ETHNOBOTANICAL STUDIES AND PHYTOCHEMICAL ANALYSIS OF SELECTED MEDICINAL PLANTS OF SENAPATI DISTRICT, MANIPUR

BY

NELI LOKHO PFOZE

DEPARTMENT OF BOTANY

CENTRE FOR ADVANCE STUDIES

SUBMITTED

IN PARTIAL FULFILLMENT OF THE REQUIREMENT

OF THE DEGREE OF DOCTOR OF PHILOSOPHY

IN BOTANY

NORTH EASTERN HILL UNIVERSITY

SHILLONG, MEGHALAYA, INDIA

AUGUST, 2012

CERTIFICATE OF DECLARATION

I, Mr. Neli Lokho Pfoze hereby declare that the thesis work for the award of the degree, Doctor of Philosophy entitled "Ethnobotanical Studies and Phytochemical Analysis of Selected Medicinal Plants of Senapati District, Manipur" is the record of original work done by me under the joint supervision of Dr. Yogendra Kumar, Associate Professor, Department of Botany, NEHU, Shillong and Professor Bekington Myrboh, Co-Supervisor, Department of Chemistry, NEHU, Shillong. The contents of this thesis work are original and to the best of my knowledge and understanding, it has not been produced elsewhere for the award of any degree under any University or research Institute. Also in the content, I duly acknowledged all the valuable helps, supports and guidaince received from different sources from the beginning till the completion of this work.

This research work is been submitted by me to the North Eastern Hill University, Shillong for the award of the degree, Doctor of Philosophy in Botany on evaluation by the panel of examiners and was found suitable and satisfactory.

28/8/2012

(Mr. Neli Lokho Pfoze)

(Head of the Derpartment)

Head
Department of Botany
School of Life Sciences
N.E.H.U., Shillong-22

28/8/2012

(Supervisor)

Dr. YOGENDRA KUMAR

28/8/12

(Co-Supervisor)

Professor
Department of Chemistry
North Eastern Hill Unive
Shillong 793022

ACKNOWLEDGEMENTS

It is indeed a great pleasure at this very pleasant moment to humbly and sincerely thank God for giving me good health and strength with wisdom and understanding for completing and successfully brings out my research work in time. In fact, I am very much grateful and deeply indebted to acknowledge the valuable services rendering to me by different people during the course of my research work. They are a constant source of inspirations and it is because of their kind cooperation, support, help and guidance that has greatly contributed to the successful bringing out this work in time.

In facts, no word of gratitude is sufficient to express my deep gratefulness to my Supervisor Dr. Yogendra Kumar, Associate Professor, Department of Botany, NEHU and Co-Supervisor Professor Bekington Myrboh, Department of Chemistry, NEHU, Shillong for their constant help and support, guidance and encouragement. Their valuable suggestions, comments and illuminating discussion concerning to my work has given me an overall impetus from the beginning till the completion of this thesis. They are the constant sources of inspiration all throughout my work and without their support, help and guidance, the present work would not have materialised and translated into reality.

I express my deep appreciation and gratitude to Professor N. Venugopal, Head of the Department, Botany, NEHU and to Professor M. S. Dkhar, Ex-Head of the Department for readily providing facilities in the Department thereby helping me to carry out my work smoothly and more efficiently. Also I would like to extend my sincere thanks to all the other faculty members of the Department for rendering their selfless help, support and encouragement in one way or the other and also readily allowing me to avail their Laboratory facilities whenever required for my work.

I wish to extend my sincere thanks to all the non-teaching staffs of the Department for their generous help, kind support and cooperation extended to me in different ways which serves as a source of catalyst for enhancing my enthusiasm and interest in my research work. In this regard, I would like to mention my deep gratitude and appreciation particularly to Dr. Gurung, Herbarium Curator for readily assisting and supporting me in the identification of my plants collected during survey to different villages in the district. I also wish to give my deep appreciation and express thankfulness to my associated Research Scholars and colleagues particularly Nilofer Sheikh, Patinglunlu Panmei and Starwell Paduna for readily extending their help, support and cooperation during the course of my research study.

I also duely acknowledged my gratefulness to the Department of Chemistry and Sophisticated Analytical and Instrumentation Facility (SAIF), NEHU for providing analytical facilities for my work. In this regard, I would like to particularly acknowledge my gratefulness to Dr. Muhammad Rumum and Mr. Andy Nengnong, Senior Technical Assistants, Department of Chemistry, NEHU and Mr. Millford Thangkiew, Senior Technical Assistant, SAIF, NEHU for their kind support and help in completing my analytical works in time. I also express my sincere thanks to Mr. Danny Synnah, Department of Geography, NEHU for his valuable help in drawing

the state maps of Manipur and Senapati district. Further, I sincerely thank to Singhania Printing Press, Shillong for printing and binding the thesis.

Also I gratefully acknowledge to University Grant Commission (UGC), New Delhi for giving financial assistant in the form of monthly stipend through Rajiv Gandhi's National Scholarship for SC/ST candidates and to the administrative staffs of NEHU for timely released of my Fellowship.

Further, I acknowledge my deep gratitude to Botanical Survey of India (BSI), Eastern Circle, Shillong for allowing me to consult their library facilities and herbarium for plants identification and also assessing the progress of my research work for up gradation to SRF in UGC sponsored Rajiv Gandhi's National Scholarship for SC/ST candidates.

My sincere thanks are also to those village elders and local herbal practitioners who readily help me to share information's about the local names of the plants, nature of its uses and also help to obtain plant samples whenever required during my field work. Also, I am very much grateful and deeply indebted particularly to those village headmen for arranging logistic support during my field tour to different villages. Without their help and support, the present investigations would not have been completed.

Last but not the least; I sincerely express my deep gratitude and gratefulness to my beloved Wife Mrs. Kholi Henia Kaje and other family members whose incessant prayers and support, inspirations and parental care rendered to me all throughout my

research work. It is because of their whole hearted sacrifice, help and support that greatly contributed to the successful completion of my work in time.

28/8/2012
Neli Lokho Pfoze

Place: Shillong

Date: 28/8/2012

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVATIONS USED

1. AR-Analytical Reagent
2. BBE-Berberine Bridge Enzyme
3. BBSI-Bulletin Botanical Survey of India
4. BP-Blood Pressure
5. BSI-Botanical Survey of India
6. CNMT- Coclaurine-N-methltransferase
7. CSCoR-Collector Share on Consumer Rupee
8. CYP80B1- Cytochrome
9. DCM-Dichloromethane
10. FL-Fidelity level
11. FA-Flora of Assam
12. FBI-Flora of British India
13. FJ-Flora of Jowai
14. FM-Flora of Manipur
15. FAD-Food and Drug Administration
16. FFM-Forest Flora of Meghalaya
17. FSI-Forest Survey of India
18. ICF-Informant Consensus Factor
19. LR-Laboratory Reagent
20. MN-Name of the local market
21. NATMO-National Atlas and Thematic Mapping Organization

22. NCS-Norcoclaurine Synthase
23. NEHU-North Eastern Hill University
24. NGOs-Non Governmental Organisations
25. NR-Not recorded due to lack of authentic local name
26. 4'OMT-4-O- methyltransferase
27. 6OMT-6-O-mthyltransferase
28. QM-Quantity marketed
29. QHC-Quantity used for HH Consumption
30. QOP-Quantity for other purpose
31. RBSI-Records Botanical Survey of India
32. RP-HPLC-Reverse Phase High Performance Liquid Chromatography
33. SSCoR-Seller Share on Consumer Rupee
34. TLC-Thin Layer Chromatography
35. TQC-Total quantity collected
36. UV-Use-Value
37. VN-Vernacular name

LIST OF PLATES

CHAPTER-I

1. INTRODUCTION

Since antiquity man have relied on nature for their basic needs such as food, shelter, clothing, transportation and medicines as a means for its survival (Cragg and Newmann, 2005). They gathered wild fruits and tubers, hunting animals for food and utilized plant as sources of medicine to ward off diseases or relieving suffering for millennia. By trial and error, man learnt that certain plants were found useful as food while others for curing various diseases or ailments. In this way with the passage of time man was able to distinguish between harmful or poisonous and useful plants. This ultimately gave rise to the field of study which is known as ethnobotany. Evidence of men's dependence on plants for his survival is demonstrated by paleo-ethnobotanical findings from pre-historic archaeological sites (Renfrew, 1963; Smith, 1986). Perhaps as early as the Neanderthal man, plants were believed to have healing powers, but as no mode of recording events existed, there are no data on the methods of treatment practiced in that period (Jain, 1968). Archaeological discoveries of 60,000 years old Neanderthal burial grounds in Iraq point to the use of several plants like marsh mallow, yarrow and groundsel as medicine that still figure in folk medicine.

The uses of plant in traditional medicine systems have been extensively documented in many different cultures and countries of the world such as the Egyptian's Ebers Papyrus dating from 1500 BC; the Chinese Materia Medica Wu Shi Er Bing Fang with the first records dating from 1100 BC, Shennong Herbal (100 BC) and the Tang Herbal (659 AD); the Indian Ayurvedic system that date back to about 1000 BC (Susruta and Charaka); the Tibetan medicine Gyu-shi (four Tantras), etc. Similarly in the Western world, the Greek and the Roman (Greco-Roman) contributed substantially to the rational development of the use of herbal drugs. Important personality in the field includes Theophrastus (300 BC) and Dioscorides (100 AD). Even today, though tremendous advances have been made in the field of technology and biotechnology, about 80% of the people in developing countries still depend on traditional medicine for their primary health care (WHO, 2001; Kim, 2005). Plant products also play an important role in the health care systems of the remaining 20% of the population, mainly residing in developed countries (Cragg and Newman, 2005).

Prior to the introduction of the term ethnobotany, the study of traditional botanical knowledge focused almost entirely on the applications and economic potentials of plants used by native people. Initially the study was known as "Aboriginal botany" (Power, 1873). However, the term ethnobotany was first coined by John William Harsberger in 1895 while he was teaching at the University of Pennsylvania and is derived from two Greek syllables "Othnikos" or "Ethnos" meaning nation or race and "Botanikos" or "Botane" means plants. He defined ethnobotany as "the study of plants used by primitive and aboriginal people" and published the term under the heading "Some New Ideas" and suggested "ethnobotany" as a field which elucidates the "cultural position of the tribes who used the plants for food, shelter or clothing" (Harshberger, 1896). In due course of time after the coinage of the term ethnobotany, the scope of the subject expanded and diversified to covers not only a utilitarian relationship, but also relationships that embrace the symbolic, ecological and cognitive as well as the human-plant relationship in a modern setting (Schultes and Von Reis, 1995; Alexiades, 1996). The study focus on a wide range of products derived from plant sources such as food, medicine, plants used in rituals, coloring agents, fiber, musical instruments, poisons, fertilizers, building materials, etc. It is now developed into a multidisciplinary ethnoscientific field of studies including ethnoecology, ethnomedicine, ethnotaxonomy, etc. as well as the anthropological and botanical study of material culture and subsistence mode. It examines all aspects of the reciprocal relationship between plants and traditional peoples on biodiversity prospecting, conservation and vegetation management. In other words, the study demands a variety of skills, botanical training for identification and preservation of plant specimens, anthropological training to understand the cultural concepts and the perception of plants, linguistic training to transcript the local terms. While taxonomists give emphasis on plants and their habitat, the ethnobotanists in addition to these aspects record the relationship of these plants communities with local population.

Different workers give different interpretations of the definition of ethnobotany. According to Powers (1873) ethnobotany is defined as "Study of all forms of vegetation which aborigines used for commodities such as medicine, food, textiles and ornaments". Robbins *et al.*, (1916) gave a broad definition of ethnobotany as "The discovery and evaluation of the knowledge of all phases of life amongst aboriginal and the influence of the plant environment upon the life, customs, beliefs and history of the tribal people". Twenty five years later, Jones (1941) put forward a more concise definition of ethnobotany as "The study of the interrelationship of primitive man and plants". Castetter (1944) defined ethnobotany as a study of the botany of man in primitive state of culture. Schultes (1962) stated ethnobotany as the "Study of relationships which exist between people of a primitive society and their environment". He further mentioned ethnobotany as "the study of human evaluation and manipulation of plant materials, substances and phenomenon including relevant concepts in primitive and unlettered societies". Ford (1978) developed the science of ethnobotanical study and included the understanding of knowledge system through the uses of anthropological methods. Vartak and Gadgil (1980) stated ethnobotany as "Branch of economic botany, a section of which deals with the role of plants in the life and culture of aborigines and tribal people". Wickens (1990) regarded ethnobotany as the "Study of useful plants prior to their commercial exploitation and eventual domestication". Ethnobotany is also interpreted as "All studies (concerning plants) which describes local people's interaction with the natural environment" Martin (1995). Jain (2001) regarded the study which involved "Total natural and traditional interrelationships between man and plants or man's domesticated animals". According to Pushpangdan and Kumar (2005), the term implies an explanation on local people perspective on culture and scientific knowledge.

Presently, ethnobotany has become increasingly valuable in the development of healthcare and conservation programms in the world (Ballick, 1996). The folk medicines or ethnomedicine of the tribal and other aboriginal communities of the world are mainly based on medicinal plants. The communities are abounding with rich storehouse of traditional knowledge. Though, it has no scientific basis but formed important source for further scientific validation. Today, chemical and pharmacological investigations have added a great deal to the use of medicinal plants by revealing the presence of the active principles and their actions on human and animal systems. These active principles are mostly on a wide variety of plant secondary metabolites such as tannins, terpenoids, alkaloids, saponins and flavonoids. Therefore it is important to understand and identify the phytochemical constituents of local medicinal plants employed by herbalists in the treatment of various diseases or ailments. Because such information will be useful not only for the discovery of new therapeutic agents but also will be highly valuable in validating the actual value of folkloric remedies (Farnsworth, 1966). In fact, all traditional systems of medicine have their root and origin from folklore medicine (Singh *et al.*, 2003). In other words it has been observed that if one wants to discover new herbal drugs, phytochemical and pharmacological studies should be conducted hand in hand with ethnobotanical studies.

In recent time, several biologically active phytochemicals of medicinal value such as quinine, cocaine, reserpine, diosgenin, digotoxin, atropine, ephedrine, vinblastine, etc. are isolated from plant sources based on traditional folklore. It has been estimated that 74% of pharmacologically active plant derived components were discovered after following up of ethnomedicinal use of the plants (Ncube *et al.*, 2008). Many drugs used today are natural products or natural-product derivatives (Jon and Christopher, 2004). Between 1981 and 2002, 5% of the 1,031 new chemical entities approved as drugs by the US Food and Drug Administration (FDA) were natural products, and another 23% were natural-product derived molecules (Newman *et al.*, 2003). In an updated third review version of the first two reviews (1997 and 2003) by Newman and Cragg (2007) analyzing the sources of new drugs from 1981 to 2006, indicates that almost 50% of new drugs introduced during this period had a natural product origin. The potential for finding more compounds is enormous as only about 1% of tropical species have been studied for their pharmaceutical potential (Ameenah, 2006). With the increased awareness of developing countries that their cultural heritage is a great treasure, studies on traditional medicine are

getting more attention. In fact, it is estimated that a total of 60% of the world population and 80% of the population of developing countries still rely on traditional medicines mostly plant based drugs for their primary health care needs (Baker *et al.*, 1995; Shrestha and Dhillion, 2003). In India an account of 70% of the population is dependent on traditional plant based medicines (Gadgil and Rao, 1998).

Of the approximate total flora of 500,000 plant species in the world, India harbors about 45,000 plant species mostly concentrated in three different hotspot regions namely Eastern Himalayas, Western Ghats and Adaman and Nicober Islands. Though the country occupies only 2.5% of the total world's geographical area. However, in terms of plant species richness it accounts 9% of global flora. Also more than 35,000 plant species have being used in various human cultures around the world for medicinal purposes (Farnsworth and Soejarto, 1991; Philip *et al.*, 2009). Further, in the world 10-18% of all plant species are used medicinally (Farnsworth and Soejarto, 1991). The data for India is significantly higher and of the total 17,000 of higher plants, 14% are ethnobotanical plants and 44% of the flowering plants are ethnomedicinal (Shiva, 1996). Moreover, 3500 plant species are used as food by various ethnic tribal communities in different parts of the country (Arora, 1991).

There are 427 tribal communities in India (Irshad Ali and Das, 2003). These communities are derived from six racial stocks viz. Negroid, Proto-Australoid, Mongoloid, Mediterranean, West Breachy and Nordic exists in different parts of the country (Pushpgandhan, 1994). The North Eastern states of India including Sikkim have over 130 major tribes and 300 sub-tribes or groups (Kala, 2005). All this tribal communities of the region have been broadly categorized into two ethnic groups. The Khasi and Jaintia tribes of Meghalaya belong to 'Mon khemar' culture of Austric dialect and the rest of the tribal groups are basically Mongoloid belonging to Sino-Tibeto-Burman group (Ramakrishnan, 1992; Mukherjee, 2005; Dutta and Dutta, 2005). The region is also one of the mega-biodiversity centers' and a hotspot (Mayer *et al.*, 2000). It covers only 7.7% of India's total geographical area but support 47.06% (ca 8000 species) of the country's total higher plant flora. About 31.58% (2526 species) of the region total flora are endemic to the region (Nayer, 1996). A large section of the tribal populations in the region are inhabited in remote areas close to the forests vicinity. They heavily depend on herbal medicine for treating diseases or ailments and other forest resources for their sustenance. It is well acknowledged in literature (Cox and Ballick, 1994; Farnsworth *et al.*, 1985; Kirtikar and Basu, 2001) that the age old practices of using plants to cure numerous ailments by the tribal and aboriginal communities have paved the way to further discovery of many life saving drugs benefiting mankind.

In addition to the use of plants in medicine, wild edible plants also formed an important and indispensable component in the diets of man. It forms an integral part of the culture and tradition of the tribal and many other indigenous or aboriginal communities of the world by providing both nourishment and variety in the diet. Moreover, it also provides rural households with supplemental income opportunities through their sale in the local markets. This dependency is particularly more significant for the poor and marginalized rural families. Although most traditional leafy vegetables have the potential for income generation, but at present due to lack of awareness, it fails to compete with the exotic vegetable crops (Jansen van Rensburg *et al.* 2004, Maikhuri *et al.* 2003, Maikhuri *et al.* 2004). The concept of biodiversity conservation will be more meaningful only when both traditional knowledge about the use of its local flora is properly recorded and documented along with the preservation and management of the resources particularly the threatened and endangered species in a more sustainable way. A number of publications (Grivetti and Ogle 2000; Kala 2007; Maikhuri *et al.* 2000; Ogoye-Ndegwa and Aagaard-Hansen 2003) also emphasized the importance of the diversity and traditional knowledge on the use of these wild food plants in search of new sources of food.

Manipur which is located in the Northeastern region of India is adorned with rich flora and fauna. The floristic composition of the state is Indo-Malayan type (Myers *et al.*, 2000; Mittermeier *et al.*, 2004) ranging from tropical to sub-tropical and temperate deciduous forests reflecting the region's rich floral diversity as well as high degree of endemism including valuable medicinal plants like *Panax pseudoginseng* Wall., *Paris polyphylla* Sm., *Kaempfera parviflora* Wall., *Taxus baccata* Linn., *Mahonia manipurensis* Takeda, *Thalictrum foliolosum* DC. and others. The rich floral diversity of the state are largely due to wide variation in the altitudes (appr. 750-2994 m), topographical features, soil characteristics and climatic factors which favoured the luxurious growth of plants. The richness of the plant diversity is also evident from the use of varieties of wild edible plants, fruits and medicinal plants by the hill tribal communities of the state. The Nagas and the Kukis are the dominant tribal communities in the hill districts of the state and are further categorized into many sub-tribes together accounting to about 29 groups as per the 2001 census.

Although some works on ethnobotanical studies listing wild edible plants,

ethnomedicine and bio-folklore from the state have been reported (Singh and Singh, 1985; Singh *et al.*, 1988; Kumar *et al.*, 1990; Sinha 1996; Chakraborty, 2003; Singh *et al.*, 2003; Ashalata *et al.*, 2005; Devi *et al.*, 2010; Khan and Yadava 2010; Yumkham and Singh 2011), however only few works (Mao 1993; Majumder and Bharroli, 1997; Mao 2003; Sumitra *et al.*, 2009; Salam *et al.*, 2010; Devi *et al.*, 2011) on traditional knowledge of the tribal residing in the hill districts of Manipur have been explored ethnobotanically. Thus, there is still a good scope of ethnobotanical field exploration in the state particularly in the hill districts due to existence of diverse cultures and the presence of rich resources of plants having ethnobotanical value. For the conservation of indigenous knowledge, proper documentation has been suggested (Rao, 2006). Hence there is an urgent need for exploration on traditional knowledge of plant uses, development of data base, strategy for conservation through sustainable use and management of bio-resources. Like any other traditional communities in the region and elsewhere, the traditional knowledge of producing herbal medicine is often closely guarded with utmost secrecy amongst the Nagas and Kukis because they believed that if the knowledge is divulged to others then the healing or medicinal properties would be lost or its potency become less effective. Further, the impact of urbanization coupled with increasing dependence on modern medicine and health care system has been given rise to negligence towards traditional knowledge and thereby leading to rapid depletion of indigenous knowledge on healthcare system. Moreover, there is no written document and transmission of the knowledge is limited through their oral and folklore tradition. Therefore, this factor has partly contributed to the lost of their knowledge on traditional health care system. Further, the environmental scenario of the region in general and the state in particular has been drastically changed due to various anthropogenic interferences. The situation is further compounded by rapid socio-economic, technological and environmental changes. The death of old people and the failures of the younger generations to learn the traditional knowledge have added new challenges to advance the transmission of this valuable knowledge. Thus, survey, collection, identification and documentation of wild edible and ethnomedicinal plants from ethnobotanical approach, diversity assessment and its local availability status, evaluation of the quantum of extraction particularly edible wild plants from its natural habitats, identification and prioritization of species, etc. are extremely important for enhancing the understanding of indigenous knowledge systems, conservation and also in the search for new potential plant sources as drugs and food. In view of this, an attempt has been made in the present study to collect, identify and document not only the diversity of the ethnomedicinal and wild edible food plants in the district but also to assess, evaluate and quantify the local dependency of selected species of edible wild plants as well as to analyse phytochemicals of plant alkaloid on selected medicinal plants.

