Indian Journal of Microbiology* 43 (2): 1-4.

Tamang, J.P. (2005). *Food Culture of Sikkim*. Sikkim Study Series volume IV. Information and Public Relations Department, Government of Sikkim, Gangtok, 120.

Tamang, J.P. and Holzapfel, W.H. (1999). Biochemical identification techniques-modern techniques: Microfloras of fermented foods. In: *Encyclopedia of Food Microbiology* (Eds: R.K. Robinson, C.A. Batt, and P.D. Patel), Academic Press, London, 249-252.

Tamang, J.P. and Nikkuni, S. (1996). Selection of starter culture for production of kinema, a fermented soybean food of the Himalaya. *World Journal of Microbiology and Biotechnology* 12**:** 629-635.

Tamang, J.P. and Nikkuni, S. (1998). Effect of temperatures during pure culture fermentation of *kinema*. *International Journal of Microbiology and Biotechnology* 14: 847-850

Tamang, J.P. and Sarkar, P.K. (1993). *Sinki*: a traditional lactic acid fermented radish tap root product. *Journal of General and Applied Microbiology* 39, 395-408.

Tamang, J.P. and Tamang, N. (1998). Traditional food recipes of the Sikkim Himalayas. Report, Sikkim biodiversity and eco-tourism project, GBPIHED, Tadong.

Tamang, J.P., Thapa, S., Tamang, N. and Rai, B. (1996). Indigenous fermented food beverages of Darjeeling hills and Sikkim: process and product characterization. *Journal of Hill Research* 9(2): 401-411.

Tamang, J.P., Dewan, S., Thapa, S., Olasupo, N. A., Schillinger, U. and Holzapfel, W. H. (2000). Identification and enzymatic profiles of predominant lactic acid bacteria isolated from soft-variety *chhurpi*, a traditional cheese typical of the Sikkim Himalayas. *Food Biotechnology* 14 (1&2): 99-112.

Tamang, J.P., Dewan, S. and Holzapfel, W.H. (2004). Technological properties of predominant lactic acid bacteria isolated from indigenous fermented milk products of Sikkim in India. In: *Proceeding Abstract of the 19th International ICFMH Symposium Food Micro 2004 on "New Tools for Improving Microbial Food Safety and Quality: Biotechnology and Molecular Biology Approaches*", organized by University of Ljubljana, Slovenian Microbiological Society and International Committee for Food Microbiology and Hygiene, Portorož, Slovenia, Sep. 12-16, 2004, 300.

Tamang, J.P., Tamang, B., Schillinger, U., Franz, C.M.A.P., Gores, M. and Holzapfel, W.H. (2005). Identification of predominant lactic acid bacteria isolated from traditional fermented vegetable products of the Eastern Himalayas. *International Journal of Food Microbiology* (on-line publication), doi: 10.1016/ j.ijfoodmicro. 2005. 04. 024.

Thapa, N. (2002). *Studies on microbial diversity associated with some fish products of the Eastern Himalayas*. Ph.D. Thesis, North Bengal University, Siliguri, India.

Thapa, N., Pal, J. and Tamang, J.P. (2005). Phenotypic identification and technological properties of lactic acid bacteria isolated from traditionally processed fish products of the Eastern Himalayas. *International Journal of Food Microbiology* (on-line publication), doi:10.1016/ j.ijfoodmicro. 2005.08.009.

Yonzan, H. and Tamang, J.P. (1998). Consumption pattern of traditional fermented foods in the Sikkim Himalaya. *Journal of Hill Research* 11(1): 112-115.

Wood, B.J.B. and Holzapfel, W.H. (1995). The Lactic Acid Bacteria, vol. 2: The Genera of Lactic Acid Bacteria. Blackie Academic & Professional, London.

PLATES

Gundruk drying

Chhurpi curry

Marketing ethnic fermented foods at Sikkim markets

Marketing edible wild plants at Gangtok

Typical meal of Sikkim

Kinema

***Castanopsis* sp. 'katus'**

***Choerospondias* sp. ' lapsee'**

***Campylandra* sp. 'nakima'**

***Urtica dioca* 'sishnu'**

ANNEXURE

ANNEXURE-I

FLORA OF NORTH SIKKIM

EXTINCT SPECIES

ANGIOSPERMS

FAMILY	TAXA	DISTRIBUTION	LIFE FORM	HABITAT	USES	REFERENCES
Asclepiadaceae	*Ceropegia lucida* Wall.	River Ryang	Climbing herb	Not known	Not known	Nayar *et al.* (1988)
Orchidaceae	*Coleogyne treutleri* Hook. f.	Sikkim Himalaya, Temperate Himalayas. (2300–3000 m)	Epiphytic herb	Not known, probably epiphytic like other species	Not known	Nayar *et al.* (1987)
Orchidaceae	*Zeuxine pulchra* King *et* Pantl.	Lachung valley (2500m)	Herb	Not known	Ornamental	Nayar *et al.* (1987)
PTERIDOPHYTA						
Dennstaedtiaceae	*Dennstaedtia elwesii* (Bak.) Bedd	Lachen (2600 m)	Herb	Not known	Not known	Nayar *et al.* (1988)

Extinct: This category is only used for species which are no longer known to exist in the wild after repeated search of the type localities and other known or likely places. As interpreted by IUCN, this includes species that are extinct in the wild but surviving in cultivation.

FLORA OF NORTH SIKKIM
ENDANGERED SPECIES

ANGIOSPERMS

FAMILY	TAXA	LOCAL NAME	DISTRIBUTION	LIFE FORM	HABITAT	USES	REFERENCES
Asclepiadaceae	*Ceropegia hookeri* Clarke ex Hook.f.		Zemu valley (3000 m)	Twinner or decumbent herb.	Not known, however it grows in areas ranging between 3000-4000 m altitude in Himalayas probably in alpine grassy meadows.	Not known	Nayar *et al.* (1988)
Asteraceae	*Lactuca cooperi* Anthony		Alpine and sub-alpine (5000m)	Perennial herb.	Alpine and sub-alpine region		Nayar *et al.* (1987)
Campanulaceae	*Codonopsis affinis* Hook .f. *et* Thoms.		Temperate Himalayas (1830-3335m)	Twinning herb	Temperate Himalayas at elevation between 1830-3335 m		Nayar *et al.* (1988)
Juncaceae	*Juncus sikkimensis* Hook. f.		Sikkim (4000-4500m)	Perennial herb	Nothing is known about its ecology	Nothing is recorded	Nayar *et al.* (1990)
Orchidaceae	*Didiciea cunningha mii* King *et* Pantl.		Lachen valley (4000m)	Herb	Sub-alpine to Alpine Himalayas	Ornamental	Nayar *et al.* (1987)

Orchidaceae	*Paphiopedilum farrieanum* (Lindl.) Stein	Restricted areas (1400-2200m)	Herb	Grow on crystaline limestone outcrops in sheltered grassy slopes.	Ornamental	Nayar *et al.* (1987)
Orchidacea	*Aphyllorchis pantlingii* Smith	Lachen valley, Yumthang (3000m)	Leaf less herb	Grows on humus rich black soil under the forest canopy of *Quercus*	Ornamental	Nayar *et al.* (1988)
Orchidaceae	*Cyperipedium himalaicum* Rolfe	Thangu, Lachen (3000-4500m)	Herb (20-40 cm)	On open hill slopes or amidst *Cotoneaster Parnassia* bushes in the subalpine and alpine meadows	Ornamental	Nayar *et al.* (1987)
Orchidaceae	*Cyperipedium elegans* Reichb.f.	Lachen valley (3000- 4000 m)	Herb (10-30 cm)	In shady places or on open hill slopes, near spring along with species of *Cotoneaste*r	Horticultural uses	Nayar *et al.* (1987)
Orchidaceae	*Calanthe alpina* Hook. f. ex Lindl.	Lachen, Zemu (1800-3200m)	Herb	Temperate – sub-alpine, near stream in shady places.	Horticultural uses	Nayar *et al.* (1988)

FUNGI

Hypocreaceae	*Cordyceps sinensis* (Berk.) Sacc.	Jiwanbuti (Nep.) Yarsa gumba (Tib.)	Alpine zone above 4000m	Arrhythmia, chronic nephropathy, chronic nephritis, impotence, emission, neurasthenic rheumatoid, arthritis, cirrhosis, coronary heart diseases, diseases to blood vessels of the brain etc. are major ailments which can be beneficially treated with herb besides its unique property of strengthening the immune system of the body.	Gurung (2002)

Endangered: Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating.

FLORA OF NORTH SIKKIM

VULNERABLE SPECIES

ANGIOSPERMS

FAMILY	TAXA	LOCAL NAME	DISTRIBUTION	LIFE FORM	HABITAT	USES	REFERENCES
Araliaceae	*Panax pseudo-ginseng* Wall.	Paanch pattay (Nep.)	Zemu (3000 m), Lachung valley under Himlock Acre Silver oak community very close to river bed (2900-4000m)	Perennial herb	Sub-alpine to Alpine	It is allied to Korean and Japenese Ginseng (same % of alkaloid) tonic in increasing longivity, mental agility in checking hypertension, cancer etc.	Nayar *et al*.(1990)
Caryophyllaceae	*Arenaria thangoensis* Smith		Thangu (4200m), Chugya (4500m)	Small herb 2-3 cm	Alpine pastures/ slopes, rock craviceps		Nayar *et al*.(1987)
Orchidaceae	*Cymbidium eburneum* Lindl.		Sikkim (300-900m)	Herb	Epiphytic or lithophytic in cool humid forest with moderate rainfall.	Ornamental	Nayar *et al*. (1987)
Orchidaceae	*Paphiopedilum venustrum* (Sims) Pfitz.		Tropical valleys upto1200m	Herb	Grows in moist shady areas preferably near water sources. It is seen growing together with *Selaginella.*	Ornamental	Nayar *et al.* (1987)

Ranunculaceae	*Aconitum ferox* Wall. ex Seringe	Bikhuma	Temperate to Alpine regions (3300-5000m)	Herb	Temperate to alpine forest	Poisonous species, used for curing various diseases, arrow poison.	Nayar *et al*. (1987)
Scrophulariaceae	*Picrorhiza kuroa* Royle. ex Benth.	Kudki (Nep.) Putse sel (Tib.)	Alpine Himalayas (3000-5000m)	Perennial herb	On rocky alpine slopes	Roots: stomachic, cardiotonic antipyretic, antihelminthic, laxative and promotes appetite.	Nayar *et al*. (1987)
PTERIDOPHYTES							
Athyria Ceae	*Athyrium duthei* (Bedd.) Bedd.		Eastern Himalayas	Herb		Academic interest. Confined to Indian region only.	Nayar *et al.* (1988)

Vulnerable: Taxa believed likely to move into the endangered category in the near future if the causal factors continue operating.

FLORA OF NORTH SIKKIM

RARE SPECIES

ANGIOSPERMS

FAMILY	TAXA	DISTRIBUTION	LIFE FORM	HABITAT	USES	REFERENCES
Balanophoraceae	*Rhopalocnemis phalloides* Jungh.	Sikkim Himalayas	Perenial herb.	Grows on diffused sun light in dense evergreen virgin forest floor either solitarily or in clusters on roots of the members of vitaceae.	Not known	Nayar *et al.* (1988)

Begoniaceae	*Begonia rubella* Buch-Ham. ex D.Don	Outer parts of Eastern Himalaya (600-1800 m)	Herb (40 cm)	Grows on moist shady banks at 600-1800 m altitude.	Medicinal	Nayar *et al.* (1990)
Begoniaceae	*Begonia satrapis* Clarke		Herb (24-30 cm)	Grows on slopes of Rangit valley below Badomtam.	Horticultural important.	Nayar *et al*. (1990)
Begoniaceae	*Begonia scutata* Wall.ex DC.	(1000-1500 m)	Herb (7-10 cm)	Grows on moist shady banks.	Horticultural importance	Nayar *et al.* (1990)
Campanulaceae	*Codonopsis affinis* Hook.f. *et* Thoms.	Temperate Himalayas (1830-3335m)	Twinning herb	Temperate Himalayas at elevation between 1830- 3335 m.		Nayar *et al.* (1988)
Juncaceae	*Juncus sikkimensis* Hook. f.	Sikkim (4000-4500 m). So far known from Sikkim only.	Perennial herb	Nothing is known about its ecology. Grows at higher altitude (4000-4500 m).	Nothing is recorded.	Nayar *et al* (1990)
Orchidacea	*Aphyllorchis pantlingii* Smith	Lachen valley, Yumthang (3000m)	Leaf less herb	Grows on humus rich black soil under the forest canopy of *Quercus.*	Ornamental	Nayar *et al.* (1988)
Orchidaceae	*Cyperipedium himalaicum* Rolfe	Thangu, Lachen (3000-4500m)	Herb (20-40 cm)	On open hill slopes or amidst *Cotoneaster Parnassia* bushes in the subalpine and alpine meadows.	Ornamental	Nayar *et al.* (1987)

Orchidaceae	*Cyperipedium elegans* Reichb .f.	Lachen valley (3000- 4000 m)	Herb (10-30 cm)	In shady places or on open hill slopes, near spring along with species of *Cotoneaster.*	Horticultural uses	Nayar *et al.* (1987)
Orchidaceae	*Calanthe manii* Hook. f.	Sikkim	Herb	Not known	Horticultural importance	Nayar *et al.* (1988)
Rubiaceae	*Ophiorrhiza lurida* Hook. f.	Sikkim	Herb	Grows on damp shady mountain slopes at 300 – 1500 m.	Academc interest	Nayar *et al.* (1988)

PTERIDOPHYTES

Hymenophylaceae	*Mecodium levingei* (Clarke) Copel.	Neebay, Lachen (2600 m)	Herb	High altitude filmy fern grows on shady moist rocks, on tree trunks.		Nayar *et al*. (1988)
Thelypteridaceae	*Oreopteris elwesii* (Bak.) Holtt.	Lachen (2700-4200 m) near Changu (3500 m)	Herb	Grows on open hill slopes in high altitude.		

Rare: Taxa with small world population that are not at present endangered or vulnerable, but are at risk. These taxa are usually localised within restricted geographical areas or habitats or are thinly scattered over a more extensive range.

FLORA OF NORTH SIKKIM

INDETERMINATE SPECIES

ANGIOSPERMS

FAMILY	TAXA	DISTRIBUTION	LIFE FORM	HABITAT	USES	REFERENCES
Apiaceae	*Pternopetalum radiatum* (Smith) Mukh.	Yumthang and Sebu valley (3500m)	Herb (30cm)		Not known	Nayar *et al*. (1987)
Apiaceae	*Angelica nubigena* (Clarke) Mukh.	Chola and Yakla passes (3800m)	Herb	Subalpine meadow/ subalpine pastures	Not known	Nayar *et al*. (1988)
Cyperaceae	*Carex kingiana* Clarke	Type collection from Phodong (1700m)	Herb	Not known	Botanical importance	Nayar *et al*. (1988)
Rosaceae	*Cotoneaster simonsii* Hort.ex Baker	Lachung valley (1545-3152m)	Shrub	Subalpine pastures/ slopes	Horticultural importance red edible berries	Nayar *et al*. (1987)

PTERIDOPHYTES

Polypodiaceae	*Christiopteris tricuspis* (Hook.) Christ	Hot valleys	Herb	Not known	Not known	Nayar *et al*. (1988)

Indeterminate: 'Taxa known to Extinct, Endangered, Vulnerable or Rare but where there is not enough information to say which of the four categories is appropriate'. This category is used for species reported as "? Extinct" or 'possibly Extinct' or "probably Extinct" on the assumption that they are either "Extinct or Endangered".