CHAPTER-II

2. REVIEW OF LITERATURES

2.1. Traditional medicine in ancient cultures: There is a vast literature available on the ancient traditional medicine systems from different regions of the world. For instances, the Egyptians, Babylonians, Greeks, Chinese and people of the Indo-Pakistan having their own characteristic Materia Medica. The Sumerians of the Tigris and Euphrates (presently called Iraq) around 4000 BC from their cuneiform writing on clay tablets are reported to have used opium, liquorice, thyme, mustard and the chemical element sulphur as medicine. The Babylonians who apparently followed the Sumerians in this field added senna, coriander, saffron, cinnamon and garlic were among the other herbs in their formulation (Farooqi and Sreeramu, 2001). The first written records of medicinal plants therapy on clay tablets in cuneiform are from Mesopotamia which dates back to 2600 BC. One of the earliest recorded uses of plants are found in Babylon circa 1770 BC in the Code of Hammurabi, a comprehensive set of civil laws carved in stone listed with several medicinal herbs and in ancient Egypt circa 1550 BC. Medicinal plants from that period, believed to have utility even in the life after dead of the Pharaohs and have been recovered from the Giza Pyramids. Schultes (1960), in his paper mentioned about the ancient ethnobotanical works like those of the Sumerian ideograms, dating back to 4000 BC which refers to uses of plants. The Ebers Papyrus (*Cyperus aquaticus*) written in Egypt about 1500 BC is a rich and one of the oldest survival medical text or ethnobotanical manuscript. It is reported to contain ancient medicinal knowledge since 3000 BC. This medical handbook covered all sorts of illnesses and includes empirical as well as symbolic forms of treatment. It contains about 870 prescriptions and 700 formulae (Okigbo, 2009) including aloe, wormwood, peppermint, henbane, myrrh, hemp, dogbane, castor oil and mandragora. It was the

Arabs who were responsible for the preservation of much of the Greco-Roman expertise. Avicenna, the Persian pharmacist, physician, philosopher and poet contributed much to the sciences of pharmacy and medicine throughout the works such as *Canone medicinae*, regarded as the "final codification of all Greco-Roman medicine". It includes elements of other healing cultures and forms the basis for a distinct Islamic healing system known today as Unani - Tibb. *Allium cepa* (Onion), *Astracantha gummifera* (Tragacanth), *Carthamus tinctorius* (Saf-flower), *Carum carvi* (Caraway), *Ferula assafoetida* (Asofoetida), *Lawsonia inermis* (Henna), *Papaver somniferum* (Opium poppy), *Peganum harmala* (Syrain rue), *Prunus dulcis* (Almond), *Punica granatum* (Pomegranate), *Ricinus communis* (Castor oil plant), etc. are some of the important medicinal plants of the Middle East and Egypt. From these ancient cultures, some of the knowledge reached Mediterranean countries through traders and migrations. It was in Hippocrates (460-377 BC) time that pharmacognosy reached a summit in Greece (Robert and Wink, 1998). Theophrastus (ca 300 to 322 BC), who was philosopher and naturalist was the first to deal with the history of plants which later on helped in the classification of plants including herbs. Pedanius Dioscorides, a Greek physician (ca 40-90 AD) produced 'De Materia Medica' in 78 AD, which was a catalogue of about 600 plants in the Mediterranean. It included illustrations and information on the plants used by the Greeks especially for medicinal purposes. It was also thought that he have taken many of his ideas from India.

Further, Asia represents one of the most important centres of knowledge with regard to the use of plant species for treatment of various diseases. Examples are the Ayurveda, Amchi (traditional healing system of Tibet and mountainous areas of

Nepal), Siddha, Unani and Chinese system of medicinal care (Karki, 2002; Kala *et al.*, 2004). The Chinese Pharmacopoeia, Pen-T Sao Keng Mu, is one of the oldest records of herbal medicine and is reported to have been written by the Chinese Emporer Shen Nung (3737-2697 BC). This ancient record described the used of Ephendra or Mahuang to improve circulation, reduce fevers, help urinary functions, suppress coughs and relieve the lungs of bronchial disorders. Its active ingredient ephedrine (an alkaloid) is now used in modern pharmaceuticals to relieve breathing difficulties and other symptoms of asthma, hay-fever and common cold. Other Chinese sources includes Erh-ya, a book on nature studies written in 3000 BC and also in the book of poems, the Svu-ching of 1000 BC and Ben-tsao and early herbal dating from 1250 AD. In ancient China, medicines were called 'Ben Cao' (Chinese Materia Medica). The oldest herbal medicinal book, Shen Nong Ben Cao was written in the late Han Dynasty. It recorded 365 types of herbs including 252 plants. Till date, approximately 12,807 kinds of medicinal materials from natural sources have been recorded in China. Among them 11,146 are of plant origin (Ming-Wei *et al.*, 2007). The spread of traditional Chinese medicine to most continents has undoubtedly contributed to the current popularity of herbal medicines throughout the world. The most complete reference to Chinese herbal prescription is the Modern Day Encyclopedia of Chinese *materia medica* published in 1977. It lists nearly 6000 drugs out of which 4800 are of plant origin. Examples of famous Chinese medicinal herbs are *Angelica polymorpha* var. *sinensis* (dang gui), *Artemisia annua* (qing hao), *Ephedra sinica* (ma huang), *Paeonia lactiflora* (bai shao yao), *Panax ginseng* (ren shen) and *Rheum palmatum* (da huang).

In India, the history of medicines can be traced back to the oldest repository of human knowledge, the Ayurveda (2500 BC – 900 BC). Ayurveda is derived from the Indían words 'Ayur' (life) and 'Veda' (knowledge or science) and hence Ayurveda means the science of life. It is perhaps the most ancient of all medicinal traditions, probably older than traditional Chinese medicine and is considered to be the origin of systemized medicine. Medicinal preparations in Ayurveda are invariably complex mixtures derived from plant and animal products as well as minerals and metals. Plants form a dominant part of Ayurvedic pharmacopoeia. Ayurvedic materia medica has stated that there is no plant which has got no medicinal value. It is also evident from the story of Vishagacharia "Jibaka" who was asked by his Acharya to collect plant from forest which has got no medicinal value but virtually Jibaka had to return with empty handed. The principles of Ayurvedic medicines and the medicinal uses of plants are contained in thousands of poetic hymns in the Rig Veda. The Ayurveda mentioned several medicinal plants and their uses including the hallucinogenic mushrooms *Amanita muscaria* and *Rauvolfia serpentina* used to treat snakebite, epilepsy, mental disorders, etc. The root of this plant is the source of a very important plant drug reserpine (an alkaloid) widely used as a tranquillizer and hypertensive agent in modern pharmacy. Other famous Ayurvedic medicinal plants includes *Azadirachta indica* (neem), *Centella asiatica* (gotu kola), C*innamomum camphora* (camphor), *Elettaria cardamomum* (ela or cardamomum), *Rauwolfia serpentina* (Indian snake root), *Santalum album* (Sandalwood), *Terminalia* species (myrobolan) and *Withania somniferum* (Aswargandha), etc. After the Vedas about 1000 years later then appeared the two most important works on Indian System of medicines, the Charaka Samhita and Susruta Samhita. The Charaka Samhita, an encyclopaedia of Indian medicine is a comprehensive record of medicinal plants and their uses.

2.2. **Ethnopharmacology and phytochemical investigations:** The medicinal value of plants lies in phytochemical substances that produce a definite physiological action in human body. The most important of these pharmacologically bioactive compounds are alkaloids, phenolic compounds, saponins and terpenoids (Weimann and Heinrich, 1997; Atindehou *et al.*, 2002; Edeoga *et al.*, 2005; Harborne, 1973). For example, antimalarial drug quinine (quinoline alkaloid) was isolated from the bark of *Cinchona officinalis* in 1820 by Caventou and Pelletier. The plant had long been used by the indigenous people in the Amazone region for treating fevers and was first introduced into Europe in the early 1600 for the treatment of malaria. Artemisinin, a sesquiterpene lactone, another potent antimalarial drug isolated from *Artemesia annua* (Quinhaosu) was reported to have been used in traditional Chinese medicine for treating fevers. The analgesic drug morphine isolated from opium poppy, *Papaver somniferum* that have long been used in ancient Mesopotamia, laid the basis for alkaloid chemistry. Evidence has been established for the medicinal use of this plant dated back to 8000 years (Stockwell, 1989; Lewington, 1990). Indole alkaloid antihypertensive agent reserpine was isolated from *Rauwolfia serpentina*. The plant has been used in Ayurvedic medicine for the treatment of snakebite and other ailments. Similarly, ephedrine first isolated from *Ephedra sinica*, a plant long been used in traditional Chinese medicine and the basis for the synthesis of anti-asthmatic agents salbutamol and salmetrol. The anticancer drugs vinca alkaloids i.e. vinblastine and vincristine (a Bis-indole alkaloids) isolated from Madagascar periwinkle, *Catharanthus roseus* which have been traditionally used in various cultures for the treatment of diabetes. An active anti-tumor agent podophyllotoxin, a lignan was also isolated from various species of the genus *Podophyllum*. This plant has long history of medicinal use by early American and Asian cultures including the treatment of skin cancer and warts. Other important examples of plant-derived therapeutic agents which were originally discovered through the study of traditional cures and folk knowledge of indigenous people include aspirin, atropine, colchicine, digoxin, physostigmine, pilocarpine and quinidine (Gelani and Atta-Ur-Rahman, 2005).

Alkaloids are the most therapeutically bioactive compounds found in traditionally used medicinal plants. Many alkaloids have traditionally been used as purgatives, antitussives, sedatives and other treatments for various ailments in the form of medicinal plant extracts (Kutchan, 2000). It also acts as stimulators, inhibitors and growth terminators (Waller, 1978; Nazrullaev *et al.*, 2001). Further a number of alkaloids exhibit the antimicrobial and antiparasitic properties (Caron *et al.*, 1988; Molinski, 1993; Lindsay *et al.*, 2000; Faizi *et al.*, 2003). Moreover, they are also found often toxic to man and many have dramatic physiological activities, hence their wide use in medicine for the development of drugs (Harborne, 1973; Okwu, 2005). In addition to therapeutic agents, plants also provides an important source of toxic bioactive products used by the traditional communities throughout the world for hunting and fishing poisons for millennia and many are used even today. One of the most well documented examples is the curare used by some traditional communities of South America for centuries as arrow poison for hunting. The extract is prepared from the bark of the rainforest vine *Chondrodendron tomentosum* and the most potent constituent in the extract is an alkaloid tubocurarine.

The chemical investigation of plants on scientific lines started from 1800 AD onwards and the important discoveries in this regard were narcotine by French chemist Derosne and analgesic drug morphine by Serturner, a German pharmacist in

1803 from the opium poppy plant *Papaver somniferum* that have long been used in ancient Mesopotamia and laid the basis for alkaloid Phytochemistry. Pelletier and Caventon isolated emetine in 1817 and colchicines in 1819. In 1820, they discovered quinine from the *Cinchona officinalis* bark universally used for treating malarial fever. Other important discovery of alkaloids from vegetable drug includes strychnines-1817; brucine, piperine and caffeine-1819; cinchonine-1820; coniine-1826; papaverine-1821 and thebaine-1835. Alkaloid represents the largest single class of plant secondary substances and the number is growing over the year. The number of plant-derived alkaloids characterized was approximately 1000 in 1950, 3300 in 1973 and by 1989, the Dictionary of Alkaloids (Southon and Buckingham, 1989) listed details of 10,000 alkaloids. Following the dramatic advances in spectroscopic techniques in the past 30 years, an analysis of the NAPRALERT database indicated 26,900 known alkaloid structures from a variety of sources (plant, fungi, marine organisms, mammals, etc.) out of about 150,000 characterized natural products (Cordell *et al.*, 2001).

One of the earliest reported organized efforts to screen plant material for alkaloids was conducted by Webb. The results for a total of 1793 species indigenous to Queensland were reported in 1949 and in 1952. In 1954 Arthur reported the results of screening 205 species of plants indigenous to North Borneo for alkaloids, cyanogenetic compounds, saponins, triterpenoids and steroids. More than 600 different species of Papua and New Guinea plants were examined for alkaloids in the field and reported in 1955 by Webb. Approximately 9% of the species examined in this study contain alkaloids. About 888 different species of higher plants representing 1000 plant extracts were screened for the presence of alkaloids and observed that 202 or 22.8% species were detected with positive test (Smolenski *et al.*, 1972). A total of 56 species representing 46 genera and 31 families were screened of which flavonoids were detected in (55%), alkaloids (55%), steroids or triterpenoids (55%), saponins (33%), tannins (32%), cardiac glycosides (7%) and cyanogenic glycosides (5%) (Bandoni *et al.*, 1971). Fifteen species from the family Chenopodiaceae have been analyzed for their chemical constituents: alkaloids, anthraquinones, coumarins, flavonoids, saponins, sterol and or terpenes and tannins. The result showed that alkaloids are detected 100%, sterol and or terpenes 73%, flavonoids 66%, saponins 66%, coumarins 53%. No anthroquinones were detected in this family (Al-Saleh *et al.*, 1997). About 100 different medicinal plants from Lombok belonging to 48 family and 88 genera were screened for the present of alkaloids and 23% of the plants were tested positively for alkaloids (Surya and Bremner, 2001).

2.3. **Ethnobotanical explorations:** Although the science of ethnobotany or its practical knowledge has been in existence since the beginning of human civilization when people relied more on plants as a way of survival. However, the study developed into a more specialized subject only during the 19th century when botanical exploration reached its peak. Historically, the field of ethnobotany belonged to the explorers and adventurers of Europe who observed and documented the uses of plants by the aboriginal peoples they encountered on their travels. The pioneer worker in this field of study was Hernandery (1570-1575). He studied the flora and fauna of Mexico in relation to human beings and published his works in 16 folio volumes. A number of economically important plants such as tobacco (*Nicotiana* spp.), corn (*Zea mays*), cocoa (*Theobroma cacao*), rubber (*Hevea brasiliensis*), sugarcane (*Saccharum officinarum*), tea (*Camellia sinensis*), coffee (*Coffee arabica*),

etc. that were originally used by the indigenous peoples of both the New and Old Worlds were discovered as a result of ethnobotanical observations and many of these plants were introduced in Europe during the Middle Ages. During the period from 1663-1870, some famous naturalists such as John Josselyn, Charles Darwin, Richard Spruce, etc. also organised expeditions into the New World and recorded ethnobotanical data in a more scientific ways. However, the first modern ethnobotanical work was conducted by Leopold Glueck (Choudhary *et al.*, 2008), a German physician working in Sarajevo and published his work on traditional medicinal uses of plants by rural people in Bosnia (1896). Until 1899, when Bayer introduced aspirin, ethnomedicine was the basis of health care for humankind (Cordell and Colvard, 2012). Towards the beginning of the 20th century, the field of ethnobotany experienced a shift from the raw compilation of data to a greater methodological and conceptual reorientation. This is also the beginning of academic ethnobotany. The founding father of this discipline is Richard Evan Schultes. Since then considerable attentions have been focused not only on how plants are used, but also on how they are perceived and managed, and on the reciprocal relationships between human societies and the plants on which they depend. The first book on ethnobotany "An Introduction to Ethnobotany" was compiled by Faulk (1958) and deals with the goods and services obtained from vegetation, physical and psychological troubles caused by vegetation, influence of man on vegetation by way of destruction, conservation, etc. and relationship of vegetation with human civilization. Another important book "The Nature and Status of Ethnobotany" by Ford (1978) contains 16 papers on various issues of ethnobotany while the concept of ethnobotany has been elaborately dealt with in some of the papers, others are mostly of anthropological origin. By the middle of 1980, ethnobotany had become widely

recognised in the USA and the American based Society of Ethnobiology was formed with first issue of its *Journal of Ethnobiology* was published in 1981. In Europe, the two most important contributions in the field of ethnobotanical studies include ethnopharmacology i.e the scientific evaluation of traditional medicines and palynology (a branch of archaeobotany) or the study of fossilised pollen. The study of this fossilized pollen greatly contributed in the field of palaeoethnobotany. Towards the beginning of the last decade of the 20th century, ethnobotanical studies gathered considerable momentum and is now developed into a truly multidisciplinary field of natural science encompassing a wide range of ethnoscientific botanical studies. The study is now increasingly playing an important role in areas such as bio-prospecting, conservation and sustainable management of the biodiversity resources.

In India, the history of ethnobotanical study is about four centuries old when Garcia (1563) published his 'Os coloquis' giving an account of the indigenous medicinal plants in India, but without using the term ethnobotany. One of the earliest works on ethnobotanical studies in India was compiled by Basu in 1918 on "Indian Medicinal Plants" which he later revised with Kirtikar in 1935. Although the study received more attention in the country since 1920 as more publications on ethnobotanical data on traditional herbal medicine become to intensified, however it was Janaki Ammal in 1954 who first initiated the ethnobotanical studies in the country. She studied subsistence food plants of certain tribal of South India (Ammal, 1955). The famous ethnography (Schultes, 1960) work "Tapping our Heritage of Ethnobotanical Lore" provides a great sense of urgency for the studies and researches into folklore medicine. However, an organized ethnobotanical study in India was carried out by S. K. Jain and his colleagues. They conducted their studies on the tribal people of central India viz., Madhya Pradesh and Bihar in their natural habitats and recorded empirical knowledge about the uses of plants through field observations (Jain 1963b; 1964c; Jain and Tarafder, 1970). During the first three decades of the fifties, sixties and seventies of the 20^{th} century, most of the publications on ethnobotany were small inventories. Since the beginning of the eighties, emphasis has been laid on more specific work like indigenous used of plant in food, medicine, culture and even on faith or tradition related to conservation of bio-resources and a particular disease or ethnic groups. A national level studies on wild edible plants was done by Singh and Arora (1978). In 1981, Jain edited the first book on Indian Ethnobotany "Glimpses of Indian Ethnobotany" which is a valuable compilation of the works of various eminent scholars from different phytogeographical areas of India and is the first book dealing with the Indian Ethnobotany. The book contains tribal uses of more than 1500 plants from different parts of our country. Another important book by Jain (1996) "Ethnobiology in human Welfare" is based on proceedings of the IV^{th} International Congress of Ethnobiology and contains 111 papers grouped into 7 sections namely food, health, conservation and biodiversity, regional studies, methodology, socio-economic aspects and general studies. In 1982, the Department of Environment, Government of India sponsored an "All India Coordinated Research Project on Ethnobiology" and this resulted in publication of over 400 research papers on Indian ethnobotany. A review on the Indian ethnobotanical work of nearly two decades (1982-2000) was conducted by Jain and Srivastava (2001) and recorded 1250 publications with 30 books and 25 theses. Work also has been published on over 125 ethnic groups. Since then starting from the 1970, a number of publications on ethnobotanical studies were reported from different parts of the country.

2.3.1. **Northeast India:** The region has the richest reservoir of plant diversity in India and is one of the 'biodiversity hotspots' of the world. About 50% of the total 17,500 flowering plants in India hails from the region and 40% of them are endemic (Mao *et al.*, 2009). Comparatively ethnobotanical studies in the region are of recent origin and are mostly involved in just listing of the various plants used by different tribes. Although the region harbors a rich heritage on traditional herbal remedies, comprehensive studies on the subject started only in the early eighties. The region including Sikkim is inhabited by over 130 major tribes and 300 sub-tribes or groups (Kala, 2005), however the ethnobotanical studies have been reported from a very limited number of tribes of the region viz. Ler, Mikir, Karbis, Miris, Khasi, Jaintia, Garo, Monpas, Nishi, Apatani, Reangs, etc. (Dutta and Dutta, 2005). Thus, the region still remained largely unexplored mainly due to inaccessibility because of remoteness, difficult terrain, poor communication system and insurgent groups from different communities. Hence, there is still a vast scope for ethnobotanical field exploration in the region.

Few early works on ethnobotanical studies listing wild edible plants and fruits, ethnomedicine and bio-folklore from the region was reported by (Carter and Carter, 1921; Borthakur, 1976). At present a number of published literatures on ethnobotany of various other tribes of the region are available from this part of the country. Saklani and Jain (1989) reported 60 plants of ethnobotanical importance for food and medicine from northeastern India. Tripathi and Goel (2001) studied the ethnobotanical uses of 43 taxa of the genus *Zingiber* from the region. Dutta and Dutta (2005) reported about the uses of 665 species of food plants from the entire north east India. Tushar *et al.*, (2010) also documented about 34 different species belonging to 9 genera of the family Zingiberaceae that are used to treat 25 type of ailments from north eastern region of India. Some ethnic fermented vegetables of the region such as gundruk, sinki, goyang, inziangsang, khalpi, anishi, etc. and fermented bamboo shoot products like mesu, soidon, soibum, soijin, ekung, eup, hiring and lung-siej was reported by (Tamang and Tamang, 2009). Although the traditional knowledge on the use of plants as medicine is fairly well documented in the region, however the knowledge on the use of wild plants as food is very limited. Of late there has been a revival of interest in medicinal and wild food plants during the last few decades among the ethnobotanists. Some recent published works on the ethnobotany particularly the tribal communities of the region were reported by different workers adding more number of plants and newer information about its ethnobotanical uses.