Annexure-II

DISTRIBUTION AND STATUS OF WILD FAUNA OF NORTH SIKKIM

MAMMALS

SL NO.	SCIENTIFIC NAME	COMMON NAME	LOCAL NAME	DISTRIBUTION	STATUS
	THE DOG FAMILY				
1	*Canis lupus chanka*	Tibetan Wolf	Buwaso(Nep.) Chanko,Changu (Lep.)	Yumthang,Lasher valley, Cho Lhamu,Lhonak valley.	Under Schedule 1 of WPA,1991.
2	*Vulpes vulpes montana*	Hill fox or Red fox	Wamu(Nep.)	Along the contours at 5400m. near Gyam Chhona lake. Also sighted near Changri meadow along the Chhomu Chu and near Oloten.	Under Schedule 2 of WPA, 1991.
3	*Vulpes ferrilatus*	Tibetan fox	Bhote Syal(Nep.) Iger (Tib.)	Menphu(Katao), Chho Lhamu, Green Lake in North Sikkim.	Under Schedule 1 of WPA,1991.
4	*Cuon alpinus primavus*	Indian wild dog	Bhoonsa and Jungli kukkur (Nep) Paoho (Bhut.) Suhu-tum (Lep.) Sidda ki and Hazee	Sighted at Chho Lhamu	Under Schedule 2 of WPA,1991.
5	*Canis aureus*	Jackal	Syal (Nep.) Amu (Bhut.)	Common all over the state.	Under Schedule 2 of WPA,1991.
	BEARS AND PANDA				
6	*Ailurus fulgens fulgens*	Red Panda	Hobre and Nigalva Pongwa (Nep.) Sankam(Lep.) Wak donga(Bhut.)	Lachung valley, Lachen, Tong RF in North.	Under Schedule 1 of WPA,1991.

7	*Ursus arctus isabellina*	Brown Bear	Dub and Rato Bhalu (Nep.); Suna (Lep.)	Phuni in Lachung and Green Lake.	Under Schedule 1 of WPA,1991.
	WEASELS				
8	*Martes foina intermedia*	Beech or Stone Marten	Dhunge malsampro (Nep.); Sarik(Lep.)	At elevations ranging between 1800 to 3600 m.Also sighted at Cho Lhamu, Lhonak valley,Kishongla and Samthong.	Under Schedule 2 of WPA,1991.
9	*Martes flavigula flavigula*	Himalayan Yellow throated Marten	Malsampro and Tuturala (Nep.) Sakku (Lep.) Shigsam and Huniah or Uniah(Bhut.)	At elevations ranging between 1200 to 2700m. Ocassionally seen at Yumthang and Yumesamdong.	Under Schedule 2 of WPA,1991.
10	*Mustela sibrica canigula and M.s. subhemachalana*	Himalayan Weasal	Himali Nyal (Nep.) Sang King (Lep.) Zmiong (Bhut.)	Temperate and Alpine forests and in the open grass and scrub above the tree line at altitudes ranging from 1500 to 4800m.	Under Schedule 2 of WPA,1991.
11	*Mustela kathiah kathiah*	Yellow bellied Weasel	Kathiah Nyal (Nep.)	Common at sub-tropical and temperate elevations.	Under Schedule 2 of WPA,1991.
12	*Mustela strigidorsa*	Stripe backed Weasel	Dharke Nyal (Nep.) Sang king (Lep.) Zimiong (Bhut.)	Temperate forests ranging between 1200 to 2100m.	Under Schedule 2 of WPA,1991.
	INSECTIVORES				
13	*Talpa micrura micrura*	Eastern Mole or Indian short tailed Mole	Lede chuchundro (Nep.); Pariam (Lep.) Biyu kantyen (Bhut.)	At altitudes ranging between 1500 to 2400m.	Status unknown
14	*Talpa micrura macrura*	Long tailed Mole	Puchare chuchundro (Nep.); Pariam (Lep.)	At altitudes ranging between 1500 to 2400m.	Status unknown
15	*Crocidura attenuata rubricosa*	Grey shrew	Khairo chuchundro (Nep.)	At sub -tropical and temperate regions of the state.	Status unknown
16	*Suncus murinus soccatus*	Hairy footed shrew	Kesh khutte chuchundro (Nep.)	At sub -tropical and temperate regions of the state.	Status unknown

17	*Suncus etruscus pygmaeoides*	Pygmy shrew	Rato chuchundro (Nep.)	At sub -tropical and temperate regions of the state.	Status unknown
18	*Soriculus caudatus caudatus*	Hodgson's Brown-toothed shrew		At sub-tropical and temperate regions of the state.	Status unknown
	RODENTS				
19	*Ratufa bicolor*	Malayan Giant squirrel	Le-hyuk (Lep.); Shing sham (Bhut.)	Tong RF, Chungthang	Status unknown
20	*Marmota bobak himalayana*	Himalayan marmot	Potsammiong (Lep.) Chibbi (Bhut.)	Cho Lhamu, Lhonak valley, Green Lake, Lasher, Yumesamdong	Under Schedule 2 of WPA, 1991.
21	*Alticola royeli*	Royle's Vole		Occurs in open areas, pastures and rocky tracts above the elevations of 3000 m.	Under Schedule 5 of WPA ,1991.
	HARES AND MOUSE HARES				
22	*Ochotona roylei*	Himalayan mouse hare or Himalayan Pika	Gumchi peechi (Bhut.)	Cho Lhamu, Lhonak valley, Kishongla, Jelepla, Lampokhari, Botangla,Thangu, Samthong and Dzongri.	Under Schedule 4 of WPA,1991.
23	*Ochotona thibetana sikimaria*	Moupin Pika			Under Schedule 4 of WPA,1991.
	HORSE				
24	*Equus kiang polydon*	Kiang or Tibetan wild Ass	Kiang (Tib.)	Cho Lhamu, Gyamchhona, Chulung valley, Yumchho and Kerang.	Under Schedule 1 of WPA ,1991.

	WILD OXEN				
25	*Bos grunniens grunniens*	Yak Wild yak	Chouri gai (Nep.) Dong (Domestic) and Brong dong (Wild) [Tib.]	No longer found in Sikkim.Domestic ones are found in Yumthang, Lachen, Lachung, Cho Lhamu, Lhonak, Lasher, Gnathang, Kupup, Dzongri, and other places of similar elevations.	Under schedule1 of WPA, 1991.
	SHEEPS				
26	*Ovis ammon hodgsoni*	Great Tibetan Sheep	Nayan (Male) and or Nayan [Tib.] Nayanmo (Female)	Bamchhona, Gyamchhona, Kerang, Chulung valley, Cha La, Lhonak valley.	Under Schedule 1 of WPA, 1991.
27	*Hemitragus jemlahicus schaeferi*	Shapi or Eastern Himalayan Tahr	Jharal (Nep.);Siphik (Lep.) Shapi (Bhut.)	An endemic species of Sikkim.Found in areas close to tree limits and snowy mountain tracts.	Under Schedule 1 of WPA,1993.
28	*Pseudois nayaur nayaur*	Blue sheep or bharal	Bharal and nevrati (Nep.) Knao (Bhut.)	Yumesamdong, Sezum Lava, Lasher, Thela, Oloten area, Green Lake	Under Schedule 1 of WPA, 1991.
	ANTELOPES AND GAZELLES				
29	*Nemorhaedus goral hodgsoni*	Goral	Ra giyu (Bhut.) Suh ging (Nep.)	Found in rocky terrain throughout the state at elevations of 1850 to 3700m.	Under Schedule 3 of WPA,1991.
30	*Capricornis sumatraensis thar*	Serow	Tahr(Nep.); Gya (Bhut.)	Found in deep oak forests throughout the state at elevations of 2200 to 3700m	Under Schedule 1 of WPA, 1991.
31	*Budorcas taxicolor taxicolor*	Takin		An occasional migrant inhabiting dense bamboo and Rhododendron forests between 2000 to 3000m.Reported from Nimphu in N. Sikkim.	Under Schedule 1 of WPA,1991.
32	*Pantholops hodgsonii*	Tibetan antelope or Chiru	Chiru (Bhut.) Tsus (Male) and Chus (Female) [Tib.]	Chho Lhamu, and Lhonak valley	Under Schedule 1 of WPA,1991.
33	*Procapra picticaudata picticaudata*	Tibetan Gazelle	Goa (Tib.); Chhang or Nakchu (Bhut.)	Chho Lhamu, Plateau region along Chhomo Chu, the meadow near Gyamchhona (5100m) and in Changri	Under Schedule 1 of WPA, 1991.

				Meadow (4000 to 4500m).	
	DEERS				
34	*Muntiacus muntjak vaginalis*	Barking deer or Muntjac	Ratwa (Nep.) Suko (Lep.); Khasha (Bhut.)	Throughout the state at elevations of 600 to 2800m.	Under Schedule 3 of WPA,1991
	PRIMATES				
35	*Presbytis entellus schistaceus*	Himalayan Langur	Dhedu (Nep.) Kubup (Bhut.); Kamba Suhu (Lep.)	Regions at elevations upto 4000m.	Under Schedule 2 of WPA,1991.
36	*Macaca mullata mullata*	Rhesus monkey	Baadar (Nep.) Piyu (Bhut.); Suhu (Lep.)	Spread at lower and higher elevations of the state.	Under Schedule 2 of WPA,1993.
37	*Macaca assamensis pelops*	Assamese macaque	Baadar (Nep.)	Its distribution ranges from Teesta and Rangit valleys reaching upto heights not less than 3000m.	Under Schedule 2 of WPA, 1991.
	THE CAT FAMILY				
38	*Uncia uncia*	Snow leopard	Hiun tendura (Nep.) Sah and Zig (Bhut.) Phale (Lep.)	Lasher valley, Yumesamdong, Cho Lhamu, near Thangu, Sebu La, Lhonak valley, Seokum Youmchu, Bhamchona, Chulung valley, Nimphu, Kishongla, Rithong, Thosa, Dzongri.	Under Schedule 1 of WPA, 1991.
39	*Felis marmorata charltoni*	Marbled cat		Chungthang at North Sikkim.	Under Schedule 1 of WPA,1991.
40	*Felis lynx isabellina*	Tibetan lynx		Seen around the meadows of Plateau region	Under Schedule 1 of WPA, 1991.

AMPHIBIA

SL. NO.	SCIENTIFIC NAME	COMMON NAME	LOCAL NAME	DISTRIBUTION IN NORTH	STATUS
1	*Ichthyophis sikkimensis*	Sikkimese Caecilian	Not Known		
2	*Scutiger sikkimensis*	Sikkimese Pelobatid Toad		.	Under Schedule 4 of WPA,1993.
3	*Megophrys major*			.	Not Known.
4	*Megophrys parva*			.	Not Known.
5	*Bufo himalayanus*	Himalayan Toad		.	Under Schedule 4 of WPA,1993.
6	*Bufo melanostictus*	Common Asian Toad		.	Under Schedule 4 of WPA,1993.
7	*Euphlyctis cyanophlyctis*	Indian Sikkim Frog		.	Under Schedule 4 of WPA,1993.
8	*Rana livida*	Bright Frog		.	Under Schedule 4 of WPA,1993.
9	*Paa liebigii*	Liebig's Frog	Lhak-pok-thalak(Lep.) Mhun-paha (Nep.)	.	Under Schedule 4 of WPA, 1993.
10	*Rana anandalii*	Annandale's Frog		.	Under Schedule 4 of WPA,1993.
11	*Rana limnocharis*			.	Under Schedule 4 of WPA,1993.

12	*Rana blanfordii*	Blanford's Frog	.	Under Schedule 4 of WPA,1993.
13	*Rana formosa*		.	Under Schedule 4 of WPA,1993.
14	*Rana gammiei*		.	Under Schedule 4 of WPA,1993.
15	*Rana assamensis*	Assamese Frog	.	Under Schedule 4 of WPA,1993.
16	*Rana monticola*		.	Under Schedule 4 of WPA,1993.
17	*Amolops gerbillus*	Gerbill Stream Frog	.	Under Schedule 4 of WPA,1993.
18	*Rana breviceps*		.	Under Schedule 4 of WPA,1993.
19	*Rana polunini*		.	Under Schedule 4 of WPA,1993.
20	*Chaparana sikimensis*	Sikkimese Frog	.	Under Schedule 4 of WPA,1993.
21	*Staurois afghanus*		.	Not known.
22	*Staurois himalayana*		.	Not known.
23	*Philautus anandalii*	Annandale's Bush Frog	.	Under Schedule 4 of WPA,1993.

24	*Philautus dubius*		.	Under Schedule 4 of WPA,1993.
25	*Rhacophorus jerdonii*	Jerdon's Tree Frog	.	Under Schedule 4 of WPA,1993.
26	*Rhacophorus maximus*	Large Tree Frog	.	Under Schedule 4 of WPA,1993.
27	*Polypedates leucomystax*	Six-lined Tree Frog	.	Under Schedule 4 of WPA,1993.
28	*Polypedates maculatus*	Himalayan Tree Frog	.	Under Schedule 4 of WPA,1993.

Annexure-III

Table 1. Edible Wild Plants of the Sikkim Himalayas

Plants	Family	Local Name	English Name	Distribution	Edible Parts	Recipe	Seasons	Consumer	Reference
Abroma angusta Linn.	Sterculiaceae	Sanu kapassi	Devils cotton	3000-4000 ft.	Seeds	Roasted	Oct-Jan	All	3
Acer caudatum Wall.	Aceraceae	Kapasaay	Maple	upto 11000 ft.	Fruits	Yield sugar	Jul-Dec	All	2, 3
Aconogonum molle D. Don	Polygonaceae	Thotnay		4000-7000 ft.	Young shoots	Pickle & chutney	Mar-Oct	All	5
Actinidia strigosa Hk. f & T	Actinidiaceae	Thekiphal		6000-9500 ft.	Fruits	Fruit	Oct-Nov	All	3
Aegle marmelos Roxb.	Rutaceae	Bel	Bel tree/ wood apple	upto 2000 ft.	Fruits	Fruit juice	May-Jun	Nepali	3
Aglaia edulis A.Gray	Meliaceae	Sanu lasune		Upto 7000 ft.	Fruits	Fruit	Mar-Jun	All	3
Amaranthus soinosus Linn.	Amaranthaceae	Dhuti ghans	Prickly amaranthus	3000-5000 ft.	Tender shoots	Vegetables	Jul-Aug	Nepali	3
Ardisia macrocarpa Wall.	Myrsinaceae	Damaiphal		3500-7500 ft.	Fruits	Fruit	Jan-Feb	All	3
Artocarpus lakoocha Roxb.	Moraceae	Barrar	Monkey jack	upto 5500 ft.	Fruits	Fruit	Nov-Dec	All	3
Arundinaria intermedia	Poaceae	Tama	Bamboo	upto 7000 ft.	Young shoots	Curry	Jun-Aug	All	3
Arundinaria maling (Gamble)	Poaceae	Malingo	Bamboo	5000-9000 ft.	Young shoots	Curry	Jun-Aug	All	3
Asparagus racemosus Willd.	Liliaceae	Kurilo	Asparagus	upto 2000 ft.	Fruit and young shoot	Curry	Jun-Aug	Lepcha, Nepali	1
Astilbe rivularies Roxb.	Saxifragaceae	Buriokhati		5000-9000 ft.	Rhizome	Rhizome is eaten as herbal material.	Apr-May	Lepcha, Nepali	5