In terms of plant diversity richness among the different states in the region, Arunachal Pradesh is the richest with about 5000 species of angiosperms has been recorded (Haridasan *et al.*, 2003). A fairly good number of published works on ethnobotany from different tribal groups of the state have been reported by different workers. Dam and Hajra (1981) conducted an observation on the ethnobotany of the Monpas of Kameng district, Arunachal Pradesh and enumerated 76 species from 65 genera. About 50 folk medicinal plant species used by various tribes of different ethnic groups like Nocte, Khamti, Tangsa, Singphow, etc., in Tirap district of Arunachal Pradesh was reported by Nath and Bardoloi (1989). Haridasan *et al.*, (1990) also give an account of about 90 wild edible plants along with their distribution zone from Arunachal Pradesh. Chakraborty *et al.*, (2003) reported ethnobotanical information on 35 species of wild edible plants sold in the daily markets of Arunachal Pradesh. Das and Tag (2006) also documented about 45 medicinal plants used by the Khamti tribe in Lohit district of Arunachal Pradesh. About 150 wild plant species are recorded to be used by the Adi tribes in Dehang Debang Biosphere Reserve in Arunachal Pradesh, of which 85 plant species were used as edible (Gajurel *et al.*, 2006). Further, 75 traditional medicinal plants belonging to 37 families used by the Bangnis tribe of the East Kameng district of Arunachal Pradesh was reported by Gupta and Vishal (2006). Khongsai *et al.*, (2011) also study the ethnomedicinal plants used by different tribal communities and reported that 28 species of medicinal plants used by Apatani, Mongpa, Sinpho and Tongsa tribes and 56 species by Padam, Ngishi and I-Idu tribes. The study also focus on the potentials of ethnobotanical research, needs for conservation and documentation of traditional medicinal knowledge. Similar studies on Nishi, Nocte and Apatani tribes of the state were carried out by (Shanker *et al.*, 1998; Bhuyan, 2003; Angami *et al.*, 2006). The nutritive values of 27 most commonly consumed wild edible plants in the Sikkim Himalaya were analyzed and observed that the nutritional contents of these wild edible plants are well comparable with various commercial fruits (Sundriyal and Sundriyal, 2001). In 2004, they presents data on marketing, value addition and management concerns of the wild edible plants of the Sikkim Himalaya and recorded a total of 44 wild edible species that are sold in the local markets. Also a total of 190 wild plant species have been reported from the Sikkim Himalaya, derived from 143 genera and 78 families and accounting for nearly 15% of total edible plants resources of India (Sundriyal *et al.*, 2004). Pradhan and Badola (2008) also reported a total of 118 species belonging from 71 botanical families and 108 genera used as ethnomedicinal by the Lepchas tribe from Dzungo valley in north Sikkim for curing 66 different ailments.

In recent time, a number of published works on ethnobotany mainly the tribal communities in Assam are available in the literature. Devi (2003) reported 156 species including 3 species of fern and 1 species of gymnosperm of wild plants of Sonitpur district of Assam used for food by local inhabitants which includes both tribals and non tribals of the area. An account of 61 species of plant traditionally used as folk medicine to treat different ailments by the inhabitants of Dibru-Saikhowa biosphere reserve of Assam in Northeast India by Purkayastha *et al.*, (2007). Barua *et al.*, (2007) reported 38 species of wild edible plants belonging to 25 families from Majuli Island and Darrang district of Assam. A survey was conducted by Das *et al.*, (2008) in different areas of Barak valley in different seasons of the year to identify the non-conventional edible plants and documented 70 edible plants belonging to 45 families of the flowering plants. Out of which some of the plants are used as edible green vegetables, edible fruits and other purposes. They also reported 107 species of medicinal plants used by different tribal communities from Cachar district of Assam against diseases such as jaundice, diarrhoea, dysentery, cough, malarial fever, skin diseases, etc. Gogoi and Islam (2010) conducted an ethnomedicinal plant survey in upper Brahmaputra valley of Assam and recorded 49 species belonging to 44 genera and 34 families. An updated estimate of wild edible, medicinal and threatened plant species of Assam was conducted by Sarma *et al.*, (2010) using the information derived through meta-analysis and observed that out of the total 3895 plant species recorded from the state, 7.34% were reported to be used as wild edible vegetables, fruits and ethnomedicines. Overall, a total of 286 edible wild plant species belonging to 93 families and 192 genera hitherto unknown or less known to the world are recorded. The estimate also revealed as many as 150 species used in traditional system of medicine. About 27 species were listed in the red data book CITIES and IUCN red list threat categories due to over exploitations and therefore require a strong conservation and protection management. Other important contributors on the ethnobotanical studies of the state include (Biossya and Majumdar, 1980; Hajra and Baishya, 1981; Baruah and Sharma, 1984; Singh *et al.*, 1996; Saikia *et al.*, 2006; Acharyya and Sharma, 2004; Patiri and Borah, 2007; Kar and Borthakur, 2008).

Quite a good number of ethnobotanical accounts have been documented from the state of Meghalaya. One of the first ethnobotanical works in the state was conducted by Joseph and Kharkongor (1981) and reported over one hundred plants of ethnobotanical importance used by the Khasi and Jaintia tribes for medicine, subsidiary food, making implements, musical instruments and religious ceremonies. In the same year they also enumerated about 100 species of folklore medicinal plants which are commonly used by the rural communities of the Khasi and Jaintia Hills people. Kumar *et al.*, (1987) also reported 74 species of ethnobotanical plant used by the "War Jaintia" of Jaintia Hills district. Ahmed and Borthakur (2005) documented a total of 577 species of plant belonging to 375 genera under 146 families used by the Hynniewtreps of Meghalaya as edibles, plant masticatories and ethnoiatrical plants. A total of 249 wild edible plants belonging to 153 genera and 82 families were reported from Meghalaya (Sawian *et al.*, 2007). Also about 110 edible wild plants used by different tribal communities of Meghalaya state was reported by Kayang (2007). Further, Hynniewta and Kumar (2008) also reported about 54 species of medicinal plant belonging to 53 genera and 38 families used as herbal remedies by the traditional healers and village folks in Meghalaya for treating various ailments.

Few works on the ethnobotanical studies of the tribes like Ao, Angami and Rengma of Nagaland was conducted by (Megoneitso and Rao, 1983; Rao and Jamir, 1990; Jamir *et al.*, 1999). Other workers from the state includes Kemp (2003) recorded 9 different species of most commonly used ethnomedicinal plants by the Rengma tribe in Dimapur district, Nagaland. Jamir *et al.*, (2008; 2010) presents an account of the traditional knowledge of Konyak and Lotha-Naga tribes in Mon and Wokha district, Nagaland and documented 53 and 55 species of medicinal plants respectively. An account of 75 species of economic plants belonging to 59 genera and 41 families related to Angami Naga tribe of Nagaland was documented by Barua *et al.*, (2008). These include 31 species of edible food, 19 species of natural dyes, 11 species of fodder, 6 species of timber, 4 species of fish poison, 2 species as fiber and 2 species as gum and oil yielding that are found as weed in the cultivated or open fields.

2.3.2. **Manipur:** In Manipur state, till date there exist some publications pertaining to ethnobotanical studies. Singh and Singh (1985) reported 30 wild edible plants belonging to 24 families from the markets of Manipur valley. This is one of the first reports on ethnobotanical work from the state. However, Sinha (1987) was the pioneer in the field of ethnobotanical study of Manipur and has reported 667 plant species including eight varieties, 442 genera and 117 families of flowering plants. Elangbam *et al.*, (1989) conducted an ethnobotanical survey of Tangkhul Naga tribe of Ukhrul district in Manipur and reported the uses of 36 plant species in their daily life such as medicines, food, fibres and shelter. Kumar *et al.*, (1990) conducted a preliminary screening test to study the presence of phytoconstituents of about 30 plants of Manipur. Out of 30 plants studied, 27 indicated presence of alkaloids, 18 saponins, 14 flavanoids and 9 tannins. Mao (1993) listed 71 wild species of plant having wide ethnobotanical application of the Mao Naga tribe. This formed the first ethnobotanical report on the Mao tribe. Sinha (1996) reported about 1200 species of medicinal plant in his book 'Medicinal Plants of Manipur' of which 430 plant species are found in Manipur and are used by the different ethnic communities in the state. Majumder and Bharroli (1997) reported about 85 species of medicinal plant in the forest areas from the three hill districts of Manipur namely Ukhrul, Chandel and Churachanpur. The paper also described the uses of these plants in the Ayurvedic formulation of the Indian traditional system of medicine. Singh *et al.*, (2003) published a book entitled "Herbal medicines of Manipur" A colour encyclopaedia where the ethnomedicinal uses of 361 plant species were reported. Chakraborty (2003) also reported about 47 wild species of edible plants sold in the local markets in and around Imphal, Manipur. Ethnobotanical studies in the four sacred groves located in the two valley districts of Manipur were reported by Ashalata *et al.*, (2005). The study revealed the therapeutic applications of 120 plant species representing 106 genera and 57 families. This work formed the first ethnobotanical studies in the sacred grove of Manipur. Khan and Yadava (2010) recorded 44 plant species belonging to 24 families from Thoubal district of Manipur used by the herbal practitioners of Meitei, Meitei-Pangal and Loi communites for curing asthma. A total of about 20 species of ferns and ferns-allies belonging to 15 families were documented and categorized into food (4), medicine (5), abrasives (2), manure (3), decoration (7) and ritual ceremonies (2) based on their mode of uses were reported from Manipur by Yumkham and Singh (2011). Jain *et al.*, (2011) also recorded 51 edible wetland species used by indigenous Meitei people for food and medicinal purposes.

Thus it has been observed that most of the ethnobotanical reports from the region involve just listing or documentation of the various plants used by different tribes or indigenous communities. However, to make ethnobotanical work more meaningful and of practical use for human welfare, some new approaches such as critical analysis for new data, prioritization of species, prospect of socio-economic benefits such as through cooperative societies value addition of marketable products and cottage industry (Jain, 2010). Further, many of the known medicinally uses of plants have not been studied empirically in detailed for the phytochemical constituents and pharmacological properties. Therefore selective screening of some locally used ethnomedicinal plants for active principle(s) will be an effective and rational approach in the search for novel plant derived compounds particularly antimicrobial drugs since microbial resistance to many conventional drugs is increasing exponentially over the years. Also such studies will validate the traditional or folklore medicine used in the treatment of various diseases or ailments. Further analysis of the nutritional values of some locally used important edible wild plants will help to identified and prioritized species for bringing into agro-forestry system for sustainable used and management of the resources which at present are highly undervalued.

CHAPTER-III

3. STUDY AREA

3.1. **General view of the state:** Manipur is a small hilly state located north of the Tropic of Cancer between 23°83′ N-25°68′ N latitudes and 93°03′ E-94°78′ E longitudes in the north eastern region of India. It is bounded on the north by Nagaland, on the south by Mizoram and Chin Hills of Myanmar, on the east by Chindwin districts of Myanmar and on the west by North Cachar district of Assam. The state covered a total geographical area of about 22, 327 Km^2 and has an altitudes ranges from 766 m-2994 m above mean sea level. It is almost like a rectangular with a little oval shape valley in NW-SE orientation in the centre encircled by mountain ranges on all sides. The valley covered only 2,067 Km^2 or 9.26% of the total geographical area of the state and is 48.3 Km in length and 32.2 Km in breadth. The remaining 20,260 Km^2 or 90.74% is covered by hills. There are 9 districts of which 5 are in the hills and 4 in the valley. The hill districts are mostly inhabited by the Nagas and the Chin-Kukis comprising 29 different sub-tribes (Scheduled Tribes) as per 2001 census. There are 7 Scheduled Caste communities in the state. The Meiteis and Meitie Pangals who occupied the valley districts are the major ethnic group of the state. In addition there are also a good number of populations of Mayans and the Nepalis immigrants who are settled both in the valley and hills of the state.

3.2. **Geographical features:** The hill ranges of Manipur are consisting of a series of parallel young folded ranges and formed as part of an extension of the eastern Himalayan mountain range. These hill ranges are broadly divided into two groups i.e. the eastern hills and the western hills which lies in the east and the west of Imphal valley respectively. These two groups meet in the southern part of Manipur and extend southwards as the Mizo hills and the Chin Hills. Eastern hills are more or less continuous and run along frontier between India and Myanmar. They are about 200 Km long and 30-50 Km wide. Mapithel, the Chingai, the Mulain, etc. are the important ranges of this group. The average height is 1,500 m. and important peaks include Khanjangbung (2833 m), Siroi (2567 m) and Kachaophung (2498 m). Limestone and shale mainly constitute the rocks of these hills.

Western hills consist of parallel ranges and series of valleys. Total length from north to south is 180 Km. In the north they are about 50 Km width and in south more than 70 Km. Yangpujilong, the Mingthou, Koubru-Laimatal, Khoupum, the Nungba, the Kalanga, etc. are important hill ranges. Mount Tenipu (2994 m) north-west of Mao, Senapati district bordering with Nagaland state is the highest peak in the State. Other important peaks included in these hill ranges are Leikot (2831 m), Tampaba (2664 m) and Koubru (2652 m). Sandstone, shale and clay constitute the rocks in these ranges.

The Barak-Brahmaputra system and Chindwin-Irrawady system drain off the entire State. Dzuko, the Leimatak, the Irang, the Makru and Tuivai flows in north-east and north-west orientation forming subsystem in the western hills and joins the Barak-Brahmaputra system. Imphal River flows through the valley in north-west and south-east directions. Important tributaries are Kongba, Iril, Thoubal, Heirak, Sekmai, Khuga and the Chakpi rivers. It passes through a gorge and flow out of the State to meet Chindwin River in Myanmar and join Chindwin-Irrawady system. The soil is alluvium and peat in the valley while red soil and literate formed the western and eastern hills of Manipur.

3.3. **Floristic diversity:** Manipur lies in the extreme east of India bordering Myanmar and hence falls in the Indo-Burma global biodiversity hotspot (Myers *et al*., 2000). The first man who did the pioneer floristic exploration of Manipur state was G. Watt (1888, 1890). He was deputed as botanist member to the Boundary Commission between Manipur and Burma by the then British Government of India. The second man who studied the flora of Manipur state including Nagaland was C. B. Clarke (1885). In 1889, he published his account as plants of Kohima and Muneypore in the *Journal of Linnean Society*. He reported 1050 flowering plants and ferns spread over 533 genera included in 114 families. Among the plant species, he gives the description of 87 new taxa from the area. He also recorded 422 species from Manipur of which 60 species are represented by ferns, 248 species are from dicots and the rest from Nagaland. However, a more detailed study was made by Deb (1957, 1961a and b) and published his floristic account in *Bulletin Botanical Survey of India* (1961). He reported 2192 plant species in 313 families and 1012 genera ranging from pteridophytes to angiosperms including collection of his earlier predecessors like G. Watt, C. B. Clarke, A. Meebold, F. Kingdon Ward, S.K. Mukerjee, N.L. Bor, etc. In the dictionary of botanical science, 8 species new to India and about 1500 species as new record from Manipur (Deb, 1958a). Singh (1990) studied the flora of Tamenlong district including some ethnobotanical aspects. Altogether 640 species were described of which 566 plants were from the district. Sinha (1996) also reported 1200 species of plant and out of which 430 species have been noted as local medicinal uses and edible including 108 plant species of medicinal importance used by various communities of Manipur. Some of the endemic, rare and endangered plant species reported from Manipur includes *Arisaema wattii* Hook. f., *Iris bakeri* Wallich, *Iris wattii* Baker, *Berberis manipurana*

Ahrendt, *Kaempfera parviflora*, *Mahonia feddei* Ahrendt, *Mahonia manipurensis* Takeda, *Mantisia saltatoria* Sims, *Aconitum nagarum* Stapf, *Hedychium marginatum* C.B. Clarke, *Ascocentrum ampullaceum* Lindley ex Wallich, *Panax pseudoginseng* Wallich, *Potentilla manipurensis* G. Watt, *Renanthera imschootiana* Rolf., *Lilium mackliniae*, *Taxus baccata* Linn., *Zanthoxylum pseudoxyphyllum* Babu, etc.

3.4. **Forest area of Manipur:** According to the State of Forest Report, 2011 released by Forest Survey of India (FSI), Dehradun, Manipur now has a forest cover of 17,090. In other words, the state has lost 190 Km^2 of forest cover, the highest among the northeastern states since the last survey in 2009 (Table-1 & 2). The FSI has attributed the decline of forest covers to "shrinking of shifting cultivation cycle and biotic pressure". The decrease of forest covers in the state is mainly from three hill districts namely Senapati, Ukhrul and Tamenglong while Chandel district has shown a 30 Km^2 increase in forest cover. Among the districts in Manipur, Senapati with 120% lost of forest cover is leading the highest lost follow by Ukhrul with 98% of its total forest area. The rapid depletion of forest cover in the hill districts is mainly attributed due to extensive jhuming cultivation. Within the forest area, 1438.98 Km^2 (8.42%) has been categorized as reserved forest, 4093.05 Km^2 (23.95%) as protected forest and 11557.97 Km^2 (67.63%) as unclassified forest.

Table-1: District-wise forest area of Manipur state

District	Geographical area (Km^2)	Forest cover (Km^2)				%
		Very dense	Moderately dense	Open forest	Total forest	
Bishenupur	496	0	0	20	20	4.03
Chandel	3313	0	734	2065	2799	84.49
Churachanpur	4570	37	1169	3068	4274	93.52
Imphal East	669	0	43	173	216	32.29
Imphal West	559	0	24	30	54	9.66
Senapati	**3271**	**233**	**940**	**1130**	**2303**	**70.41**
Tamenglong	4391	264.	1584	2063	3911	89.07
Thoubal	514	0	4	52	56	10.89
Ukhrul	4544	167	976	2504	3647	80.26
Manipur	**22,327**	**701**	**5474**	**11105**	**17280**	**77.40**

(Source: State Forest Report 2009, FSI, Dehradun)

Table-2: Comparison of forest covers of Manipur state and Senapati district

Year	District	Forest cover (Km^2)				%
		Very dense	Moderately dense	Open forest	Total forest	
2003	Manipur	720	5,818	10,681	17,219	77.12
	Senapati	235	1,004	1,320	2,559	78.23
2005	Manipur	923	5541	10622	17,086	76.53
	Senapati	296	936	1251	2483	75.91
2009	Manipur	701	5474	11105	17,280	77.40
	Senapati	233	940	1130	2303	70.41

(Source: State Forest Report, FSI, Dehradun)

3.5. **Location of the study area:** Senapati is one of the 9 districts of Manipur covering an area of 3271 Km^2. or 14.63% out of the total geographical area of 22,356 Km^2. of the state. The district is located in the northern part of the State in between 24°37" and 25° 25" N latitudes and 93° 45" and 94° 29" E longitudes. It is bounded in the north by Paren, Kohima and Phek districts of Nagaland, in the east by Ukhrul, in the west by Tamenlong and in the south by Imphal valley (Fig.1). The floristic composition of the district is part of the Indo-Malayan type ranges from tropical to sub-tropical and temperate deciduous forests with rich floral diversity including a number of important rare and endemic medicinal plant species such as *Taxus baccata* Linn., *Panax pseudoginseng* Wallich., *Mahonia manipurensis* Takeda, *Paris polphylla* Sw., *Kaempfera parviflora* Wall.ex Baker, *Thalictrum foliolosum* DC., etc.