Baccaurea sapida Muell.	Euphorbiaceae	Kusum		3000-5000 ft.	Fruits	Fruit	May-Jun	All	3
Bauhinia purpurea Linn.	Caesalpinaceae	Tanki	Orchid tree/ Butterfly tree	upto 4000 ft.	Flowers	Pickle	Nov-Dec	All	3
Begonia inflata C.B.Clarke.	Begoniaceae	Magarkache		upto 7000 ft.	Young twigs	Pickle	Apr- Jun	All	6
Bergenia ciliata (How.) Sternb.	Saxifragaceae	Pakhanbeth	Rock foil	5000-12000 ft.	Roots & Rhizome	Pickle	Mar- Apr	All	3
Betula utilis	Betulaceae	Saur		upto 10000 ft.	Bark	Eaten as it is	Apr-Oct	All	1, 3
Bidens pilosa Linn.	Asteraceae	Kuro	Beggars lice/ Spanish needles	upto 5500 ft.	Young shoots	Taste of tea	Mar-Dec	All	5
Calamus erectus Roxb.	Arecaceae	Betphal		upto 4500 ft.	Fruits	Fruit	Feb-Mar	All	3
Calamus flavium Griff.	Arecaceae	Putlibet		upto 4000 ft.	Young shoots/ tender stem	Curry	Jan-Mar	All	3
Callicarpa arborea Roxb.	Verbenaceae	Guenlo		1000-6000 ft.	Fruits	Fruit	Sep-Nov	All	3
Campylandra aurantiaca Wall.	Liliaceae	Nakima		4000-7000 ft.	Inflorescence	Vegetable	Aug-Oct	All	2, 5
Caryota urens	Palmae	Rangbhang	Hill palm/Indian bastard	3000-5000 ft.	Pith/ nuts	Dry fruit	Nov-Dec	All	3
Casearia glomerata Roxb.	Samydaceae	Barkunlay		4000-7500 ft.	Foliage	Vegetable	Jun-Aug	All	3
Cassia fistula Linn.	Caesalpinaceae	Rajbriskh	Indian laburnum	upto 2000 ft.	Pods	Vegetable	Oct-Dec	All	3
Castanopsis purpurella (Miq.) Balakrishnan	Fagaceae	Jat katush	Indian chestnut	1000-4500 ft.	Nut	Dry fruit	Jun-Dec	All	2, 3
Celosia sp.	Amaranthaceae	Lali sag		upto 6000 ft.	Foliage	Vegetable	Mar-May	All	3

Chenopodium album Linn.	Chenopodiaceae	Bethusaag	Wild spinach/ lambs quarters	upto 12000 ft.	Leaves/ twigs	Vegetable	Jul-Aug	All	3
Choerospondias axillaries (Roxb.) Burtt & Hill.	Anacardiaceae	Lapsee	Hog plum	upto 3000 ft.	Fruits (Pulp)	Pickle	Jul-Dec	All	2, 3
Cinnamomum impressinervium Meissn.	Lauraceae	Sinkauli	Cinnamon leaf	Upto 4500 ft.	Dry bark	Condiment	Feb-Jul	All	3
Cinnamomum tamala Nees & Ebesm.	Lauraceae	Tejpatta	Tejpat	upto 3000 ft.	Dried leaves	Condiment	Mar-May	All	3
Cissus adnata Roxb.	Vitaceae	Charcharay		upto 3500 ft.	Berries & leaves	Vegetable	Aug-Sep	All	3
Cissus repanda Vahl.	Vitaceae	Pani lahara		1000-3500 ft.	Fruits	Fruit	Aug-Sept	All	3
Cissus repens Lamk.	Vitaceae	Pureni		upto 2500 ft.	Berries	Fruit	Sep-Oct	All	3
Coffea bengalensis Roxb.	Rubiaceae	Akub fajee rip		upto 3500 ft.	Fruits	Processed into coffee	Jun-Nov	All	3
Corylus ferox Wall.	Corylaceae	Thekiphal		8000-10000 ft.	Fruits	Raw or roasted	Jul-Nov	All	3
Dendrocalamus hamiltonii Nees.	Poaceae	Tama	Bamboo	upto 7000 ft..	Young shoot	Curry/pickle	Jul-Sep	All	3
Dillenia pentagyna Roxb.	Dilleniaceae	Tantri		upto 3500 ft.	Fruits & flower buds	Fruit	Apr-Jun	All	3
Dioscorea bulbifera Linn.	Dioscoreaceae	Bantarul	Bulb bearing yam	4500-10500 ft.	Root stock	Roasted	Jul-Sept	Nepali, Lepcha	3
Diplazium esculentum (Retz)Sw.	Athyriaceae	Ningro	Fern	4000-8000 ft	Young fronds	Vegetable	Feb-Apr	All	3
Diploknema butyracea (Roxb.)Lam	Sapotaceae	Chiuri		upto 4000 ft.	Fruits	Fruits	Apr-Jun	All	2, 3
Elaeagnus conferta Roxb.	Elaeagnaceae	Musledi		4000-6000 ft	Fruits	Fruit/Pickle	Mar-Apr	Nepali, Lepcha	2, 3

Elaeocarpus lanceaeolius Roxb.	Elaeocarpaceae	Bhandrasay		6000-8000 ft.	Fruit	Fruit	Sep-Oct	All	3
Eriolobus indica Schn.	Rosaceae	Mehal		4000-6000 ft	Fruits	Pickle	Mar-Jun	All	3
Evodia fraxinifolia Hk.f.	Rutaceae	Khanakpa		4000-7000 ft.	Fruits	Pickle	Oct-Nov	Nepali.	3
Ficus hookeriana Corner	Moraceae	Nebara		1950-5000 ft.	Fruits	Fruit	Mar-Nov	Nepali, Lepcha	2, 3
Ficus benjamina Linn.	Moraceae	Kabra		4000-10000 ft	Fruits/buds	Pickle	Mar-Apr	Nepali	2, 3
Fragaria nubicola Lindl.	Rosaceae	Bhui aiselu	Wild strawberry	6000-11000 ft.	Fruits	Fruit	Apr-Jun	Nepali, Lepcha	3
Garcinia unotoria (DC)Wt	Guttiferae	Chunyel		upto 5000 ft	Fruits	Fruit	Mar-Apr	All	3
Garuga pinnata Roxb.	Burseraceae	Dabdaby		upto 3000 ft.	Fruits	Fruit	Aug-Sep	All	3
Gaultheria fragrantissima Wall.	Ericaceae	Machino	Wintergreen	6000-8000 ft.	Fruits	Fruit	Sep-Oct	All	3
Girardiana diversifolia (Link) Friss	Urticaceae	Bhangray sishnu		4000-9000 ft.	Inflorescence& young leaves	Soup	Jul-Sep	All	4
Grewia sapida Roxb	Tiliaceae	Kuail		upto 5000ft..	Fruits	Fruit	Feb-Apr	All	3
Gynocardia odorata R.Br	Flucourtiaceae	Bandray/ Gantay		upto 400 ft.	Pulp	Fruit	Aug-Oct	All	3
Heracleum wallichi DC.	Apiaceae	Chimphing	Sikkim herb	8000-13000 ft.	Inflorescence	Pickle	Aug-Nov	All	5
Holboellia latifolia Wall.	Lardizabalaceae	Gofla		4000-10000 ft.	Fruits	Fruit	Oct- Nov	All	3
Hottuynia cordata Wall.	Sauraceae	Hilay jhar		upto 5500 ft	Entire plant is eaten	Curry	Feb-Sep	All	3
Hovenia dulsis Thunb.	Rhamnaceae	Banghi kath		2500-5000 ft.	Fruits	Fruit	Aug-Feb	All	3

Indigofera atropurpurea Horn em.	Leguminosae	Chiringi jhar		upto 5000 ft.	Leaves	Vegetable	Sept-Nov	All	3
Juglans regia Linn.	Juglandaceae	Okhar	Walnut	3000-6000 ft.	Fruits (endosperms)	Dry fruit	Sept-Nov	All	3
Kadsura heteroclita T.ex Benth.	Magnoliaceae	Pattiamilo		upto 8500 ft.	Seeds	Fruit	Aug-Sep	Nepali, Lepcha	3
Leea macrophylla Roxb.	Vitaceae	Bulyettra		upto3000 ft.	Berries	Fruit	Oct-Nov	All	3
Litsea citrata Bl.	Lauraceae	Siltimmur		upto 7000 ft.	Fruits	Pickle	Mar-May	All	3
Maesa chisia D.Don.	Myrsinaceae	Billaunay		2000-6000 ft	Fruits	Fruit	Mar-Aug	All	3
Mahonia nepaulensis DC.	Berberidaceae	Chutro	Berbery	4000-8000 ft.	Ripen berry	Fruit	Feb-Mar	All	3
Malus sikkimensis	Rosaceae	Aiphal			Fruits	Fruit	Sep-Oct	All	3
Mangifera sylvatica Roxb.	Anacardaceae	Chuche aap	Mango	upto 4000 ft.	Fruits	Fruit	Jul-Oct.	All	3
Momordica cochinchinensis Spreng.	Cucurbitaceae	Ban karayla	Gourd	3000-5000 ft.	Fruits	Curry	Jun-Sep	All	3
Morus macroura Miq.	Moraceae	Kimbu	Mulberry	upto 6000 ft	Fruits	Fruit	Mar-May	All	2, 3
Musa balbisiana Colla.	Musaceae	Ban kera	Adams fig	upto 1500 ft.	Fruits	Fruit	Jan-Dec	All	3
Mussaenda ruxburghii Roxb.	Rubiaceae	Dhobiphul		3500-5000 ft.	Buds	Vegetable	Jun-Aug	All	3
Myrica gale Linn.	Juglandaceae	Kaphal	Box myrtle	upto 6000 ft.	Fruits/ Bark	Fruit		All	3
Nasturtium officinale Brown	Brassicaceae	Simrayo	Water cress	upto 12000 ft.	Young twigs	Vegetable	Feb-Dec	Nepali	2, 3
Ophiopogon intermedius D.Don	Liliaceae	Kaligeri		upto 7000 ft.	Flowers & fruits	Curry	May-Sep	All	3

Oxalis corniculata Linn.	Oxalidaceae	Chariamilo	Clover sorrel	upto 6000 ft..	Young leaves & fruits	Pickle	Jan-Dec	All	5
Paeonia emodi Wall.ex Royal	Ranunculaceae	Bhuma madrya		2000-3000 ft.	Shoot	Vegetable	Apr-May	All	3
Pandanus nepalensis St.John	Pandanaceae	Tarika	Screw pine/ Umbrella tree	1500-4000 ft.	Fruits	Pickle	May-Jul	Lepcha	3
Pentapanax leschenaultii Seem.	Araliaceae	Chinday		upto 9000 ft.	Leaf buds	Pickle	Nov-Dec	Nepali	3
Machilus fructifera Kost.	Lauraceae	Pampsi/lapchay kawlo/Famphal		5000-8000 ft.	Fruits	Fruit	Mar-Apr	All	2, 3
Phlogacanthus thursiflorus Nees.	Acanthaceae	Chua/ Titay		2500-4000 ft.	Inflorescence	Vegetable	Jan-Apr	All	3
Phoenix rupicola T.Anders	Palmae	Bedgayra/ Phekray		2001400 ft	Fruits	Fruit	Oct-Nov	All	3
Phylanthus emblica Linn.	Euphorbiaceae	Rukhamala	Emblicmyrobalan tree	upto 4000 ft.	Fruits	Pickle	Nov-Dec	Nepali, Lepcha	3
Physalis peruviana Linn.	Solanaceae	Phakpakay	Sunberry	upto 6000 ft.	Fruits	Fruit	Aug-Nov	All	5
Piper nepalense Miq.	Piperaceae	Bankhorsani		3000-6000 ft.	Fruits	Fruit	Nov.-Dec	All	3
Podophyllum emodi	Berberidaceae	Papri		8000-12500 ft	Fruits	Fruit	Jun-Jul	All	3
Persicaria runcinata (Buch-Ham ex D.Don) H. Gross.	Polygonaceae	Ratnaulo	Herp	8000-11500 ft.	Whole plants	Raw or as vegetables	Feb-Dec	All	3
Prinsepia utilis Royal	Rosaceae	Phekray		4000-10500 ft.	Seed	Seed oil is used	Dec-Mar	All	3
Prunus cerasoides A.DC.	Rosaceae	Paiyon	Himalayan cherry	2500-7000 ft.	Ripened fruits	Fruit	Sep-Oct	All	3
Pyrularia edulis A.DC.	Santalaceae	Amphi		2500-6000 ft.	Fruits	Fruit	Jun-Oct	All	3
Pyrus pashia Ham.	Rosaceae	Naspati	Pears	3000-7000 ft.	Fruits	Fruit	Jul-Sep	All	3

Rheum nobile Hk.f	Polygonaceae	Tohuka		11000-13000 ft.	Leaves	Curry	Jun -Jul	Bhutia, Lepcha	3
Rhododendron arboreum Sm.	Ericaceae	Lali Gurans	Rhododendron	6000-10000 ft.	Flowers	Alcoholic drink	Mar-May	All	3
Rhus javanica Linn.	Anacardaceae	Vhakimlo		3000-7000 ft.	Fruits	Extract	Oct-Dec	All	3
Rosa macrophylla Lindl.	Rosaceae	Bangulab	Rose	4500-5500 ft. from	Fruits	Fruit	Aug-Nov	All	3
Rubus calycinus Wall.	Rosaceae	Aiselu	Berry	upto 6500 ft.	Fruits	Fruit	Jun-Sep	All	1
Rubus ellepticus Sm.	Rosaceae	Aiselu	Raspberry	2000-6000 ft.	Fruits	Fruit	Apr-Jun	All	3
Rubus hookeri Hk.f	Rosaceae	Aiselu	Berry	6000-10000 ft.	Fruit	Fruit	Jun-Sep	Lepcha, Nepali	1
Rubus moluccanus Hk.f	Rosaceae	Aiselu	Berry	upto 6500 ft.	Fruits	Fruit	Jul-Oct	All	2
Rubus niveus Thunb.	Rosaceae	Aiselu	Berry	upto 85000 ft.	Fruits	Fruit	May-Sep	All	1, 2
Rumex nepaulensis Spreng.	Polygonaceae	Halhalay	Yellow dock	6000-7000 ft.	Young shoots	Vegetable	Jun-Aug	All	3
Salmalia malabarica Scott.	Bombacaceae	Simal		2000-4500 ft.	Seeds	Fruit	Apr-May	All	3
Saurauia nepaulensis DC.	Sauruiaceae	Gogun		4000-5500 ft.	Fruits	Fruit	Sep-Nov	All	3
Saurauia punduana Wall.	Sauruiaceae	Ratey gogun		4000-5500 ft.	Fruits	Fruit	May-Jun	All	3
Saurauia roxburghii Wall.	Sauruiaceae	Aulay gogun		4000-5500 ft.	Fruits	Fruit	Feb-Mar	All	3
Schizandra grandiflora Hk.f&T	Magnoliaceae	Singhatta lahara		6000-7000 ft.	Red fruits	Fruit	Jun-Oct	Lepcha, Nepali	3
Shorea robusta Gaertn.	Dipterocarpaceae	Shakhua	Sal tree/Indian dammer	upto 3000 ft.	Seeds	Edible oil is extracted	May-Jun	All	3
Smilex zeylanica Linn.	Liliaceae	Kukurdainy	Greebriet	upto 6000 ft.	Young shoot	Pickle	Feb-Apr	Nepali, Lepcha	5

Sorbus cuspidata Hedl.	Rosaceae	Tenga		8000-11500 ft.	Fruits	Fruit	Nov-Dec.	All	3
Spondias pinnata (L.f.)Kurz.	Anacardaceae	Amaro	Bile tree/Indian hog plum	upto 3000 ft.	Fruits	Fruit	Nov-Dec	All	2, 5
Sterculia roxburghii Wall.	Sterculiaceae	Churiphal		2000-5000 ft.	Fruits	Fruit	May-Jun		3
Swertia chirayita (Rowb.) Karsten	Gentianaceae	Chirowto	Indian gentian	5000-10000 ft.	Dried plants	Herbal material	Sep-Nov	Nepali, Lepcha	2, 3
Syzygium claviflorum Wall.	Myrtaceae	Harey jamun	Jamun	upto 4000 ft.	Fruits	Fruit	Feb-Mar	All	3
Syzygium kurzii (Duthie.)Balakr	Myrtaceae	Ambakay		upto 7000 ft..	Fruits (outer) rind	Fruit	Feb-Apr	All	2, 3
Syzygium tetragonum Wall.	Myrtaceae	Chamlanay		4000-6000 ft.	Fruits	Fruit	Feb-Mar	All	3
Tamarindus indica Linn.	Casalpinaceae	Tittiri	Tamarind	upto 3000 ft.	Fruits (mealy pulps)	Pickle	Nov-Jan	All	3
Taxus baccata Linn.	Taxaceae	Dengray salla	Yew	6000-11000 ft.	Fleshy aril	Fruit	Jul-Oct	All	3
Terminalia bellirica Roxb.	Combretaceae	Barra	Bastard myrobalan	upto 3000 ft.	Fresh or dry fruits	Herbal material	Apr-Jun	All	3
Terminalia chebula Retz.	Combretaceae	Harra	Black myrobalan/ Chebulis myrobalan	upto 2000 ft.	Fresh or dry fruits	Herbal material	Apr-Jun	All	3
Trichosanthes palmata Roxb.	Cucurbitaceae	Indreyni		upto 6000 ft.	Tender shoots	Vegetable	Jun-Aug	Nepali	1
Turpinia pomifera DC.	Staphylaceae	Thali/ Nagpat		4000-7000 ft.	Fruits	Edible oil is extracted	Sep-Dec	All	3
Urtica dioica Linn.	Urticaceae	Ghariya sishnu	Stinging neetle	upto 7000 ft.	Inflorescence & young leaves	Soup	Feb-Oct	All	3
Urtica parviflora Roxb.	Urticaceae	Sishnu	Neetle	5000-12000 ft.	Inflorescence & young	Soup	Jul-Sept	All	5