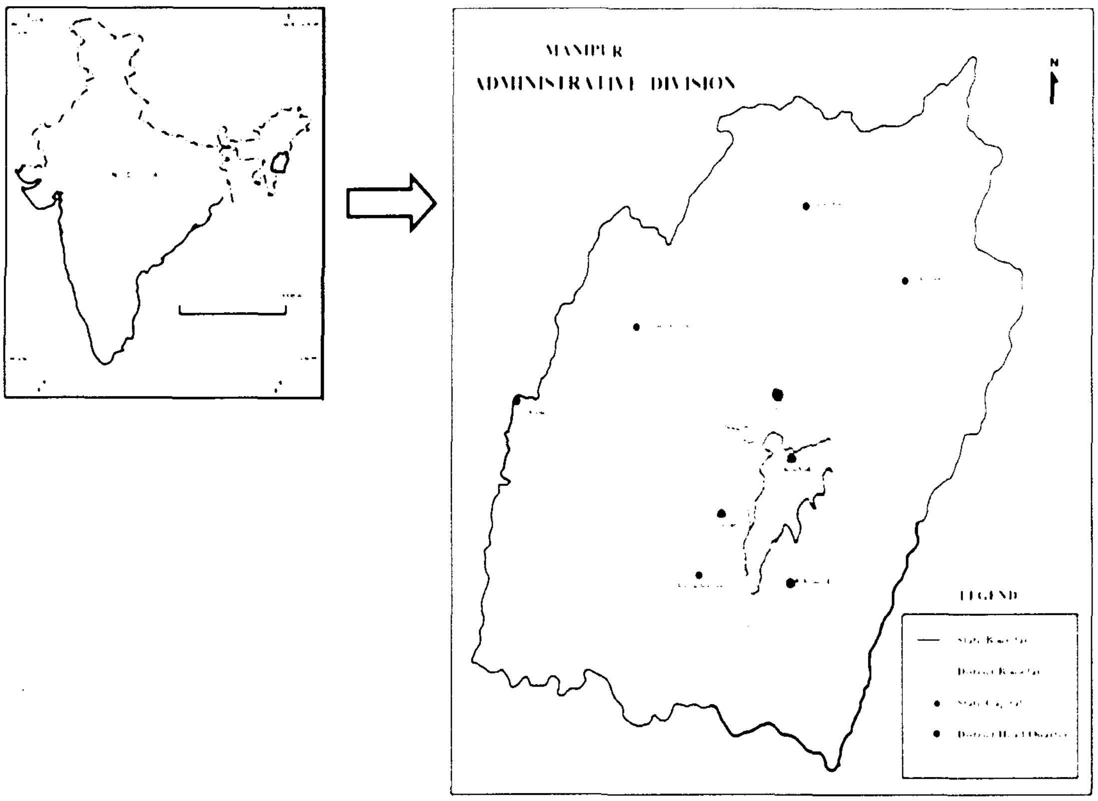


Fig.1. Map showing the location of Manipur state in Northeast India and Senapati

3.6. **Geology and climate of the study area:** Geologically, the region as a whole is formed during the tertiary period. The western part of the district is composed of sandstone, shale, grit and conglomerate. The eastern parts are made up of sandstone, shale and clay. Further, patches of alluvium, sandstone, shale and limestone are also found in the southern part of the district. Regarding soil type, the district is predominantly formed by red sandy soil. Red gravelly and older alluvial soils are also found in patches. Important major rivers in the state such as Barak, Imphal, Iril and Thoubal all originated from the district. The climate in general is cold in winter and temperate in summer with heavy rainfall during Monsoon season (Fig.2). The average annual rainfall and temperature are 135.5 cm and 20° C respectively. The western part of the district is more moist than the eastern for its location on the windward slope of the hills.

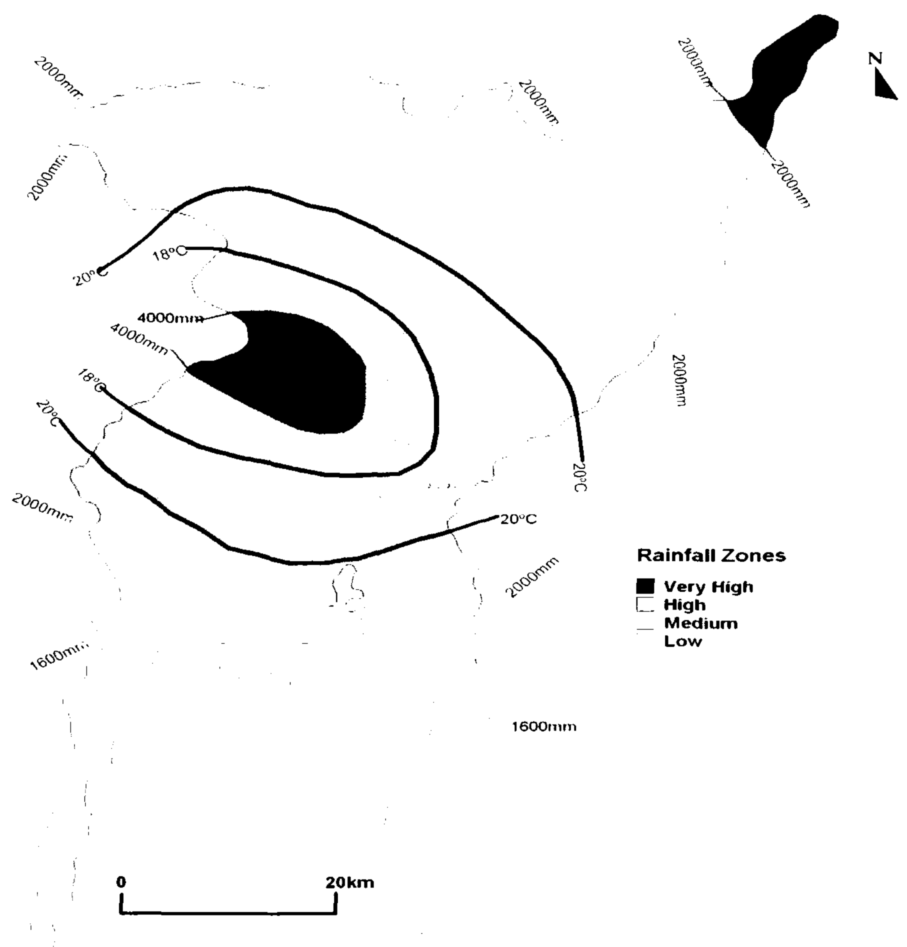


Fig.2. Map of Senapati district showing humidity and rainfall (NATMO).

3.7. **Forest types of Senapati district:** Forest covers the major area of the district. Kozii and Chakha, both located in the north-western and some area of the north eastern part of the district are the important dense forests covered in the district (Fig.3). Based on the ecological classification of Champion and Seth (1968) the forest of Senapati district has been broadly classified into the following three different types.

(a) **Tropical wet evergreen:** This type of forest is mostly confined at an altitude above 1200 m in the north and north-west part of the district with an average annual rainfall of more than 200 cm coupled with high relative humidity. The forest harbors rich tree species diversity and is restricted to inaccessible hills as well as near catchment areas. The ground in this forest is dark and moist due to lofty trees with thick canopy and has thick layer of undisturbed humus. Some important tree species in this forest in the district includes *Michelia champaca* Linn., *Phoebe hainesiana* Brandis, *Elaeocarpus serratus* Linn., *Elaeocarpus floribundus* Bl., *Artocarpus heterophyllus* Lam., *Magnolia griffithii* Hook. f. & Thomson, *Schima wallichii* (DC) Korth., *Prunus cornuta* (Wall. ex Royle) Steud., *Cinnamomum tamala* (Buch.-Ham) Nees & Eberm, *Betula alnoids* Buch.-Ham., *Rhododendron armatum* Sw., *Goniothalamus sesquipedalis* (Wallich) Hook. f. & Thomson, etc.

(b) **Tropical moist deciduous forests:** This type of forests are found at an altitude up to 900 m in the district where the annual rainfall is 150-225 cm with high humidity during the monsoon and is ca 80% in the month of July and August. These forests are characterised by seasonal leaf shedding and profuse flowering of the trees. Important tree species in these forests include *Rhus semialata* Roxb., *Bombax ceiba* Linn., *Ficus auriculata* Lour., *Gmelina arborea* Roxb., *Quercus serrata* non Thunb., *Quercus griffithii* Hook. f. & Thomson ex. DC., *Oroxylon indicum* Vent., *Bauhinia purpurea* Linn., *Bauhinia variegata* Linn., *Castanopsis tribuloides* (Smith) DC., *Melia composita* Willd., *Melia birmanica* Kurz., *Juglan regia* Linn., *Parkia* Lour., *roxburghii* G. Don., *Eurya acuminata* DC., *Alnus nepalensis* Linn., *Ficus auriculata*

Clerodendron colebrookianum Walp., *Schima wallichii* (DC) Korth, etc.

(c) **Montane wet temperate forest:** The temperate vegetation is usually found at an altitude ranging from 1500 m -2500 m and are confined to part of Koupru hill ranges, in the lower hill ranges of Mt. Tenipu (Esii in Mao) and in some pockets of Chilivei and Lapoana circles. These are close evergreen forests with trees of medium height. At lower elevation, the forests show an intermixing of elements from tropical to sub-tropical zones and species composition changes gradually with the increase in the altitude. Sometimes sub-tropical and temperate vegetations occur side by side apparently under similar environmental conditions where the two zones are not well defined. Some dominant tree species found in these forests include *Alnus nepalensis* D. Don, *Betula alnoides* Buch.-Ham. ex D. Don, *Cephalotaxus griffithii* Hook. f., *Eurya acuminata* DC., *Exbucklandia populnea* (R. Br. Ex. Griffith) R. W. Brown, *Lithocarpus dealbata* (Miq.) Rehder, *Myrica nagi* (non Thunb.) Hook., *Prunus cerasoides* D. Don, *Prunus nepaulensis* (Seringe) Steud., *Quercus griffithii* Hook. f. & Thomson ex. DC. and *Rhododendron arboretum* Smith. In some places, species of *Cinnamomum*, *Juglans*, *Magnolia*, *Michelia*, *Quercus*, etc. are also present.

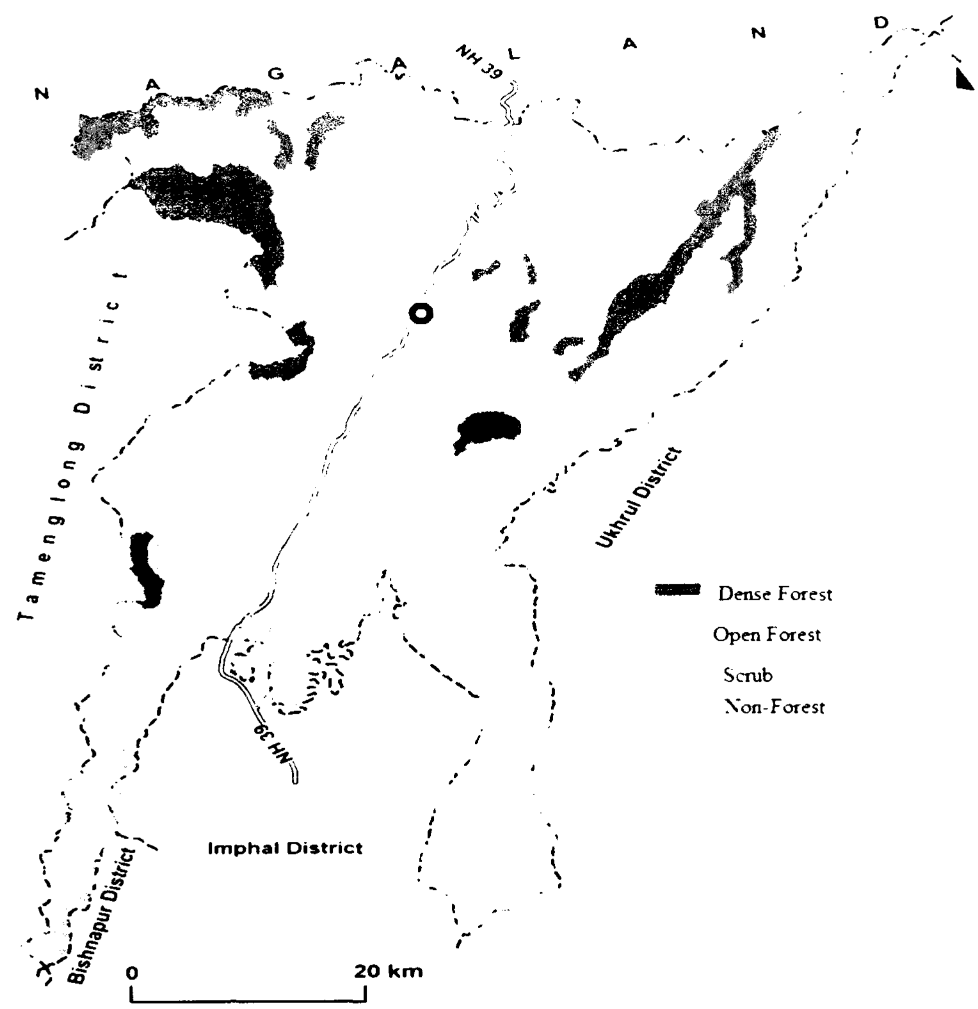


Fig.3. District map showing forest types (www.mapsofindia.com).

3.8. **Inhabitants of the study area:** Senapati district is the smallest in terms of its geographical area but is the most populous among the five hill district of Manipur. The Nagas and the Kukis are the two dominant hill tribal communities inhabiting the district. Ethnically, these two communities are basically Mongloid stock in their origin belonging to the Tibeto-Burman sub-family of the Tibeto-Chinese linguistic group. Both these two tribal communities have distinct cultures and traditions. The Kukis have closer cultural, traditional and ethnic affinity with the people of Mizoram, Chittagong Hills of Bangladesh and the Chins of Chin-Hills in Burma. These two tribal peoples are further consists of several sub-tribes or clans. For instants, the Mao in the north, Poumei in the northeast, Maram in north central, Tangkhul in the east, Zemei and Liangmei in the North West are the dominant sub-tribes of the Naga in the district. Some important Kuki sub-tribes of the district include Haokip, Kipgen, Doungel, Misao, Gangte, etc. and mostly inhabit in the southern part particularly in the Sadar hills area of the district. In addition the non-tribal particularly the Nepali immigrants are also found in good number of population in the district.

CHAPTER-VI

4. WILD EDIBLE AND ETHNOMEDICINAL PLANTS

4.1. OBJECTIVES OF THE STUDY

(a) To survey, collect, identify and to document the diversity of wild edible and ethnomedicinal plants in the study area

(b) Assessment and evaluation of local dependency on selected wild edible plants and fruits

(c) Assessment of local availability status of selected wild edible plants and fruits

4.2. MATERIALS AND METHODS

4.2.1. **Site selection:** A reconnaissance or preliminary survey was conducted in the district in the month of July 2008 and obtained the general physiognomy of the vegetation and identified survey sites or villages based on the accessibility,

Table-3: List of the present study villages with their locations

Name of the village	Location		Altitude (m)	Accuracy (m)
	North	East		
Kayinu	25° 30. 935'	094° 08. 101'	1705	12.8
Chowainu	25° 30. 402'	094° 10. 054'	1613	10.3
Poamata Centre	25° 31. 352'	094° 08. 189'	1817	12.7
Liyai Khullen	25° 27. 847'	094° 16. 183'	1905 ·	15.4
Emeifiithumei	25° 28. 365'	094 05. 102'	1678	13.8
Maopondung	25° 28. 220'	094 05. 915'	1665	10.4
Karong	25° 18. 244'	094 02. 620'	1016	9.9
Okhro-Ekhro	25° 31. 400'	094 07. 696'	1820	9.6
S. Bungnom	24° 59. 364'	093 54. 050'	874.9	9.9
Motbung	24° 59. 364'	093 54. 050'	874.9	9.9
Changlobung	25° 10. 975'	093 58. 594'	1120	11.9
Rikhumei Taphou	25° 15. 857'	094 01. 069'	1082	10.0
Phoibung	25°06. 997'	093 55. 640'	1232	13.2
Upper-Khabung	25° 18. 960'	094 03. 997'	1649	8.4
Phaijang	24 59.363'	093 54.049'	885.6	8.5

availability of local informants or traditional practitioners and the willingness of the village community to extend support to the present investigation. The present ethnobotanical study covers altogether 14 villages of both the Naga (9) and Kukis (5) that spread across the district (Fig. 4). List of the villages surveyed, its location and altitude is presented on the (Table-3).

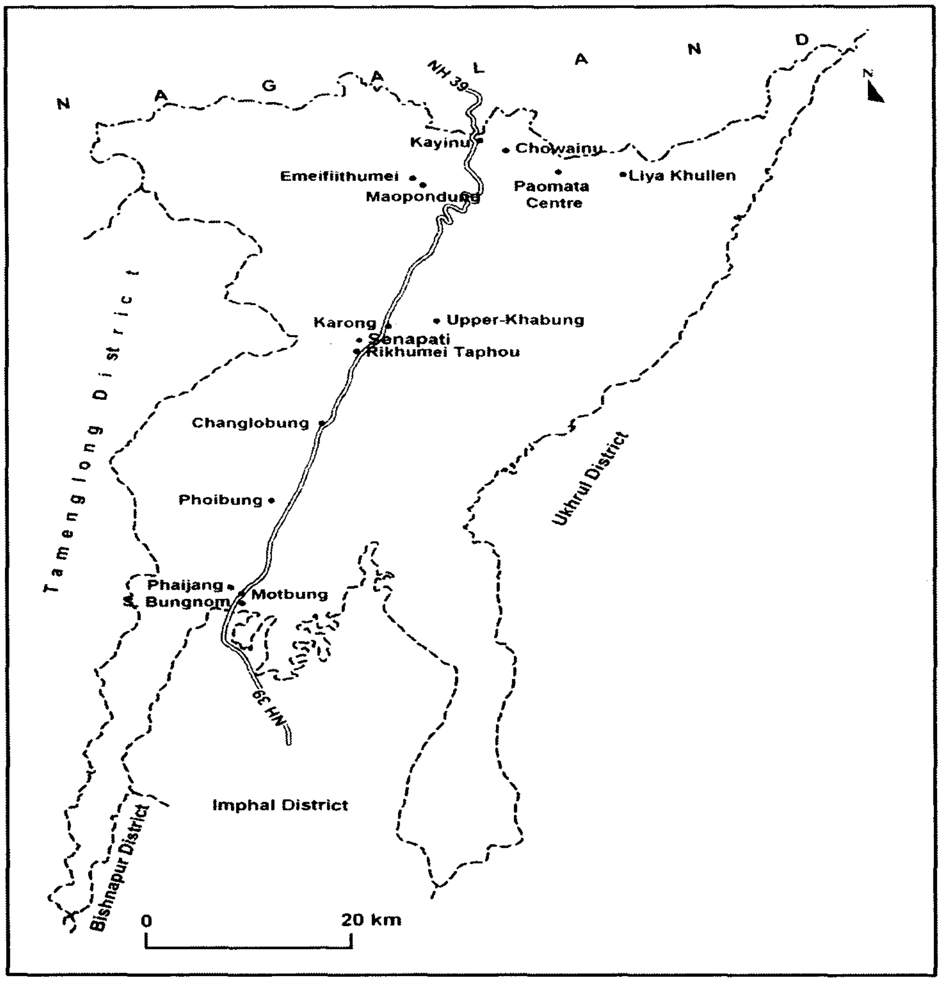


Fig.4. District map showing different study sites.

4.2.2. **Data collection:** The data on wild edible and ethnomedicinal plants were collected following the methods like focus group discussion, key informant, structured and semi-structured interviews. A pre-designed format as shown in data sheets (A, B, C and D) and field note book were used to records the data. Before a formal interview was conducted, verbal or prior informed consent was sought and obtained from the concern village Chief or Chairman as well as the concern individual practitioners by briefing clearly about the objectives of the study to them. After obtaining the formal consent, the informants were gathered in one place (usually in community hall) and the interview was conducted to collect relevant data as shown in the data sheet. Wherever possible the informants were asked to collect and bring a plant samples which they used as medicine or as edible for easy identification and also to prepare for herbarium specimens. Moreover, the morphological characteristics, habit and habitat, phenology and fruiting period of the plant used were observed and recorded in the field note book.

4.2.3. **Plants collection and identification:** Voucher specimens were collected during field survey to different villages, allotted collection number, washed, poison with 10% Formalin and pressed for future identification when returned from the field. GARMIN GPS 76 was used for taking the readings of latitudes, longitudes and altitudes of all the villages where the study was carried out. The collected plants were identified by consulting various regional and state floras including Flora of British India (FBI) Vols 1-7 (Hooker, 1872-1897), Flora of Assam (FA) Vols1-5 (Kanjilal *et al.*, 1934-1940), Flora of Jowai (FJ) Vols 1-2 (Balakrishnan, 1981 & 1983), Forest Flora of Meghalaya (FFM) Vols 1-2 (Haridasan and Rao, 1985 & 1987), Flora of Manipur (FM) Vol. 1 (Singh *et al.*, 2000), species of the families Zingiberaceae and Costaceae of South India (Sabu, 2006), already identified herbarium specimens from BSI herbarium, Eastern Circle, Shillong and from NEHU herbarium. The identified voucher specimens were deposited at the NEHU herbarium.

4.2.4. **Market survey:** Market surveys were carried out by visiting four different local markets namely Mao Gate, Senapati (District HQ), Kangpokpi and Motbung with a data sheet on market survey (B) for collecting data on wild edible plants and fruits from local vegetable vendors and sellers during weekly market day. The survey was conducted 6 times in two consecutive years i.e. March-April, July-August and December-2008; January-February, August-September and December- 2009. This was done so as to establish the different edible species of wild food plants available in the local markets in different seasons of the year. A total of 48 vegetable sellers or vendors (44 women and 4 men) with an average age of 43.8 years were interviewed (Table-4). During the survey the data such as local name, place of collection, rate per unit in kg, varieties of edible species, local availability status according to informant's perception, age and sex of the vendors or sellers were noted and recorded along with relevant photographic pictures. Further to support, verify and supplement the market data particularly prices of the vegetable items, a number of collectors and local farmers were also interviewed to obtain more authentic information on the data.

Table-4: Number of sellers or vendors interviewed during markets survey

Names of the market surveyed	No. of Sellers or Vendors interviewed	Sex		Average age
		Male	Female	
Mao Gate	14	1	13	41.6
Senapati (HQ)	13	Nil	13	48.3
Kangpokpi	11	2	9	39.8
Motbung	13	1	12	45.4
Total	48	4	44	43.8

4.2.5. **Household survey, a case study:** A household survey was conducted in three localities from two different villages of the Mao tribal community in order to assess and evaluate the local dependency on selected wild edible plants during the period from January 2009 to December 2009. Out of the total 218 households in the two villages, about 126 households (57.8%) were surveyed. The survey was carried out following a pre-designed format as shown in (Data sheet-C). The format was distributed to every household to record the data such as quantum of extraction, amount used for household consumption, amount marketed, rate per unit in kg and name of the local market where the collections were sold. The recorded data for each household was supervised at regular intervals (on monthly basis) by one literate person (10+2 standard passed) from the same locality engaged by the author. Before the data collection was initiated, the author has trained the supervisors and clear instructions were given to every household member who would enter the relevant data. The supervisors were entrusted the responsibilities of overseeing and supervising their respective localities/villages for the proper entering and record keeping of the data format provided to them.

4.2.6. **Calculation of Mean Price Value:** The mean value of the prices received by the collectors and vendors or sellers for a particular vegetable item or fruit was calculated following simple statistical formula using the software tool MS Office Excel 2007:

Mean value, MV = $\sum Af_a + Bf_b + Cf_c \ldots\ldots Zf_z/N$; Where, A, B, C.....Z etc. represents the variable of selling rates of a particular wild edible vegetable or fruit (Rs. kg^{-1}); f_a, f_b, $f_c \ldots\ldots f_z$ are the variable frequencies of selling rates of a particular item and indicates the total number of collectors and vendors or sellers interviewed for that particular item.

4.2.7. **Calculation of CSCoR and SSCoR percentage:** Calculation of percent profit sharing on the sale of wild edible plant resources between the collectors and sellers on the consumer rupee was done following Bisht *et al.*, 2005.

4.2.8. **Assessment of local availability status:** It is an undeniable fact that the local people have the best knowledge about the flora in their localities. Preliminary assessment of the local availability status of selected species of wild edible plants and fruits according to local people's perception is an important tool and should form an integral part for ethnobotanical field investigation. This exercise is more relevant from the perspective of identification and prioritization of species for conservation and sustainable management of biodiversity resources (Pfoze *et al.*, 2011). Considering this, the following criteria were designed to assess and determine the overall local availability status (village vicinity/forest area) of the selected species in the study areas based on consensus of the informant's or collector's perception conducted during the interviews and group discussion with the local people.

Abundant: Reported from all the villages under study as abundant or common

Common: Reported from all the villages under study and recorded as common by more than 50% but less than 100% of the villages

Not so common: (a) Not reported from all the villages under study and recorded as common by less than 50% of the villages surveyed.

(b) Reported from all the villages under study but recorded as common by less than 50% of the villages surveyed.

Rare: Reported by one third or less from the villages under study and recorded as few plants or less from the locality or surrounding village vicinity.

4.2.9. **Informant consensus on ethnomedicinal plants:** This technique was employed to evaluate the reliability of the information on ethnomedicinal plant uses recorded during the previous interview. During the second field trip, the same questions from the previous interview schedule were asked to the same informants

(Herbal Practitioners) to compare and verified whether the information obtained from the two interviews were in agreement with each other or not. The final data recorded in this method were taken into account for analysis. Moreover, the information given by different informants to treat a given ailment were also cross checked and enumerated to identify the most popularly used medicinal plant species. This method was adopted from Alexiades (1996).

4.2.10. **Data analysis**

(a) **Informant Consensus Factor (ICF):** For data analysis, informant consensus factor (IFC) and relative importance of plant use according to (Heinrich *et al.*, 1998; Gazzaneo *et al.*, 2005) was employed to identify the agreement of the informants on the reported cures for the group of ailments. All citations were placed into ailment categories for which the plant was claim to be used. ICF values will be low (near 0) if plants are chosen randomly, or if informants do not exchange information about their use. Values will be high (near 1) if there is a well defined selection criterion in the community and/or if information is exchanged between informants. The ICF is calculated as in the following formula:

$$ICF = Nur - Nt/Nur{-}1,$$

Where Nur is the number of use citations in each ailment category and Nt is the number of species used.

(b) **Use-Value (UV):** A quantitative method that demonstrates the relative importance of species known locally was also calculated as according to (Phillips *et al.*, 1994) in the following formula.

$$UV = \sum U/N,$$

Where, UV is the use value of a species, U the number of citations per species; N the number of informants. Use values are high when there are many use-reports for a plant and low when there are few reports related to its use.

(c) **Fidelity level (FL):** The fidelity level (FL), the percentage of informants claiming the use of a certain plant for the same major purpose, was calculated for the most frequently reported diseases or ailments as:

$$FL\ (\%) = Np/N \times 100,$$

Where Np is the number of informants that claims a use of a plant species to treat a particular disease, and N is the number of informants that use the plants as a medicine to treat any given disease (Alexiades, 1996). The plant species with the highest FL value is considered as the most preferred species for a given ailment category.

.2.11. DATA SHEETS ON WILD EDIBLE AND ETHNOMEDICINAL PLANTS

(A) Data sheet for collection of wild edible plants and fruits

1. Local/Vernacular name........................ and Voucher /Collection No..........

2. Plant identified as .... (Botanical name)

3. Community: (Mao/Poumei/Kuki)

4. Place of collection .... (Name of the village)

5. Informants profile:

Name	Sex (M/F)	Age	Occupation
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

6. Marketable status (Yes/No)

7. Mode of uses: ....

8. Availability period

(i) From .... to .... (Mention name of the months)

(ii) Round the year

9. Local availability status:

a. Abundant b. Common c. Not so common d. Rare

10. Medicinal food remedy if any: (Yes/Not) .... (specify)

Date: ....

(B) Data sheet on market survey

1. Name of the market ....

2. Local/Vernacular name ....

3. Plant identified as .... (Botanical name)

4. Place of collection .... (Name of the village)

5. Seller profile:

	Name	Sex (M/F)	Age
a.	....	....	....
b.	....	....	....
c.	....	....	....
d.	....	....	....
e.	....	....	....
f.	....	....	....

6. Price/rate per Kg.

(a) Collector selling rate (in Rs.): i .... ii .... iii .... iv. ....

(b) Seller selling rate to customers (in Rs.): i. .... ii. .... iii. .... iv........

7. Mode of uses: ....

8. Availability period (i) From .... to ....

(Mention name of the months)

(ii) Round the year

9. Local availability status:

a. Abundant b. Common c. Not so common d. Rare

10. Medicinal value if any: (Yes/Not) ....

(Specify) Date: ....

(C) Data sheet to assess the local dependency on selected wild edible plants and fruits

Name of the Village/Locality:

Name of the family:

Total family members: a. Male: b. Female: Family No.

VN	1st Quarter (January to March, 2008)																		2nd Quarter (April to June, 2008)																	
	TQC (kg)			QHC (kg)			QOP (kg)			QM (kg)			R/U (kg)			MN			TQC (kg)			QHC (kg)			QOP(kg)			QM (kg)			R/U (kg)			MN		
	J	F	M	J	F	M	J	F	M	J	F	M	J	F	M	J	F	M	A	M	J	A	M	J	A	M	J	A	M	J	A	M	J	A	M	J

VN	3rd Quarter (July to September, 2008)																		4th Quarter (October to December, 2008)																	
	TQC (kg)			QHC (kg)			QOP (kg)			QM (kg)			R/U (kg)			MN			TQC (kg)			QHC (kg)			QOP (kg)			QM (kg)			R/U (kg)			MN		
	J	A	S	J	A	S	J	A	S	J	A	S	J	A	S	J	A	S	O	N	D	O	N	D	O	N	D	O	N	D	O	N	D	O	N	D

N.B.: TQC = Total quantity collected, QHC = Quantity used for HH Consumption, QOP = Quantity for other purpose
QM = Quantity marketed, R/U = Rate per unit, MN = Name of the local market where they sold, VN = Vernacular name

(D) Data sheet on ethnomedicinal plants collection

(I) **INFORMANTS PROFILE**

Name of the village .... Tribe: ....

Sl.No.	Name	Sex (M/F)	Age (in years)	Occupation
1.	....	....	....	....
2.	....	....	....	....
3.	....	....	....	....
4.	....	....	....	....
5.	....	....	....	....
6.	....	....	....	....
7.	....	....	....	....
8.	....	....	....	....

(II) **MEDICINAL PLANT USES**

1. Plant (Local/Vernacular name)

a. Mao ....b) Poumei .... c) Kuki ....

2. Plant identified as .... (Botanical name)
3. Part(s) of plant used ....
4. Habit of the plant (Tree/Shrub/Herbs/Climber/Creeper/Others)
5. Phenology and fruiting period ....
6. Preparation method(s) ....
7. Use or nature of ailment treated ....
8. Number of citations or use-report for each ailment treated ....
9. Route of administration (i) External (ii) Oral (iii) Nasal (iv) Ear/eye
10. Response of the informant(s)/Patient(s)

(a) Effective /Good .... (b) Fair................. (c) Poor ....

(III) **INFORMANTS DECLARATION**

We, the above mentioned hereby willingly accepted to participate in this study with our full consent and declare that the information and knowledge provided to Neli Lokho Pfoze during the course of interview and discussion is to the best of our knowledge and is accurate and complete.

Dated: ....

CHAPTER-V

5. PHYTOCHEMICAL ANALYSIS

5.1. OBJECTIVES OF THE STUDY

(a) Phytochemical screening of some lesser known ethnomedicinal plants

(b) Extraction, fractionation and isolation of alkaloids from stem bark of *Mahonia manipurensis*

5.2. PHYTOCHEMICAL SCREENING

5.2.1. MATERIALS AND METHODS

5.2.1.1. **Chemicals and solvents used:** The different chemicals or solvents used in the experiment are of laboratory or analytical and HPLC grades purchased from different chemical companies. The detail lists of these chemicals or solvents along with the assay percent of the company are listed in the (Table-5) below:

Table-5: Chemicals and solvents used in the experiments

SN	Chemical and solvent	Grade	Assay %	Company
1	Acetic acid glacial	AR	98.8	SRL Pvt. Ltd, Mumbia
2	Acetic anhydride	LR	98	Sd fine-CHEM Ltd., Mumbia
3	Ammonia extrapure	LR	25-28	Sd fine-CHEM Ltd., Mumbia
4	Bismuth nitrate extrapure	AR	98	SRL Pvt. Ltd, Mumbia
5	Chloroform	AR	99.7	Sd fine-CHEM Ltd., Mumbia
6	Conc. H_2SO_4	.....	97	Qualigens Fine Chemical
7	Conc. HCl	.....	35-38	Sd fine-CHEM Ltd., Mumbia
8	Methanol extrapure	AR & HPLC	99.8	SRL Pvt. Ltd., Mumbia
9	Potassium Iodide Extrapure	AR	99	Sd fine-CHEM Ltd., Mumbia
10	Silica Gel G for TLC	.....	.....	SRL Pvt. Ltd., Mumbia
11	Sodium hydroxide	AR	98	Sd fine-CHEM Ltd., Mumbia
12	Sodium sulphate anhydrous	AR	98	Central Drugs House, New Delhi

5.2.1.2. **Preparation of reagents for phytochemical screening test**

(a) **Dragendroff's reagent**

Solution A: Dissolved 2 gm of bismuth subnitrate in 25 ml of acetic acid and added with 100 ml of distilled water.

Solution B: Dissolved 50 gm of KI in 125 ml of distilled water. OR Dissolved 5 gms of KI in 12.5 ml of distilled water.

Mix 5 ml of solution A and 5 ml of solution B with 20 ml of glacial acetic acid and 100 ml of distilled water.

(b) **Mayer's reagent:** Dissolved 1.358 g of $HgCl_2$ in 60 ml of water. Dissolve 5.0 g of KI in 10 ml of water. Mix the two solutions and add water to make 100 ml.

(c) **5% $FeCl_3$ solution:** Dissolve 5 grams of $FeCl_3$ in double distilled water and make the final volume to 100 ml solution.

5.2.1.3. **Preparation of plant extracts:** The plant materials (root, tuber, rhizome, bark, flower and leaf) were washed thoroughly in running tape water. In case of root, tuber and rhizome, it is cut into thin slices and then dried in the oven at temperature 30°C for 36 hours. The well dried plant material is then pulverized into fine powder using grinder mixture. In case of leaf or flower material, the dried sample is directly crushed into fine powder using grinder mixture. About 15 gm each of the powder plant sample was extracted with 150 ml of methanol in 250 ml conical flasks with continuous shaking in an orbital shaking incubator-RIS24 at 30°C for overnight. The extract is filtered using Whatman No.42 filter paper and 20 ml of the filtrate was kept separately for testing flavonoids. The remaining portion of the filtrate was concentrated to 1/10th volume at 40°C in a Buchi rotary vacuum evaporator. The concentrated extract is then transfer to a Petri dish and dried in the oven at 30° C for overnight. The dried residue obtained from the filtrate is collected and then subjected to qualitative test for the presence of alkaloids, saponins and tannins.

5.2.1.4. **Phytochemical screening test:** Qualitative phytochemical test for the presence of various classes of bioactive plant secondary metabolites such as alkaloids, flavonoids, saponins, tannins, etc. were conducted on the methanolic *extracts of different plant parts such as root, leaf, flower, rhizome, bark, etc. of some* locally used lesser known ethnomedicinal plants following the standard qualitative detection methods (Harborne, 1998; Kapoor *et al.*, 1969; Kokate, 1999; Mace, 1963; Odebiyi and Sofowora, 1978). Preliminary quantitative assessment of the presences of different bioactive phytochemicals was also interpreted based on the observations of certain characteristic features that are specific to a particular class of compounds like turbidity, coloration, formation of precipitate, frothing, etc.

(a) **Alkaloids:** The methanol extract was evaporated to dryness. A little portion of the residue is dissolved in 5 ml of 1% HCl, filter, make it alkaline with 25% NH_4OH and extract with an equal volume of $CHCl_3$. The $CHCl_3$ solution is then extracted with an equal volume of 1% HCl by shaking vigorously, separate and test with Mayer's/Dragendorff's reagents. Any precipitate (reddish-brown or cream color ppt.) or turbidity confirms the presence of alkaloids (Kapoor *et al.*, 1969).

Quantitative assessment: Clear solution = - ve; translucent solution with some precipitate = + ve; turbidity/translucent solution with clear precipitate formation = ++ ve; heavy precipitate formed immediately = +++ ve

(b) **Flavonoids:** Add a few drops of concentrated HCl and Mg turning or Mg ribbon to 3ml of ethanol extract. Appearance of pink or magenta-red or crimson colour developed indicating the presence of flavonoids (Kapoor *et al.*, 1969; Harborne, 1998).

Quantitative assessment: Without appearance of colour = - ve; light pink or magenta = + ve; clear magenta-red = + + ve; deep magenta-red or crimson = +++ ve.

(c) **Saponins:** The methanol extract was evaporated to dryness and the residue is dissolved in water and shakes vigorously. A honey comb froth persisting for 15-30 minutes indicates the presence of saponins (Kapoor *et al.*, 1969; Kokate, 1999).

Quantitative assessment: No froth = - ve; froth less than 1 cm = + ve; froth 1 - 2 cm high = ++ ve and froth more than 2 cm high = +++ ve.

(d) **Tannins:** Methanolic extract of each sample (0.5 g) was separately stirred with 10 ml of distilled water and then filtered. The filtrate was added two drops of 5% $FeCl_3$ reagent. A dark green to blue-black coloration or precipitate was taken as an indication of the presence of tannins (Mace, 1963; Odebiyi and Sofowora, 1978).

Quantitative assessment: No coloration = - ve; light green or blue-black = + ve; dark green or blue-black with some precipitate = ++ ve; blue-black with heavy precipitate = +++ ve.

5.3. PHYTOCHEMICAL ANALYSIS OF *M. MANIPURENSIS*

5.3.1. **General review of the genus *Mahonia*:** The family Berberidaceae contains 17 genera and about 630 species (Chen *et al.*, 2009). The largest genus in the family is *Berberis* containing about 450 species (Terry and Frank, 1981) followed by *Mahonia*. In the world, these species are distributed mainly as evergreen shrubs in East and South-East Asia, western North America, Central America and western South America. Ahrendt, (1961) and Chao *et al.*, (2009) reported a total of 70 different species of *Mahonia*. However, according to Li *et al.*, (2000) there are about

109 different species of *Mahonia* in the world. Of this, about 13 different species of *Mahonia* are recorded from India (Ahrendt, 1961) of which 11 species occurred from North-East India. About 4 species viz. *Mahonia feddei* Ahrendt, *Mahonia magnifica* Ahrendt, *Mahonia manipurensis* Takeda and *Mahonia roxburghii* (DC.) Takeda are found in Manipur (Singh *et al.*, 2000).

5.3.2. **Why *M. manipurensis* for phytochemical analysis:** Many species of the genus *Mahonia* are well known medicinal plants widely used in folk medicine (Rohrer *et al.*, 2007; Tseng *et al.*, 2007). Shidagonglao, a traditional Chinese herb which was first recorded in the book Zhiwumingshitukao written by Qijun Wu of Qing dynasty in Chinese history is derives from several species of the genus *Mahonia* (Ji *et al.*, 2000). The dried stems of *Mahonia bealei* (Fort.) Carr. and *Mahonia fortunei* (Lindl.) Fedde. are commonly used against fever, swelling, inflammation, jaundice, dysentery and constipation in Chinese traditional medicine (Pharmacopoeia Committee, 1990). The extracts from stem and leaves of this two species also showed strong antimicrobial activities (Airong Li *et al.*, 2008). Boiled extract from the stem of *Mahonia acanthifolia* Don is given against blood dysentery, diarrhoea and jaundice by traditional practitioners in Darjeeling Himalaya (Pranay and Ritu, 2009). Root decoction of *Mahonia repens* (Lindl.) G. Don is prescribed as remedy for hemorrhages, prevent or stop bloody dysentery. *Mahonia oiwakensis* is traditionally used by herbalists and doctors for substituting *Phellodendi* cortex which is the bark of *Phellodendron amurense* or *P. chinese* (Rutaceae) known traditionally as antipyretic and analgesic drugs and used for inflammatory disorders, abdominal pain and diarrhea, gastrointestinal disorders and liver diseases (Committee on Chinese Medicine and Pharmacy, 2003). The stems and roots of the plant are used to cure common cold and enterogastritis in Taiwan (Kan, 1980; Luo *et al.*, 2007). Root decoction of *Mahonia aquifolium* (Pursh) Nutt is given against hemorrhage, stomach trouble, etc. Also infusion is taken to purify the blood and gargle for sore throat. Similarly root decoction of *Mahonia pinnata* is taken for rheumatism, as a wash for cuts and bruises. Also, decoction of the stem bark or root of *Mahonia manipurensis* Takeda is given for fever and jaundice by some local herbalists of the Mao Naga tribe (Pfoze *et al.*, 2012). Further, pharmacological studies carried out by various workers showed that the plants belonging to the genus *Mahonia* showed antibacterial, antifungal, anticancer, antioxidant, antiproliferative and anti-inflammatory effects (Mcutcheon *et al.*, 1994; Muller and Zieresis, 1994; Muller *et al.*, 1995; Misik *et al.*, 1995; Bezakova *et al.*, 1996; Duraiswamy *et al.*, 2006; Wong *et al.*, 2009; Pfoze *et al.*, 2011) and thus support the claimed of the uses of these plants in traditional or folkloric medicine.

The main biologically active compound in *Mahonia* plant is alkaloid with marked physiological activity. Some of the well known alkaloids which are widely distributed in this genus include berberine, palmatine and jatrorrhizine. *In vitro* studies showed that all these alkaloids possess antimicrobial properties (Schiff *et al.*, 1987). Further it is demonstrated that these alkaloids also possesses significant anti-inflammatory and hepatoprotective activities (Virtanen *et al.*, 1988; Kupeli *et al.*, 2002). Berberine alkaloid for instant has been reported to have multiple pharmacological activities and is usually used for diarrhea as antibiotic and antivirus. It is antibacterial against a wide variety of Gram-positive and Gram-negative bacteria, fungi, protozoa, trypanosomes and plasmodia (Amin *et al.*, 1969; Cowan, 1999; Sarma *et al.*, 1999; Cerakova and Kotalova, 2002). These cytotoxic effects of berberine observed above are attributed to intercalation with DNA in combination with the inhibition of protein biosynthesized (Zhu *et al.*, 1998; Merschjohann, 2001). Berberine also displays antitumor activity against human and rat malignant brain tumor cells (Zhank *et al.*, 1990; Anis *et al.*, 1999). Further, Schmeller *et al.*, (1997) found that berberine inhibits the synthesis of DNA and reverse transcriptase. Moreover, some chemical investigators have also reported that this compound also exhibits anti-hyperglycemic effects. The therapeutic efficacy of berberine in type 2 diabetes based on comprehensive metabolomics was further demonstrated by Gu *et al.*, (2010).