					leaves				
Viburnum erubescens Wall.	Caprifoliaceae	Asaray		6000-10000 ft	Fruits	Fruit	Sep- Oct	All	3
Viscum articulatum Burm.f	Loranthaceae	Harchoor	Mistle toe	1000-6000 ft.	Dried plants	Herbal material	Jun-Oct	Nepali, Lepcha	3
Wallichia disticha T.Anders	Palmae	Thakal		1000-4000 ft.	Pith/ Fruits	Fruit	Mar- Jun	Nepali	3
Zanthoxylum oxyphyllum Edgew.	Rutaceae	Laharay timmur		upto 9000 ft.	Fruits (Berries)	Pickle	Oct-Jan	All	3
Zanthoxylum rhetsa (Roxb.) DC.	Rutaceae	Timmur		upto 7000 ft.	Fruits	Pickle	Apr-Jul	All	2, 3

All, all ethnic groups of Sikkim.

1, Hara (1966); 2, Bennet (1987); 3, Sundriyal and Rai (1996); 4, Rai *et al*., (1998); 5, Gurung (2002); 6, Rai (2002).

BUTTERFLIES

SL. No.	SCIENTIFIC NAME	COMMON NAME	DISTRIBUTION	STATUS
1	*Parnassius imperator agustus*	Imperial Apollo	North Sikkim	Under Schedule 1 of WPA,1993
2	*Parnassius hardwickii virdicans*	Common Blue Apollo	Found between 2800 to 4200 m, usually in open alpine country or among low growing shrubs and junipers	Status unknown
3	*Pathysa xenocles phrontis*	Great Zebra	Two specimens were seen in Tolung valley	Status unknown
4	*Pathysa macareus indicus*	Lesser Zebra	Tolung valley	Status unknown
5	*Graphium sarpedon sarpedon*	Common Bluebottle	In Himalaya found up to 2000 m sightings made from Mangan, Sankalang	Status unknown
6	*Graphium cloanthus*	Glassy Bluebottle	Common at low elevations up to 1500 m, but also recorded as high as 2800 m sighted in the Teesta and Rangeet valleys	Common between the mentioned elevations
7	*Atrophaneura latreillei*	Rose Windmill	Males have been recorded by Sanders to be common between 1500 m to 2000 m around Chungthang in May and June	Common
8	*Atrophaneura dasarada dasarada*	Great Windmill	Seen in the Teesta valley around Chungthang	Status unknown
9	*Chilasa epycides epycides*	Lesser Mime	A few individuals seen in Mangan, and Tolung valley feeding on the flowers of *Citrus* sp. Recorded up to 1200 m in March and April	Under Schedule 2 of WPA,1993
10	*Chilasa agestor agestor*	Tawny Mime	One individual was seen near Linza in Tolung Valley beating up and down the path, throughout the day but not seen in the same area after two days (Haribal, 1992)	Status unknown
11	*Papilio machaon sikkimensis*	Yellow Swallowtail	A high altitude butterfly, found up to 4800 m. and not recorded below 3000 m in Sikkim collected from Thangu, Nathula, Lohnak and Lachung valleys	Under Schedule 2 of WPA,1993

12	*Princeps protenor euprotenor*	Spangle	Mangan	Status unknown
13	*Princeps alcmenor*	Redbreast	Seen in Mangan,and the Tolung valley	Status unknown
14	*Princeps memnon agenor*	Great Mormon	Found in open forest glades and also around human habitation almost everywhere up to 1800 m	Very common
15	*Princeps helenus helenus*	Red Helen	Common up to 2100 m generally found in dense jungles; also seen around human habitations	Very common
16	*Princeps paris paris*	Paris Peacock	Mangan, Penlong La, etc.	Status unknown
17	*Princeps arcturus arcturus*	Blue Peacock	Found at higher and cooler areas up to 3000m even recorded at 3200 m uncommon in the higher reaches of the Tolung, Teesta valleys	Status unknown
18	*Pieris brassicae nepalensis*	Large Cabbage White	Seen from about 1000 to 4000 m in winter these migrate to the plains of the adjoining areav mostly seen in higher altitudes	Not very common in Sikkim
19	*Appias lalage durvasa*	Spot Puffin	Found up to 2000 m altitude recorded from Teesta valley around Mangan, and the Tolung valley	Status unknown
20	*Cepora nadina nadina*	Lesser Gull	Butterfly of hilly regions with heavy rainfall recorded from the Tolung valley	Under Schedule 2 of WPA,1993
21	*Hebomoia glaucippe glaucippe*	Great Orangetip	Seen up to 2000 m., in Mangan	Status unknown
22	*Delias descombesi descombesi*	Redspot Jezebel	Seen in Mangan	Not very common
23	*Delias agostina agostina*	Yellow Jezebel	Recorded from the Tolung valley	Not very common in Sikkim
24	*Dercas lycoris lycoris*	Plain Sulphur	A single specimen was observed in the Tolung valley feeding on the flowers of *Fragaria* sp.	Rarer than the preceding species
25	*Gonepteryx rhamni nepalensis*	Common Brimstone	Found between 1500 to 3500 m in Himalaya several species were observed in the Tolung valley feeding on the low growing flowers	Common

26	*Cheritra freja freja*	Common Imperial	Flutters weakly at the edge of the jungles and in forest clearings seen in the Teesta Valley at Mangan	Status unknown
27	*Lycaena younghusbandi*	Chumbi Green Underwing	Collected from high altitudes of Sikkim and Chumbi valley	Status unknown
28	*Jamides alecto eurysaces*	Metallic Cerulean	Common around Mangan, and Singhik	Under Schedule 2 of WPA,1993
29	*Albulina pheretes arcaseia*	Azure Mountain Blue	Butterfly of very high altitudes found only from 5000 to 5500m earlier collected from high altitude of Chumbi valley and N. Sikkim	Status unknown
30	*Dodona dipaea dipaea*	Lesser Punch	Common in Sikkim from about 1800 to 3000 m sighted at Gangtok and collected from North Sikkim	Status unknown
31	*Dodona adonira adonira*	Striped Punch	Seen in Tolung valley	Not very common in Sikkim
32	*Abisara fylla*	Dark Judy	Common in densely wooded areas seen up to 2000 m common in Chungthang areas	Common
33	*Melanitis leda ismene*	Common Evening Brown	In Sikkim it is found in the Mangan area	Common
34	*Lethe sidonis sidonis*	Common Woodbrown	Collected in North Sikkim	Status unknown
35	*Lethe nicetella*	Small Woodbrown	A butterfly of temperate region	Under Schedule 2 of WPA,1993
36	*Lethe maithrya*	Barred Woodbrown	A specimen collected from Lachen	Status unknown
37	*Lethe chandica chandica*	Angled Red Forester	Habits similar to those of the Genus observed near Sankalang	Status unknown
38	*Lethe isana dinarbas*	Common Forester	Observed in Gangtok and N.Sikkim, in forested regions	Status unknown
39	*Lethe sinorix*	Tailed Red Forester	In Sikkim it has been collected from Lachen-Lachung valley	Under Schedule 2 of WPA,1993