5.3.3. **Alkaloids phytochemistry of the genus *Mahonia*:** One of the most important alkaloid producing plant family is Berberidaceae. Phytochemical studies conducted in some species of this genus leads to an isolation and characterization of a number of bisbenzylisoquinoline and protoberberine alkaloids such as berberine, jatrorrjizine, palmatine, umbellatine, coloumbamine, berbamine, oxycanthine, etc. These alkaloids are found in the root, rhizome, bark and leaves of the plant. Chatterjee *et al.*, (1951) and Chatterjee and Guha (1951) isolated the alkaloids berberine, jatrorrhizine, palmatine and oxycanthine from the root of *Mahonia manipuresnsis* Takeda. Comparative morphological, histological and chemical studies have revealed that it is well consider *M. manipurensis* Takeda as a variety of *M. borealis* Takeda rather than a separate species (Chatterjee and Guha, 1951). Some important alkaloid compounds with their structures and molecular weight occurred in different species of the genus *Mahonia* are shown in the (Table-6 & 7) belows:

Table-6: Alkaloids phytochemistry of the genus *Mahonia*

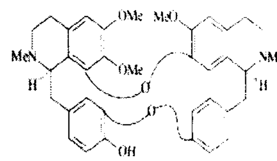
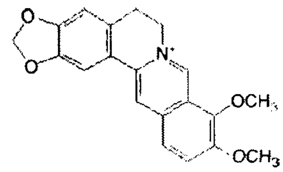
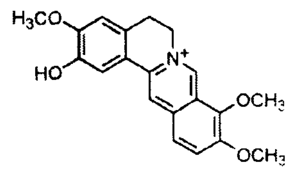
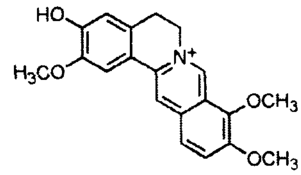
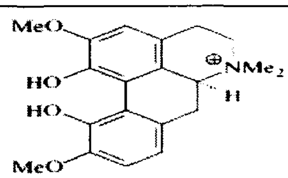
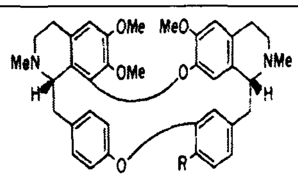
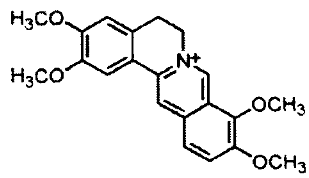
Name of the alkaloid	Molecular Formula	Molecular wt.	Structure
Berbamine	$C_{37}H_{40}N_2O_6$	608.74	
Berberine	$C_{20}H_{18}NO_4CH_3$	336.37	
Columbamine	$C_{20}H_{20}NO_4CH_3$	338.39	
Jatrorrhizine	$C_{20}H_{20}NO_4CH_3$	338.39	
Magnoflorine	$C_{20}H_{24}NO_4CH_3$	342.42	
Oxycanthine	$C_{37}H_4ON_2O_6$	608.74	
Palmatine	$C_{21}H_{22}NO_4CH_3$	352.42	

Table-7: The alkaloids in different species of the genus *Mahonia*

Name of the *Mahonia* species	Name of the alkaloids present				
Mahonia acanthifolia G. Don	Berberine	Jatrorrhizine	Oxycanthine	Palmatine	X
Mahonia aquifolium (Pursh.) Nutt.	Berberine	Berbamine	Jatrorrhizine	Oxycanthine	Corydine
Mahonia borealis Takeda	Berberine	Jatrorrhizine	Oxycanthine	Palmatine	X
Mahonia fortunei (Lindl.) Fedde	Berberine	Berbamine	Jatrorrhizine	Magnoflorine	Palmatine
Mahonia griffithii Takeda	Berberine	Berbamine	Jatrorrhizine	Oxycanthine	Palmatine
Mahonia leschenaultii (Wall) Takeda	Berberine	Jatrorrhizine	Magnoflorine	Oxycanthine	X
Mahonia manipurensis Takeda	Berberine	Jatrorrhizine	Oxycanthine	Palmatine	X
Mahonia napaulensis DC	Berberine	Jatrorrhizine	X	X	X
Mahonia sikkimensis Takeda	Berberine	Jatrorrhizine	Oxycanthine	X	X
Mahonia simonsii Takeda	Berberine	Jatrorrhizine	Oxycanthine	Palmatine	X

5.3.4. **Berberine alkaloids biosynthetic pathway:** The starting material for the biosynthesis of berberine alkaloids in the isoquinoline biosynthetic pathway is the amino acid L-tyrosine. Two molecules of tyrosine undergo hydroxylation, decarboyxlation and deamination reactions to formed one molecule each of dopamine and 4-hydroxyphenyl-acetaldehyde. This two molecules are condense together in a reaction catalysed by an enzyme norcoclaurine synthase (NCS) to formed (S)-norcoclaurine. (S)-norcoclaurine is the central intermediate or precursor to all the isoquinoline alkaloids family. This molecule through a series of methylation and hydroxylation reactions catalyzed by the enzymes such as 6OMT, CNMT, CYP80B1 and 4'OMT to produced (S)-reticuline, another important precursor in the pathway. In the presence of an enzyme berberine bridge enzyme (BBE), (S)-reticuline is converted to (S)-scoulerine which is further converted to (S)-

tetrahydrocolumbamine by the enzyme scoulerine methyl transferase. (S)-tertrahydrocolumbamine undergo a series of chemical reactions to produced different types of berberine alkaloids such as berberine, palmatine, canadine, columbamine, etc. (Fig.5).

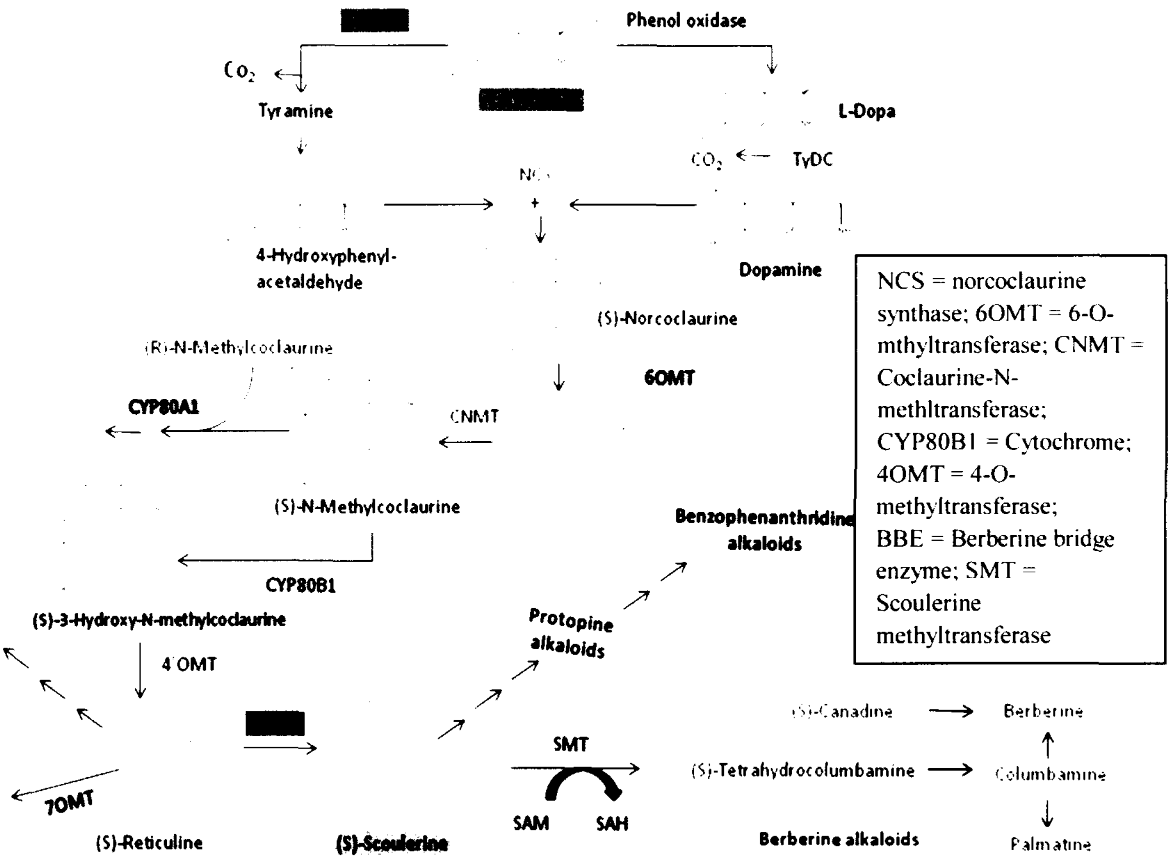
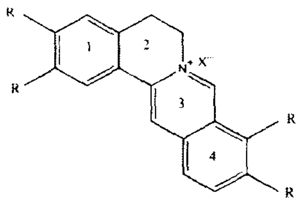
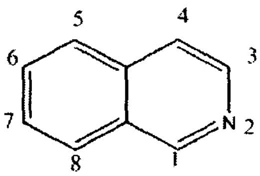
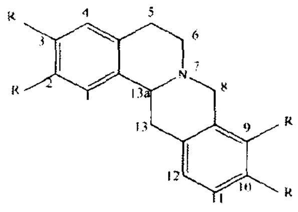
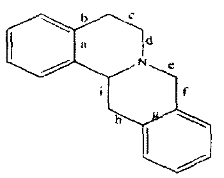


Fig.5. Isoquinoline biosynthetic pathway for the biosynthesis of berberine alkaloids

5.3.5. **Protoberberine alkaloids:** These are group of alkaloids belonging to the isoquinoline family and contain within their structures an isoquinoline or hydroisoquinoline ring system. They are considered to be derivatives of the dibenzo quinolizidine system. In nature most protoberberine alkaloids exist either as tetrahydroprotoberberine or as quaternary berberinium salts. Substituents are usually present at C-2 and C-3 on aromatic ring 1 and either at C-9 and C-10 or at C-10 and C-11 of aromatic ring 4. Also known are compounds where a OH or methoxyl substituent is present at C-1 and an alcoholic OH may be found at C-13 or at C-5. In some protoberberines, a methyl group is present at C-8 or C-13.

(a)Quaternary berberinium salts (b) Isoquinoline (c) Tetrahydroprotoberberines



R= —OH, —OCH_3, O —CH_2 —O, etc.

(d) Dibenzo quinolizidine system

Plants that contain protoberberine alkaloids are reported to be used as analgesics, antiseptics, sedatives and stomatics in Chinese folk medicine. In Indian and Islamic folk medicine, such plants are used for bleeding disorders and eye diseases and as antiseptics, sedatives, stomatics and uterine muscle depressants.

5.4. EXTRACTION AND ISOLATION OF PROTOBERBERINE ALKALOIDS

5.4.1. MATERIALS AND METHODS

5.4.1.1. **Chemicals and solvents used:** The different chemicals and solvents used in the experiment are of laboratory or analytical and HPLC grades purchased from different chemical companies and are listed in the (Table-8).

Table-8: Chemicals and solvents used in the experiments

SN.	Chemical and solvent	Grade	Assay %	Company
1.	Ammonia extrapure	LR	25-28	Sd fine-CHEM Ltd., Mumbai
2.	Bismuth nitrate extrapure	AR	98	SRL Pvt. Ltd, Mumbai
3.	Chloroform	AR	99.7	Sd fine-CHEM Ltd., Mumbia
4.	Conc. H_2SO_4	.....	97	Qualigens Fine Chemical
5.	Conc. HNO_3	.....	69-71	Qualigens Fine Chemical
6.	Dichloromethane (DCM)	GR	99.5	Merck (India) Ltd., Mumbia
7.	Diethylamine	AR	99.5	Sd fine-CHEM Ltd., Mumbia
8.	Ethyl acetate extrapure	AR	99.5	SRL Pvt. Ltd., Mumbia
9.	Formic acid	HPLC	98-100	Sd fine-CHEM Ltd., Mumbia
10.	Hexane	AR	95	Sd fine-CHEM Ltd., Mumbia
11.	Methanol extrapure	AR & HPLC	99.8	SRL Pvt. Ltd., Mumbia
12	Potassium Iodide Extrapure	AR	99	Sd fine-CHEM Ltd., Mumbia
13.	Silica Gel G for TLC	.....	.....	SRL Pvt. Ltd., Mumbia
14.	Sodium hydroxide	AR	98	Sd fine-CHEM Ltd., Mumbia
15.	Sodium sulphate anhydrous	AR	98	CDH, New Delhi
16.	Water	HPLC	.....	SRL Pvt. Ltd., Mumbia

5.4.1.2. **Plant description:** *Mahonia manipurnesis* Takeda is an under growth woody perennial shrub belonging to the family Berberidace ae. The plant is endemic to the northeastern region of India in the state of Nagaland and Manipur and parts of the Indo-Burma region and is found at an altitude ranges from 2000 to 2500 m. Leaflets 7-11 pairs, overlapping, ovate to broadly ovate, coriaceous, glabrous above, dull beneath with sharp scattered spines on the margin; racemes 4-8 cm long in 3-5 fascicles; bracts 10-15 mm long; bracts 2.5-3.5 mm long. Outer sepals ovate, median sepals oblong-ovate, obtuse, inner ones elliptic or oblong-ovate. Petals oblong, ovate, bilobed at apex. Stamens produced, obtusely subapiculate; connective s depressed, triangular; anthers shorter than filaments. Ovules 1-2, style short.

5.4.1.3. **Plant collection and identification**: The stem bark of *Mahonia manipurensis* and herbarium specimen were collected from Mao area in the foot hill of Mt. Tenipu, Senapati district, Manipur in the month of April-2009, identified from BBSI, 1961 and FI, 1993 and verified from Kew Herbarium, Edingburgh. A voucher specimen (Coll. No. 188) was prepared from the collected plant and deposited in the herbarium of the Department of Botany, NEHU.

5.4.1.4. **Alkaloid extraction**: The plant stem bark was removed, dried in oven and pulverized into fine powder using grinder. About 100 g of the fine powder plant sample was extracted with 1000 ml of 80% methanol in 2.5 liters beaker with stirring at interval in room temperature. The extract was filtered and then concentrated to $1/5^{th}$ of the original volume in a Buchi rotavapor under reduced pressure. The concentrated extract was then used for extraction of alkaloid following Harborne method (1998) and yielded 1.12 gm crude alkaloid extracts corresponding to 1.12% in terms of dry weight starting materials. The alkaloid extraction flow chart is shown in (Fig.6) below:

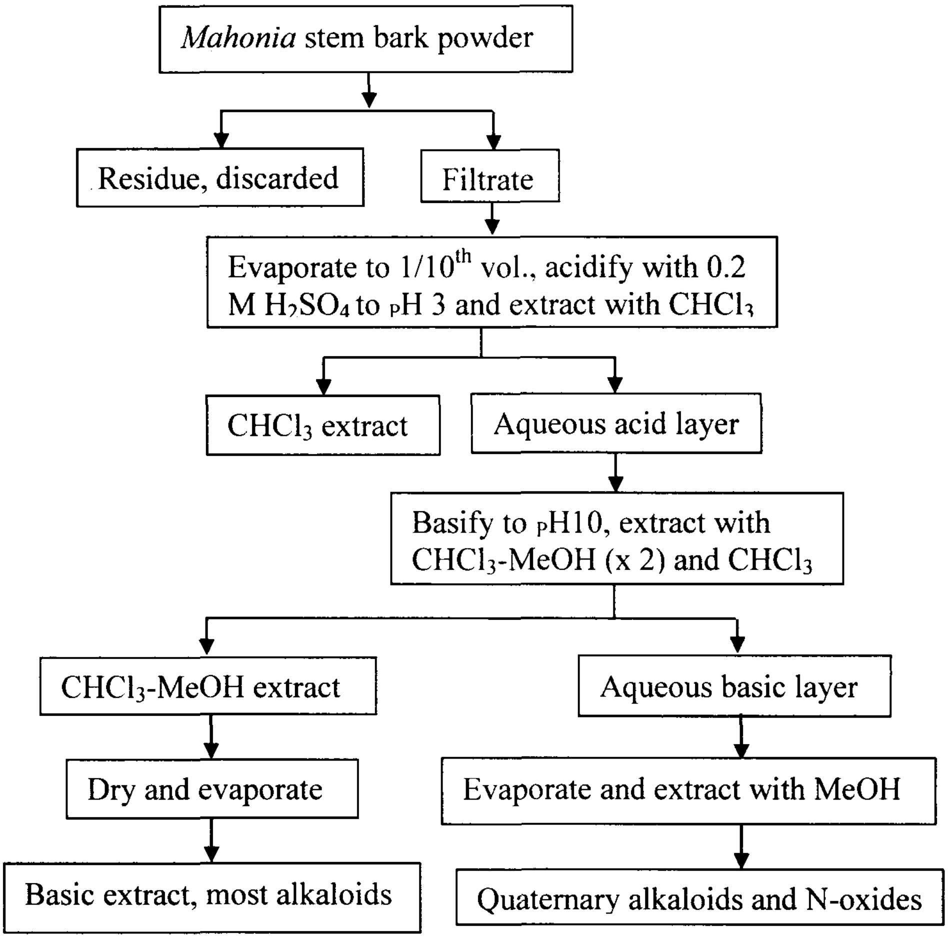


Fig.6. Extraction of alkaloids from *M. manipurensis* stems bark

5.4.1.5. **Analysis of the crude alkaloid extract:** At present, a number of analytical tools (chromatographic and spectroscopic) have been used to analyze alkaloids in plant samples or crude drugs. Thin Layer Chromatography (TLC) is one of the most popular and widely used separation techniques because of its ease of use, cost effectiveness, high sensitivity, speed of separation as well as its capacity to analysis multiple samples simultaneously. The technique can be utilized for separation, isolation, identification and quantification of components in a mixture. It can also be utilized on a preparative scale to isolate a particular component (Gorman and Jiang, 2004). However, the technique lacks quantitative precision, complete resolution and separation power. Therefore at present, Reverse Phase (RP) - High

Performance Liquid Chromatography (HPLC) is the most commonly used chromatography technique for qualitative and quantitative analysis of protoberberine and other plant alkaloids. However, alkaloids strongly interact with free silanol groups on the surface of the silica particles. These ion-exchange interactions produce peak tailing which affects resolution, sensitivity and reproducibility. For this reason, the determination of protoberberine alkaloids requires RP packing based on high purity silicas with a low level of silanol activity and mobile phases with high ionic strength and amine modifiers. Most modern columns are made from high purity silica materials with the absence of or low content of metals, encapped to decrease the number of surface silanols and ensure low silanol activity. This reduces peak tailing and gives good resolution. This technique can be coupled to Mass Spectrometry (MS) to provide both analytical separation and structural determination of unknown bioactive compounds. Several HPLC or HPLC coupled with Mass Spectroscopy or diode array detector (DAD) methods have been reported for the determination of protoberberine alkaloids (Chue and Shue, 1996; Luo *et al.*, 2005; Shi *et al.*, 2006; Ren *et al.*, 2007; Deng *et al.*, 2008; Chao *et al.*, 2009). In the present investigation the various steps involved from extraction to isolation of the compounds is presented in (Fig.30) of the results.

5.4.2. **Chromatography techniques**

5.4.2.1. **Thin Layer Chromatography (TLC):** The presence of alkaloids in the crude extract was initially analyzed by TLC using Dragendroff's reagent. The purified fraction that showed positive reagent test was collected and was subjected to further analysis according to the following procedures:

(a) **Preparation of TLC plate:** About 20 g of silica gel G containing ~13% ($CaSO_4$. ½H_2O) as binder) was dissolved in 52 ml of double distilled water. The slurry of silica gel was poured on clean dry glass plates of size (8 x 15 cm) and was kept for drying on hot plate at 40° C for about 30 minutes.

(b) **Activation of the silica gel:** After the silica gel gets dried the plates are then further heated to 75°C for another 20 minutes to remove the bonded water molecules from the polar sites of the silica gel on the plate.

(c) **Spotting the activated TLC plate:** About 2 mg of the crude alkaloid extract is dissolve in 1 ml of Dichloromethane (DCM) in an appendroff tube (1.5 ml capacity) and shacked vigorously for 1 minute. It is then allowed to settle those substances which are not dissolved in the DCM solvent. The solution to be analyzed was then allowed to rise in the capillary tube of 10 μl capacity. Once the capillary tube is loaded, the end of the tube is held vertically and just touches the line of origin so that the diameter of the spot is not more than 2 mm. The solvent portion of the solution was allowed to completely evaporate from the spot by placing the spotted glass plate in the oven for 10 minutes at 30°C. The plate was then placed in the developing chamber at an inclined position while the top of the plate rest against the wall of the chamber containing the solvent system. The plates were left in the chamber until the solvent front moved up to the top line marked on the plates through capillary action. The plates were then removed from the chamber and keep on a flat clean dry surface at room temperature for about 30 minutes for developing.

(d) **Visualization**

i. **Dragendroff's reagent:** The already developed plates were sprayed with a solution of the reagent and the fractions containing alkaloidal compounds are active and will react with the reagent. A clear reddish-brown colour developed in those spots confirmed the presence of alkaloid in the fraction (See PLATE-IX, J and L).

ii. **Iodine vapour:** The dried plate was placed in a glass chamber containing few crystals of Iodine. The chamber was sealed and keeps for few minutes. The Iodine vapour oxidizes the compounds presence in the various spots that turn tan-brown in color, making them clearly visible to the eye. Once the spots are visible, they were outlined with a pencil before the iodine color getting fades. However, in the presence investigation all the four alkaloid containing fractions (I, II, III and IV) except fraction IV are partially active with the Iodine vapour and hence not distinct tan-brown colour was observed.

(e) **Fractionation and separation:** Using the solvents hexane, ethyl acetate and methanol in the ratio 56:20:5 as the mobile phase, most of the less polar non alkaloidal compounds dissolved in DCM of the crude alkaloid extract were removed. The more polar alkaloid compounds which still remain intact at the origin of spotting is collected along with the silica gel and dissolved in methanol. The process is continue for several days and after obtaining sufficient amount, methanol solution where the compounds get dissolved is collected by separating the silica gel through filtration. The methanol is evaporated using Buchhi rota vapor and the dried residue containing the compounds is collected. The fraction of the residue thus collected is then further subjected to analysis qualitatively by comparing their Rf values with the standard alkaloids.

(f) **Rf value of standard alkaloids and fractions:** About 10 μl of sample solution (purified alkaloid residue) of concentration 1 mg/ml was loaded to the line mark as origin on the pre-coated Silica gel G F_{254} aluminum back plate of size 20 cm x 5 cm x 0.2 mm using a glass capillary of 10 µl capacity. A standard alkaloids berberine chloride and palmatine chloride hydrate with similar amount and concentration as the sample solution was also loaded to pre-coated Silica gel G F_{254}. The solvents use to dissolve the sample and standard alkaloids were dichloromethane for sample fraction and Chloroform for standard compounds respectively. The solventsystem Chloroform, ethylacetate, diethylamine, methanol and 20% NH_4OH in

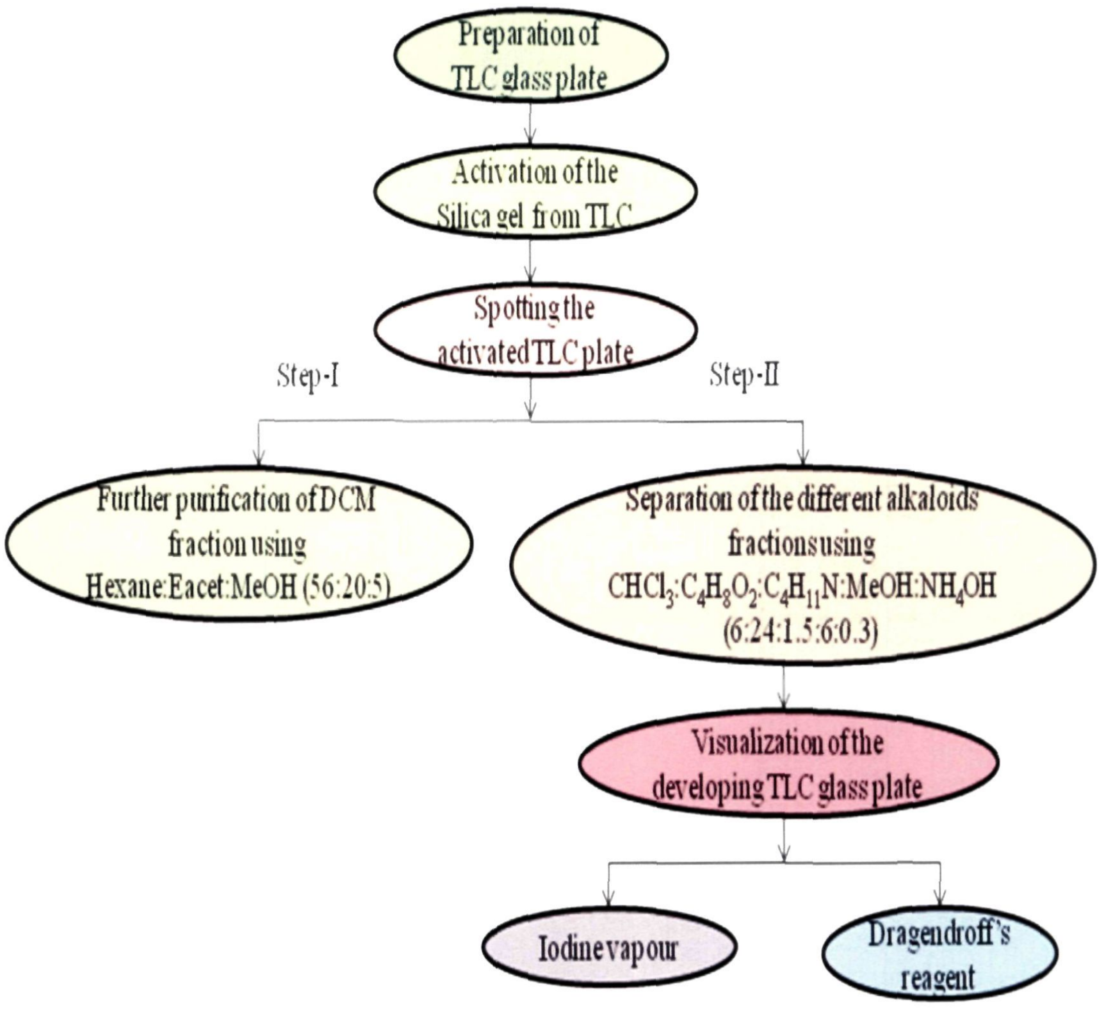


Fig.7. TLC analyses of protoberberine alkaloids in *M. manipurensis* stem bark

the ratio 6:24:1.5:6:0.3 was used as the mobile phase. After the plate is develop, then it is put to dry at room temperature for half an hour and then spray with

Dragendorff's reagent so as to detect and visualized the fractions which are active with the reagent and Rf values were recorded (Table-23)

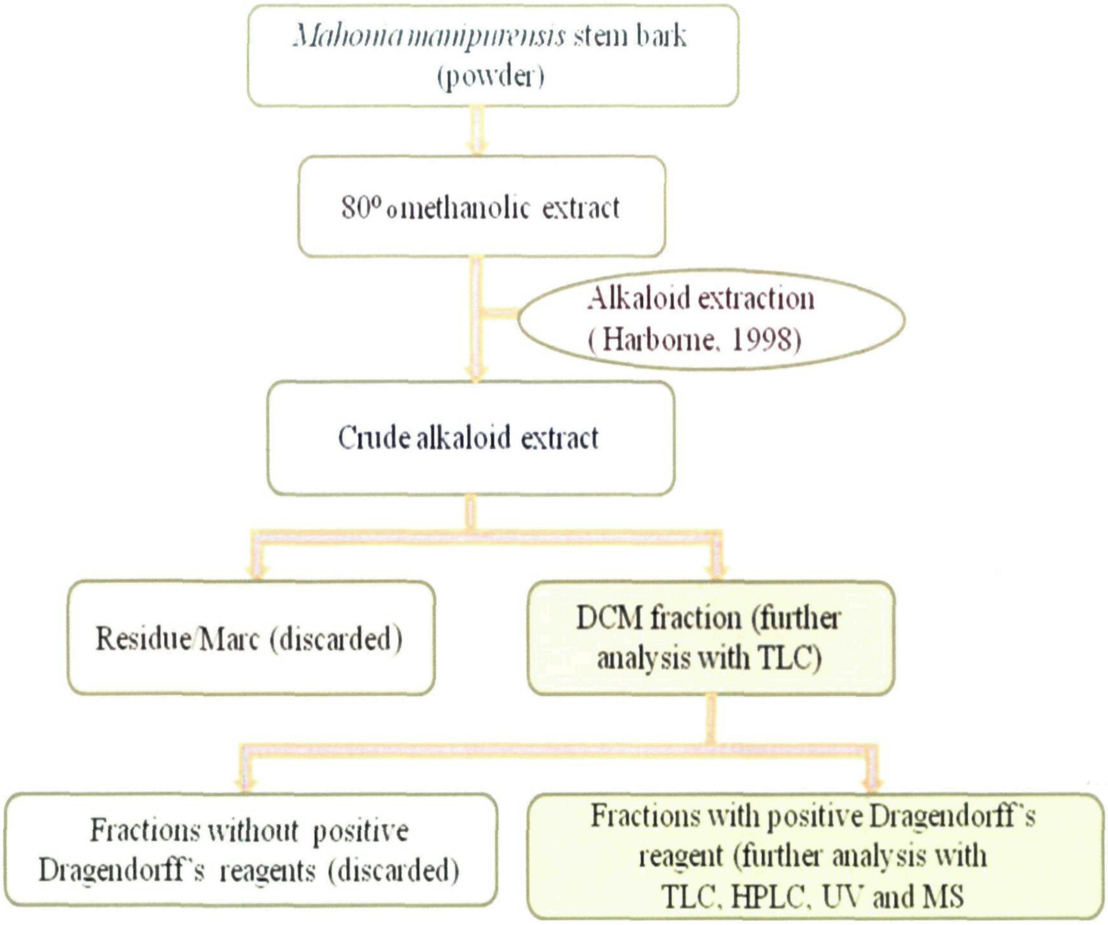


Fig.8. Fractionation and purification of alkaloid crude extract

5.4.2.2. **HPLC analysis**

(a) **Apparatus:** The HPLC system (Waters Alliance, Milford, MA, USA) consisted of a Waters 515 HPLC Pump, an automatic thermostatic column compartment, a degasser and Waters 2489 UV/VIS Detector.

(b) **Reagents and materials:** HPLC-grade methanol and water for analysis of protoberberine alkaloids was purchased from Sisco Research Laboratory (SRL), Mumbai (India). Analytical grade formic acid (98-100%) was purchased from Sd fine-CHEM Ltd. (Mumbia). The standard compounds of Bebrebrine chloride and Palmatine chloride hydrate were purchased from Sigma Aldrich.

(c) **Sample preparation**

i. **Purified alkaloid residue:** About 5 mg of this purified alkaloid residue is dissolved in 5 ml of Dichloromethane (DCM) and loaded on preparative TLC glass plate using glass capillary tube. The plate is place at an inclined position and one end is rested against the wall of the glass jar containing mobile phase consisting of $CHCl_3$:CH_3COOH:CH_3OH:E_2NH:NH_4OH in the ratio 6:24:6:1.5:0.3. The different alkaloidal compounds which get separated out in this solvent system is then collected in an eppendruff tubes (2 ml) by scrapping along with silica gel from glass plate, dissolved in HPLC grade methanol and centrifuge using SPINWIN at 6000 rpm for 5 minutes. The supernatant is than collected by pippeting and filtered through membrane filter nylon-66 of 0.22 pore size (AXIVA). About 20 µl of the solution is loaded into the HPLC system and allow it to run for 35 minutes using methanol and 0.1% (v/v) Formic acid buffer as mobile phase. The HPLC chromatograms of the protoberberine alkaloids fractions II and III were compared with the standard alkaloids berberine chloride and palmatine chlorohydrate and are shown (Figs. 23, 24, 25 & 26).

ii. **Alkaloid standards:** About 1 mg each of the alkaloid standards Berberine chloride (94%) and Palmatine chloride hydrate (97%) from Sigma Aldrich were dissolved in 1 ml each in HPLC grade methanol. It is then diluted in 4 ml of methanol making the final volume to 5 ml each. About 20 µl each of this diluted standard solutions are loaded into the HPLC system and the HPLC chromatographic detection was recorded at 345 nm (Figs.18 & 20).

(d) **Chromatographic conditions:** HPLC chromatography was performed at room temperature on a Reverse Phase (RP) column WATER SYMMETRY C18 (5 µm, 250 mm x 4.6 mm ID). The mobile phase for the alkaloids of different fractions was methanol and formic acid buffer (0.1% v/v). The flow rate was maintained at 1 ml/min and the mobile phase gradient for the column was 20-40% methanol for 35 mins.

5.4.2.3. **Spectroscopy techniques**

(a) **UV-VIS Spectroscopy:** Each fraction II and III were scrapped from the TLC glass plates along with Silica gel and collected in 2.5 ml appendroff tube. The mixture is dissolved in 1.5 ml of HPLC grade water and shakes vigorously for about 1 minute. It is then centrifuge at 6000 rpm for 5 minutes using mini SPINWIN centrifuge (TARSON). The process is repeated 3-4 times and the supernatant where the compound gets dissolved is collected by pipetting in another 2.5 ml appendroff tube. Further, the supernatant is filtered using membrane filter nylon-66 of 0.22 µm pore size (AXIVA). About 1.2 ml of the supernatant is transfer into 1.4 ml capacity quartz cuvette and the absorbance is scan from 250 nm to 500 nm using Perken Elmer UV-VIS lambda-25 spectrophotometer and also compared with the standards berberine chloride and palmatine chlorohydrate (Figs.19, 20, 21 & 22).

(b) **MS-Spectroscopy:** Each fraction II and III were scrapped from the pre-coated TLC Silica gel G F_{254} aluminum back plate of size 10 cm x 5 cm x 0.2 mm and collected in 1.5 ml appendroff tube. The mixture is dissolved in 1 ml of HPLC grade methanol and shakes vigorously for about 1 minute. It is then centrifuge at 6000 rpm for 5 minutes using mini SPINWIN centrifuge (TARSON). The supernatant is collected and filtered using membrane filter nylon-66 of 0.22 µm pore size (AXIVA) and the same is taken for Mass Spectra using LC-MS spectrometer Waters ZQ-4000 model. The mass spectra thus generated are shown (Figs. 28 & 29).

CHAPTER-VI

6. ENUMERATION OF PLANTS DOCUMENTED

6.1. Wild edible plants

1. *Acacia oxyphylla* Graph. ex Benth., London J. Bot. 1: 514. 1842; Kanjilal *et al.*, FA 2: 157. 1938.

   Coll. No. 208-K

   LN: NR

   Uses: Tender pods are use for making chutney and also eaten as vegetable.

   Description: Woody prickly climber; leaflets 40-50, obliquely oblong, rounded or subtruncate at base; flowers white in globose heads arranged in terminal panicles; pods compressed, dark brown.

2. *Alpinia nigra* (Gaertn.) Burtt in Notes Roy. Bot. Gard. Edinburgh 35: 213. 1977; *A. allughas* (Retz.) Rosc. in Trans. Linn. Soc. London 8: 346. 1807; Baker in Hook. f., FBI 6: 253. 1892.

   Coll. No. 113-MPK

   LN: Kashapro (M); Shiraprou (P)

   Uses: Tender shoots and leaves are eaten as cook vegetable.

   Description: Leaves oblong-lanceolate glabrous beneath; panicle narrow copiously compound, flowers small, corolla-segmented linear-oblong greenish-white, lip cuneate pink distinctly emarginated with two small linear-subulate glands at the base.

3. *Amaranthus viridis* Linn., Sp. Pl. ed. 2: 1405. 1763; Hook. f., FBI 4: 720. 1885; Prain, Bengal Pl. 2: 651. 1903 (Rep. ed. 1963); Duke in Ann. Missouri Bot. Gard. 48: 14. 1961.

   Coll. No. 021-MPK

LN: Tobopha-vu (M); Dalekhao-Khao (P); Banglache (K)

Uses: The leaves are eaten as green leafy vegetable.

Description: An erect annual herb, glabrous, brownish in colour; leaves ovate, obtuse, entire, base cuneate, glabrous, green; flowers borne on axillary clusters in terminal paniculate spike, consisting dichasial cymes as glomerules; fruits utricle, sub-orbicular, rugose; seeds lenticular, smooth and black.

4. *Arundinaria callosa* Munro., Hook. f., FBI 7: 380-381. 1897.

Coll. No. 128-MPK

LN: Chiteba (M); Teiba (P); Leivah or Vitou (K)

Availability period: July-September

Uses: The tender shoots are eaten as cooked vegetable. Like bamboo shoot, it is also used for preparation of fermented product which is used for making chutney, give more flavor and better taste when added in meat curry preparation.

Description: Internodes smooth, nodes girth by the base of the fallen sheath, leaves thin oblong-lanceolate acuminate tessellate glandular-scarbrid above pubescent beneath, margins scabrous-serrulate, spikelets bracteates; nodes spinous and with a ring of soft brown hairs; stem sheath as long as the internodes or longer.

5. *Auricularia delicata* (Fr.) P. Henn.

Coll. No. 127-MPK

LN: Ozenabi (M); Yaonupa (P); Pachop (K)

Uses: Eaten as cooked vegetable either in dried or fresh forms. It is available in the local markets for selling either in fresh or dried forms during rainy season.

Description: Sporophores growing solitary or gregarious or in dens tufts; fruiting body jelly like or gelatinous, soft and starchy with dark brown color, sessile to sub-stipitate, shallow cup shapes or flattened or shaped like an ear.

6. *Bauhinia purpurea* Linn., Baker in Hook. f., FBI 2: 248. 1878; Kanjilal *et al.*, FA 2: 141. 1938; Balakr., FJ 1: 172. 1981; Haridasan & Rao, FFM 1: 316-317. 1985.

   Coll. No. 118-MPK

   LN: Levosii (M); Shivapa/Vopa (P); Vaibeh (K)

   Uses: Flowers are eaten as cooked vegetable.

   Description: A middle-sized erect tree, with moderately stout glabrescent branchlets; leaves rigidly subcoriaceous, glabrous, lobes obtuse or subacute; flowers in terminal and axillary short peduncled few-flowered corymbs, petals oblanceolate with a long claw, reddish; pod firm, flat, glabrous, late in dehiscing; . 12-15 seeded.

7. *Begonia picta* Smith, Clarke in Hook. f., FBI 2: 638. 1879; Kanjilal *et al.*, FA 2: 334. 1938; Deb in BBSI 3: 285. 1961; Balakr., FJ 1: 217. 1981.

   Coll. No. 025-M

   LN: Makhrabi-kongho (M), Koltheidon (K)

   Uses: Petiole skin cover is peel off and taken raw which is moderately sour taste.

   Description: Slender herbs; leaves ovate-orbicular, unevenly rounded or cordate at base, acute to short-acuminate, coarsely dentate-serrulate at margins; flowers pimkish-white; capsules triquetrous.

8. *Begonia roxburghii* (Miq.) DC., Prodr. 15(1): 398. 1864; FBI 2: 635. 1879; Kanjilal *et al.*, FA 2: 333. 1938. (Begoniaceae)

   Coll. No. 166-MK

   LN: NR

   Uses: Tender leaves are eaten as cooked vegetable.

Description: Erect herbs; leaves broadlt ovate, cordate at base, acute to short-acuminate, stipules lanceolate; flowers white; capsules pendent, 4-lobed.

9. *Cardamine hirsuta* Linn., Sp. Pl. 655. 1753; Hajra & Chaudhery in Sharma *et al.*, Fl 2: 112. 1993; Balakr., FJ 1: 73. 1981; C. *hirsuta* Linn. var. *sylvatica* (Link.) Hook. f. & Anderson in Hook. f., FBI 1: 138.1872; Kanjilal *et al.*, FA 1. 70-71. 1934.

   Coll. No. 019-M

   LN: Tosanini vu (M)

   Uses: Whole plants are eaten as cooked vegetable.

   Description: An annual herbs, 15-30 cm; leaves pinnatisect or pinnate, leaflets 5-11, variable in size and shape, orbicular or elliptic, entire or dentate-lobed; flowers white; capsules linear, flate; seeds ellipsoid, smooth.

10. *Cassia laevigata* Willd., Enum. Hort. Berol. 441. 1809; Kanjilal *et al.*, FA 2: 132-133. 1938.

    Coll. No. 207-K

    LN: NR

    Uses: Tender pods are eaten as cooked vegetable or used for making chutney.

    Description: A glabrous undershrubs or shrubs found in secondary forests and forest edges; leaflets 3-5 pairs, ovate to elliptic, rounded to cuneate, acute to acuminate; flowers yellow, racemes; pods linear, cylindric or subcylindric.

11. *Centella asiatica* (Linn.) Urban., Deb in BBSI 3: 328. 1961; Balakr., FJ 1: 218. 1981; *Hydrocotyle asiatica* Linn., Sp. Pl. 234. 1753; Clarke in Hook. f., FBI 2: 669. 1879.

    Coll. No. 133-MPK

    LN: Koreio (M); Reivu (P); Changkongcha (K)

Uses: Whole plant is eaten by the local people as cooked vegetable and is reported to have gastro-intestinal remedy. It is also used by local vegetable vendors for preparation of singju/salad for selling, a kind of local preparation where the plant is chopped into pieces along with some other vegetables, mixed with sesame and chilly powdered and eaten.

Description: Perennial creeping or stoloniferous herbs; leaves orbicular or cordate reniform, crenate to crenulate, glabrous or slightly pubescent; peduncled fascicled; flowers in simple umbel, pink often monoecious; fruits laterally compressed.

12. *Chenopodium album* Linn., Sp. Pl. ed. 1: 219. 1753; Hook. f., FBI 5: 3. 1886; Watt, Dict. Econ. Prod. 2. 265. 1889; Prain, Bengal Pl. 2: 657. 1903 (Rep. ed. 1963); RBSI 3(2): 267. 1905.

Coll. No. 126-MPK

LN: Oruo (M); Haba-vu (P); Houche (K)

Uses: Tender leaves are eaten as cooked vegetable.

Description: An erect herb usually coated with a mealy substance; leaves oblong-lanceolate to rhomboid-lanceolate, more or less toothed or lobulate; flowers minute, bisexual, green in spikes which are usually in panicled

13. *Chimonobambusa callosa* (Munro) Nakai., Kanjilal *et al.*, FA 5: 46-47. 1940.

Coll. No. 144-MP

LN: Chiteba (M); Teiba (P); Leivah or Vitou (K)

Availability period: July-August

Uses: The tender shoots are eaten as cooked vegetable. Like bamboo shoot, it is also used for preparation of fermented product for making chutney, give more flavor and better taste when added in meat curry preparation.

Description: A shrubby thorny bamboo; culms 4-7 m, greyish-green, smooth, noodes studded with thick, short, conical spines; leaves 20.22.5 cm long, 1.75-3.25 cm wide, oblong- lanceolate, pale and pubescent beneath, leafsheath densely tawny pubescent, glabrescent ending in a short ciliate callus

14. *Cinnamomum tamala* Fr. Nees., Hook. f., FBI 5: 128. 1886; Watt, Dict. Econ. Prod. 2. 319. 1889; Prain, Bengal Pl. 2: 673. 1903 (Rep. ed. 1963); Naskar, Pl. Wlth. L. Ganga Delta 563. 1993; Kanjilal *et al.*, FA 4: 56.1940.

Coll. No. 125-MPK

LN: Kokheisii/Soso (M); Siisitou/Siisikao (P); Thingthal (K)

Uses: Dried leaves are usually added to meat or fried curries as spices to give more flavor and better taste in the preparation.