40	*Zophoessa atkinsonia*	Small Goldenfork	One specimen has been collected from Lachen	Recorded as rare in Sikkim
41	*Zophoessa goalpara goalpara*	Large Goldenfork	An uncommon butterfly of the forested regions between 1000 to 3000 m earlier recorded from Lachen-Lachung valley	Status unknown
42	*Zophoessa baladeva baladeva*	Treble Silverstripe	Flies in the forested areas and along paths and streams sighted in the Tolung valley	Status unknown
43	*Chonala masoni*	Chumbi Wall	A locally common butterfly in the upper Teesta valley	Common
44	*Raphicera satricus satricus*	Large Tawny Wall	A butterfly of temperate regions. Found in the Himalayas between 2500- 3500 m	Under Schedule 2 of WPA,1993
45	*Mycalesis franscica santana*	Lilacine Bushbrown	Found up to 2000 m, three specimens collected from North Sikkim	Status unknown
46	*Orsotrioena medus medus*	Nigger	Very common in Mangan	Common
47	*Ypthima methora methora*	Variegated Fivering	Common in the Tolung valley during April and May	Under Schedule 2 of WPA,1993
48	*Ypthima baldus baldus*	Common Fivering	In Teesta valley it is common up to Chungthang	Common
49	*Callerbia scanda scanda*	Pallid Argus	A very common butterfly along Chungthang to Lachung road in the month of Aug.	Common
50	*Paraoeneis pumilus bicolor*	Mountain Argus	Collected from the northern frontier of Sikkim	Status unknown
51	*Aulocera saraswati*	Striated Satyr	Found in more open areas as low as 1000 m. observed only once at Mangan	Status unknown
52	*Polyura arja*	Pallid Nawab	Seen in the Teesta valley near Sangkalang	Status unknown
53	*Polyura dolon centralis*	Stately Nawab	Abundant near Chungthang between 1500 and 1700 m	Common
54	*Apatura ambica ambica*	Indian Purple Emperor	One specimen seen basking on top of a tree, in the Teesta valley near Mangan	Status unknown

55	*Herona marathus marathus*	Pasha	Fairly common up to about 1800 m in Sikkim seen in Chungthang and Mangan areas	Under Schedule 2 of WPA,1993
56	*Sephisa chandra*	Eastern Courtier	Found in shaded nullahs bordering forested regions and along streams up to 1500 m. observed in North Sikkim	Under Schedule 1 of WPA,1993
57	*Hestina nama*	Circe	Found in both open country as well as forested edges seen in Sikkim up to 2000 m in the Teesta, Rangit and Rangpo valleys	Status unknown
58	*Stibochiona nicea nicea*	Popinjay	Common throughout up to 1500 m very common in cardamom plantations in both north Sikkim	
59	*Penthema lisrada lisrada*	Yellow Kaiser	A few specimens taken by the earlier collectors from Singhik areas between 800 and 1500 m	No current record from Sikkim Under Schedule 2 of WPA,1993
60	*Psuedergolis wedah*	Tabby	Found near streams and shaded nullahs in the forested areas up to 2000 m locally common in the Teesta and Rangeet valleys	Common
61	*Phalanta phalanta*	Common Leopard	Occurs up to about 2000 m, in more open and drier areas and most abundant after the rains in Sikkim it is very common up to Sanklang and Mangan in the Teesta valley	Common
62	*Cirrochroa aoris aoris*	Large Yeoman	Butterfly of more open areas seen up to 1500 m very common in South Sikkim around Mangan	Common
63	*Argyreus hyperbius hyperbius*	Indian Fritillary	Occurs in the hilly regions between 1000 to 3000 m common around fields and open areas of the inner valleys like Chungthang	Common
64	*Childrena childreni childreni*	Large Silverstripe	Occurs from about 1800 to 3000 m higher elevation in Sikkim it occurs Lachen, Lachung, etc.	Status unknown
65	*Melitaea arcesia sikkimensis*	Blackvein Fritillary	A typical high altitude butterfly found above 4800 to 5500 m seen only in North Sikkim beyond Giagong to Chho Lhamu area	Status unknown
66	*Argynnis gemmata altissima*	Mountain Silverspot	Habits are similar to those of the preceding species however found higher than the former but at Giagong both species were found flying together	Under Schedule 2 of WPA,1993
67	*Precis hierta magna*	Yellow Pansy	A butterfly of open grassy patches in the forest clearings and	Status unknown

			fields Occurs up to 3000 m in the Himalayas in North Sikkim it is found in Singhik and Mangan	
68	*Precis orithya ocyale*	Blue Pansy	Occurs up to 2000 m in Sikkim seen in Mangan	Not so common
69	*Vanessa indica indica*	Indian Red Admiral	In Sikkim seen around the Tolung valley, and Mangan in north found in open forest glades, open area, human habitations, and gardens	Status unknown
70	*Symbrenthia hypselis cotanda*	Himalayan Jester	In Sikkim seen in Mangan, the Tolung valley etc.	Status unknown
71	*Doleschallia bisaltide indica*	Autumn Leaf	In Sikkim occurs in the Teesta valley around Mangan, Singhik and also seen in the Tolung valley	Under Schedule 2 of WPA,1993
72	*Kallima horsfieldi*	Blue Oakleaf	Found in heavy forested areas in Sikkim it has been observed in the Tolung valley, where they are locally common	Common
73	*Neptis miah miah*	Small Yellow Sailer	Seen in North Sikkim	Fairly common in Sikkim during summer and Oct.
74	*Pantoporia hordonia hordonia*	Common Lascar	A butterfly of forested area although seen near human habitations found up to 1800 m seen near Mangan in Nov.	Status unknown
75	*Parathyma ranga ranga*	Blackvein Sergeant	Found in evergreen regions up to 1500 m males commoner than females up to Sankalang in the Teesta valley	Common
76	*Parathyma perius*	Common Sergeant	A butterfly of low elevations, found in fairly open country and around human habitations seen around Tashiding and Ryngym monastery in North Sikkim	Status unknown
77	*Parathyma selenophora selenophora*	Staff Sergeant	Occurs up to 1800 m found near streams and rivers four specimens seen near Tolung bridge early in the morning also seen along the Teesta valley	Status unknown
78	*Lebadea martha martha*	Knight	Confined to low elevations recorded to be flying in spring in Sikkim one possible record from Singhik in Nov.	Status unknown
79	*Euthalia franciae franciae*	French Duke	In Sikkim it has been recorded from the heaviest jungles in mid-summer up to 1500 m one specimen has been photographed in the Tolung valley	Under Schedule 2 of WPA,1993

80	*Cethosia biblis tisamena*	Red Lacewing	In Sikkim occurs up to 2000 m common at lower altitudes up to 1400 m around Mangan, Singhik etc.	Common
81	*Parantica melaneus platiniston*	Chocolate Tiger	A butterfly of more forested areas. Seen near Mangan in North Sikkim	Rare in Sikkim
82	*Tirumala septentrionis*	Dark Blue Tiger	Particularly common in the Teesta valley Mangan, and Sanklang	Status unknown
83	*Notocrypta fiesthamelii alysos*	Spotted Demon	A butterfly of forested region collected from Munshithang in North Sikkim	Status unknown

VOLUME - WISE DETAILED CONTENTS

C O N T E N T S

VOLUME-I

INTRODUCTORY VOLUME

VOLUME-II

LAND ENVIRONMENT – GEOPHYSICAL ENVIRONMENT

VOLUME – III

LAND ENVIRONMENT - SOIL

VOLUME – IV

WATER ENVIRONMENT

VOLUME – V

AIR ENVIRONMENT

VOLUME – VI

BIOLOGICAL ENVIRONMENT

TERRESTRIAL AND AQUATIC RESOURCES

VOLUME – VII

BIOLOGICAL ENVIRONMENT

FAUNAL ELEMENTS

VOLUME – VIII

BIOLOGICAL ENVIRONMENT

FOOD RESOURCES

VOLUME – IX

SOCIO-ECONOMIC ENVIRONMENT

VOLUME – X

SOCIO-CULTURAL ENVIRONMENT

EXECUTIVE SUMMARY AND RECOMMENDATIONS