Description: A medium-sized tree with bark grey-brown; leaves alternate, ovate-oblong or elliptic to oblong-lanceolate, acuminate, glabrous; flowers small, in large axillary axillary and terminal panicles; fruits sub-globose to obovoid; drupe black when ripe.

15. *Clerodendrum colebrookianum* Walp., Clarke in Hook. f., FBI. 4: 593. 1885; Gamble, Man. Ind. Timb. 543. 1902; Kanjilal *et al.*, FA 3: 489. 1939; Balakr., FJ 2: 370. 1983; Haridasan & Rao, FFM 2: 676. 1987.

Coll. No. 161-MPK

LN: Pejii-o (M); Piduvu (P); Anphui (K)

Uses: Tender leaves are eaten as cooked vegetable and are reported to control high blood pressure. Its consumption is popular among the Kuki community.

Description: Shrubs 2-5 m high, bark grey, shining green usually with foetid smell; leaves ovate-orbicular, obtuse, base subcordate or truncate, glabrous and pale beneath; corymbs compound, flowers white; drupelets globose, bluish-green.

16. *Commelina bengalensis* Linn., Sp. Pl. 41. 1753; Clarke in Hook. f., FBI 6: 370. 1892; Prain, Beng. Pl. 1082. 1903; Fischer in Gamble, Fl. Pre. Madras 1539. 1931.

Coll. No. 179-M

LN: Khollomotsii-vu (M)

Uses: The tuberous rootstocks are eaten as cooked vegetable.

Description: Small diffuse herbs; rooting at lower nodes, glabrous; leaves sessile or petiolate, elliptic-ovate, rounded at the base, sheaths pubescent, spathe pubescent, 1-3 together, turbinate, base auricled on one side; flowers blue, cymose; capsules membranous, 5-seeded, seeds pitted.

17. *Crawfurdia speciosa* Wall., Clarke in Hook. f., FBI 4: 106. 1883.

Coll. No. 173-M

LN: Letikorei (M)

Uses: The leaves and flowers are cooked along with rice and eaten as vegetable.

Description: Leaves cordate-lanceolate acuminate, entire; calyx-tube subterminal; corolla large purple; capsule 2-valved dry oblong short stalked included in the corolla.

18. *Curcuma angustifolia* Roxb., Baker in Hook. f., FBI 6: 210. 1890.

Coll. No. 170-MPK

LN: Kodziiapa or Todziiapa (M); Kuturapa or Kodziirapa (P)

Uses: The inflorescences of this plant are cooked along with other vegetable as food. According to Mao and Poumei Nagas folk tale, the flowering of this plant indicates the right time to starts sowing paddy for transplantation in the ensuing season.

Description: Leaves petiolate with lanceolate blade, plain green; spike with

peduncle aestival; flowers bracteate, green, ovate; pink; bracts of coma few or many; staminode and lip bright yellow, the latter orbicular-cuneate, emarginated.

19. *Dioscorea pentaphylla* Linn., Sp. Pl. ed. 1: 1032. 1753; Hook. f., FBI 6: 289. 1892; Prain, Bengal Pl. 2. 801. 1903 (Rep. ed. 1963); Balakr., FJ 2: 537. 1983.

Coll. No. 026-M

LN: Kophrehro (M)

Uses: The roasted tubers are eaten raw by some local people of the Mao and Poumei Naga tribes.

Description: Herbaceous twinner; Stem abundantly prickly; bulbils many, globose or elliptsoid; leaves 3-5 foliates, leaflets acutely rounded at base; fruit capsule; seeds winged at base.

20. *Diplazium esculentum* (Retz.) Sw., in Schrad. J. Bot. 1801: 312. 1803; Bedd., Handb. Ferns Brit. India 192. 1883; Jamir & Rao, Ferns of Nagaland 311. 1987.

Coll. No. 106-MPK

LN: Pfochouchojii (M); Machuovu (P); Gamchekoh (K)

Uses: Fronds are cooked along with rice and eaten as vegetable.

Description: Terrestrial; rhizomes black, toothed darkbrown; fond bipinnate, lamina spreading, secondary pinnae distant on the rachis, pinnatifid at the base, serrate at apex, sori linear, short, parallel on both sides of the viens; veins anastomosing, free.

21. *Diplazium pseudosetigerum* (Ching) Fras.-Jenk., *D. polypodioides* Blume, loc. Cit. 194; Holtt. in Gard. Bull. ss. 11: 93. 1940; *Athyrium polypodioides* (Blume) Milde Bot. Zeit. 1870.

Coll. No. 141-MP

LN: Chiteipfochou (M); Kokoronche (K)

Uses: Fronds are cooked along with rice and eaten as vegetable.

Description: Rhizome erect, massive short, scaly at the apex; roots thick, glabrous, stiff, arising from the basal region of the rhizome; fronds bipinnate, lanceolate-acuminate, glabrous, glossy green; stipe erect, slender, green, fleshy, covered with deciduous scales; lamina membranous, rachis finelly pubescent; sori dorsal on the vein globose; spores round to bean shaped.

22. *Elatostema sessile* Forst., Hook. f., FBI 5: 563. 1888; Kanjilal *et al.*, FA 4: 284. 1940; Chauhan *et al.*, Fl. of Namdapha 226. 1996.

Coll. No. 140-MPK

LN: Edeio (M); Dai-vu (P); Ansung-lung or Solunche (K)

Uses: The leaves are eaten as cooked vegetable or boiled along with rice and eaten.

Description: A perennial herbaceous plant often epiphytic or lithophytic; leaves oblong, oblong-lanceolate, elliptic obovate, entire or coarsely crenate or serrate above the middle, acuminate; receptacle sessile; achenes ellipsoid, ribbed, etc.

23. *Eryngium foetidum* Linn., Sp. Pl. 1: 232. 1753; Kanjila *et al.*, FA 2: 340. 1938; C.E.C. Fischer in RBSI 12(2): 99. 1938; Fl. Mizoram 1: 662-663. 2002.

Coll No. 192-MPK

LN: Oshu vu or Burmadonia (M); Padaiku (P)

Uses: Leaves are cooked in meat curry as spices or condiment to add more flavor and good palatability. Also it is chopped into pieces for making chutney.

Description: Diffuse perennial aromatic herbs with fusiform roots; stem dichotomously branched, deeply striate; leaves crowded at nodes, spinous-toothed at margins; flowers white in oblong-cylindrical umbels, bracts spinulose; fruits ellipsoid.

24. *Eurya acuminata* DC., Dyer in Hook. f., FBI 1: 285. 1874; Kanjilal *et al.*, FA 1: 125. 1934; Deb & Dutta, J. Econ. Tax. Bot. 10(1): 29. 1987; Chauhan & Paul in Sharma *et al.*, 3: 178. 1993.

Coll. No. 107-MK

LN: Moriisii (M); Shizou (K)

Uses: Leaves are cooked along with meat curry and eaten. It gives good flavor and palatability to the preparation.

Description: Shrubs with brown bark; leaves 1-6 x 0.5-2 cm, oblanceolate, oblong-elliptic, elliptic, acute, base cuneate, glabrous, crenate often narrowly revolute; flowers white or yellowish-white, sepals and petals glabrous, obovate, orbicular; stamens yellow, ovary ovoid, style united and persistent in fruit; fruit globose, purple.

25. *Fagopyrum dibotrys* (D.Don) Hara., FEH 69. 1966; Haridasan & Rao, FFM 2: 701. 1987.

Coll. No. 119-MPK

LN: Mareio-vu (M); Mari-vu (P); Anbongche (K)

Uses: Tender leaves are boiled along with rice and eaten as cooked vegetable.

Description: Undershrubs or herbs; leaves ovate-deltoid, acuminate, base cordate, puberulous; panicles of cymes; flowers white or pinkish.

26. *Globba clarkei* Baker in FBI. 6: 201. 1890; Rao & Verma in BBSI 14: 118. 1972.

Coll. No. 016-MP

LN: Rapro (M); Raprou (P)

Uses: Tender shoots are eaten as cooked vegetable or boiled along with rice and eaten.

Description: An annual herbs; leaves glabrous beneath, lanceolate, caudate, entire; panicle long narrow; bracts small deciduous, flowers yellowish-brown or orange-yellow, anthers crested; capsule smooth.

27. *Gnaphalium luteo-album* Linn., Sp. Pl. 851. 1753; Hook. f., FBI 3: 288. 1881; Deb in BBSI 3: 332. 1961; Plant in Hajra *et al.*, FI 13: 87. 1995.

Coll. No. 205-P

LN: Paomata Centre

Uses: Tender plants are boiled with rice and eaten.

Description: Erect annual densely woolly ascendingherbs; leaves oblong-spathulate, narrowed at base, obtuse; Capitula in terminal clusters, whitish yellow-golden yellow, tinged with brown, involucral bracts obtuse or rounded at apex; achenes linear to oblong, subterete, tubercled or with curved bristles; pappus hairs white, minutely barbed.

28. *Hedychium coronarium* Koening in Retz., Obs. Bot. Fasc. 3: 73. 1783; Baker in Hook. f., FBI 6: 225. 1892; Prain, Bengal Pl. 2: 781. 1903 (Rep. ed. 1963) and in RBSI 3(2): 284. 1905.

Coll. No. 189-MPK

LN: Shekra bu (M)

Uses: Tender shoots are eaten as cooked vegetable. It is also boiled and slices into pieces for making chutney along with dried or fermented fish.

Description: Erect perennial rhizomatous herb; Leaves oblong or oblong-lanceolate, spike dense-fid; flowers white or tinged with yellow, bracts large oblong imbricate 3-4 fid, staminodes oblong or oblong-lanceolate, lip broad shallowly bifid distinctly clawed; fruits capsule, subglobose.

29. *Houttuynia cordata* Thumb., Hook. f., FBI 5: 78. 1886; Kanjilal *et al.*, FA 4: 31. 1940.

Coll. No. 035-MPK

LN: Eshakama or Shatongun (M); Aithanglou (K)

Uses: Whole plant is eaten as cooked vegetable. It is also used for making chutney and salad. The plant has got a pleasant aroma that adds more flavor and taste in the preparation.

Description: Foetid glabrous herbs with creeping root-stock; leaves ovate, reniform-cordate at base, acute or acuminate; flowers white, anthers yellow; spikes cylindric, 1-3 cm, terminal; capsules subglobose; seeds 2-4, globose or ellipsoid.

30. *Impatiens racemosa* DC., Prodr. 1: 688. 1824; Hook. f., FBI 1: 479. 1874; Balakr., FJ 1: 111. 1981.

Coll. No. 018-MP

LN: Eshou-vu (M); Shou-vu (P)

Fls. & Frts.: July-September.

Uses: Tender leaves are cooked along with rice and dried fish and eaten.

Description: Annual glabrous herbs; leaves cuneate-acute at base, acute-acuminate, crenate at margins, bracts ovate with stout glandular points; flowers yellowish white; capsules with obovoid seeds, apiculate.

31. *Lentinula lateritia* (Berk.) Pegler (Polyporaceae)

Coll. No. 141-MPK

LN: Papinii (M); Veipa (P); Cipa (K)

Uses: This edible mushroom is one of the most common species available for selling in the local markets in the district. It is nutritious with good palatability and has a high demand in the markets for local consumption. During growing season, the fruiting bodies are available for selling (fresh or dried usually in the form of garland) in the local markets and sale at the rate of Rs.160-180/- per kg.

Description: Sporophores centrally stipitate, growing solitary or gregarious on dead wood of Fagaceae particularly Castanopsis sps., pileus 4-9.5 cm diam., plano-convex subumbonate or slightly depressed at the centre, glabrous, light yellowish brown to reddish brown, darker at the centre, margin thin, incurved; lamellae white to creamy white, narrow, 2-3.5 mm wide; stipe 3-9 cm long, central or eccentric.

32. *Litsea cubeba* (Lour.) Pers., Syn. *Litsea citrata* Bl., Bijdr. 565. 1825; Hook. f., FBI 5: 155. 1886; Gamble, Man. Ind. Timb. 570. 1902; Brandis, Ind. Trees 535. 1906; Kanjilal *et al.*, FA 4: 81. 1940; Haridasan & Rao, FFM 2: 729. 1987.

Coll. No. 064-MPK

LN: Shingainisii (M); Daisiitho (P); Thing-Thing (K)

Uses: Roasted fruits are use for making chutney along with dried or fermented fish.

Description: Deciduous trees; leaves lanceolate to ovate-lanceolate, oblique at base, caudate-acuminate; umbels 5-flowered, solitary or in corymbs; fruits globose.

33. *Maesa chisia* (non D. Don.) Clarke in Hook. f., FBI 3: 509. 1882; Gamble, Man. Ind. Timb. 438. 1902; Brandis, Ind. Trees 414. 1906; Kanjilal *et al.*, FA 3: 163. 1939; *Maesia montana* DC. Prodr. 8: 79. 1844.

Coll. No. 183-MP

LN: Kohra-o (M); Hra or Ha-vu (P)

Uses: Tender leaves are cooked along with rice and eaten as vegetable.

Description: Shrub with dark brown bark; leaves ovate or ovate-elliptic, base rounded or obtuse, cuneate, glabrous; racemes up to 5 cm long; flowers white;

fruits white or creamy, globose or sub-globose.

34. *Momordica dioica* Roxb. ex Willd., Sp. Pl. 4: 605. 1805; Clarke in Hook. f., FBI 2: 618. 1879; Kanjilal *et al.*, FA 2: 330. 1938; Deb in BBSI 3: 284. 1961; Chakrav. in Fasc. FI 11: 92. 1982.

Coll. No. 024-M

LN: Heimio (M)

Uses: Tender leaves and unripe fruits are cooked along with rice and eaten.

Description: Perennial climbers; leaves ovate-orbicular, cordate at base, acute to obtuse mucronate, entire or denticulate at margins; flowers yellow or pale brownish yellow; fruits berries ovoid, beak at base; seeds ellipsoid or ovoid, pale yellow, slightly compressed, irregularly corrugated.

35. *Morus alba* Linn., Sp. Pl. 986. 1753; J. Linn. Soc. Bot. 26: 455. 1894.

Coll. No. 040-M

LN: Huhreshi or Kheloshi (M); Thingteimi (K)

Uses: Tender leaves are eaten as cooked vegetable.

Description: A deciduous tree with brown stem bark; leaves ovate or ovate-cordate, acute or acuminate, serrate or crenate-serrate; flowers greenish; fruit dark purple or nearly black when ripe, acidulous sweet.

36. *Musa sapientum* Linn., Hook. f., *et al.*, FBI 6: 262. 1894.

Coll. No. 136-MPK

LN: Ovii (M); Vii (P); Changlou (K)

Uses: Tender parts of the pseudostems or shoots are eaten as cooked vegetable. It is also used for making chutney with dried or fermented fish.

Description: Stout rhizomatous herb; aerial stem made of sheathing leafbases; 8-12 ft. tall, cylindrical; leaves 4-5 ft. long, oblong, large, lanceolate, glabrous, bright green above, paler beneath; flowers in spadix, drooping fruit oblong, trigonous, 2-3 inches in the wild form and full of seeds.

37. *Nasturtium montanum* Wall. ex. Hook. f. et Thomson in J. Proc. Linn. Soc. Bot. 5: 139. 1861; Hook. f. & T. Anderson in FBI 1: 134. 1872.

Coll. No. 204-P

LN: Leriu (M); Routei-vu (P)

Uses: Tender plants are eaten as cooked vegetable.

Description: An annual herbs, erect upto 45 cm high; basal leaves petiolate, obovate-oblong, sinuate-pinnatifid; upper leaves variable, ovate, entire or minutely tooth, sessile or subsessile; flowers small pedicels spreading.

38. *Oenanthe javanica* (Blume) DC., Prodr. 4: 138. 1830; Deb in BBSI 3: 328. 1961; Balakr., FJ 1: 220. 1981.

Coll. No. 142-PK

LN: Thrai-vu or Bey-vu (P); Andum (K)

Uses: The plants are chopped into pieces along with other vegetable like cabbage. It is then prepared as salad by mixing with chili and sesame powders along with salt and eaten. The preparation is commonly sale in the local markets by vegetable vendors.

Description: Perennial glabrous herbs; leaflets ovate to elliptic-lanceolate or rhomboid, shallowly-serrate to pinnatifid; white flowers umbel terminal or leaf opposed.

39. *Oenanthe stolonifera* (Wall.) DC., Prodr. 4: 138. 1830; Clarke in Hook. f., FBI 2: 696. 1879; Kanjilal *et al.*, FA 2: 341. 1938.

Coll. No. 009-MP

LN: Okhru vu (M); Tru-vu (P); Andum (K)

Uses: This vegetable is common and popular among the Mao and Poumai tribes.

The whole plants are cooked along with other vegetables like potatoes and dried fish and eaten. It is also half boiled and eaten along with meat curry.

Description: Stoloniferous, glabrous herbs; rooting from the undersurface of nodes; leaflets ovate-lanceolate or lanceolate-rhomboid, laxly serrate, rachis sheathing at base; umbels compound with white flowers; fruits orbicular, compressed.

40. *Oroxylum indicum* (Linn.) Vent., Clarke in Hook. f., FBI 4: 378. 1884; Gamble, Man. Ind. Timb. 510. 1902; Kanjilal *et al.*, FA 3: 401. 1939; Balakr., FJ 2: 348. 1983; Haridasan & Rao, FFM. 2: 656. 1987.

Coll. No. 066-MPK

LN: Katheimei-dokre (M); Phasii/Vaopha (P); Bahlong (K)

Uses: Tender pods are half boiled, slices into pieces and used for making chutney along with dried or fermented fish.

Description: Small or middle sized trees with corky grayish bark; leaflets ovate, broadly ovate-orbicular, obtuse-acuminate, base usually oblique, often cordate or subcordate; racemes terminal stout; flowers greenish-yellow purple tinged, fleshy; pods black, drooping, seeds white winged all around.

41. *Paederia foetida* Linn., Mant. Pl. 1: 5. 1767; Hook. f., FBI 3: 195. 1881; Watt, Dict. Econ. Prod. 6(1): 2. 1892; Kanjilal *et al.*, FA 3: 77. 1939; Deb in BBSI 3: 312. 1961; Naskar, Pl. Wlth. L. Ganga Delta 388. 1993.

Coll. No. 154-MPK

LN: Pighiirai or Borei (M); Shiveirei (P); Guidup or Veinamgui (K)

Uses: Tender leaves are eaten as cooked vegetable.

Description: A slender twinning or wiry foetid climber; leaves elliptic-ovate, oblong-ovate or lanceolate, entire, glabrous; flowers grayish purple with reddish purple mouth in axillary and terminal cymose panicles; fruit ellipsoid, reddish, dorsally compressed; pyrenes with a board wing.

42. *Phlogacanthus curviflorus* Nees in Wall. Pl. As. Rar. 3: 99. 1832; Clarke in Hook. f., FBI. 4: 511. 1884; Kanjilal *et al.*, FA. 3: 443. 1939; Balakr., FJ 2: 359. 1983; Haridasan & Rao, FFM 2: 664. 1987.

Coll. No. 056-MPK

LN: Totsiipa (M); Heyavu or Maheaboi (P); Kolhou apah-asan (K)

Uses: The flowers are eaten as cooked vegetable. It is also half boiled and prepare for making chutney along with dried or fermented fish.

Description: Shrubs, young parts rusty tomentose; leaves obovate, broadly oblanceolate elliptic, obtuse or acute, base cuneate, glabrous (tomentose beneath) when young; flowers red, curved; capsules 4-6 cm long.

43. *Plantago erosa* Wall., Syn. *P. major* Linn., Kanjilal *et al.*, FA 3: 531. 1939.

Coll. No. 137-MPK

LN: Dziipao (M); Dziivu or Pah-vu (P); Vobilche (K)

Uses: The plants are eaten as cooked vegetable or boiled along with rice and taken.

Description: An almost glabrous perennial herb; leaves alternate, ovate-oblong or oblong-ovate, entire or sinuate toothed, sub-coriaceous, puberulous when young, almost glabrous when mature; flowers spikes slender, 2-6 in. long; capsule 4-8 seeded; seeds angled, minute, blackish, rugose.

44. *Pogostemon elsholtzoides* Benth., in DC., Prodr. 12: 153. 1848; Hook. f., FBI 4: 634. 1885; Mukerjee in RBSI 14(1): 72. 1940.

Coll. No. 185-MP

LN: Phiziio (M)

Uses: Tender leaves are eaten as cooked vegetable or boiled along with rice and

dried fish and eaten.

Description: Erect branched herbs; leaves lanceolate, serrulate, glabrous or puberulous above; flowers in verticillasters on long, terminal, tomentose spikes, purple or creamy white.

45. *Polygonum chinense* Linn., Sp. Pl. 363. 1753; Hook. f., FBI 5: 44. 1886; Kanjilal *et al.*, FA 4: 16. 1940; Balakr., FJ 2: 390. 1983; Haridasan & Rao, FFM 2: 702. 1987.

Coll. No. 178-MPK

LN: Obiovu (M); Bai-vu (P); Theidon (K)

Uses: The leaves are eaten as cooked vegetable or boiled with rice along with dried fish and taken.

Description: Shrubs; leaves oblong-lanceolate to ovate-deltoid or elliptic, truncate, subcordate, serrulate at margins; heads in corymbose panicles, achenes trigonous, dull black, enclosed in fleshy or coriaceous perianth.

46. *Polygonum molle* D. Don., Hook. f., FBI 5: 50. 1886; Kanjilal *et al.*, FA 4: 20. 1940; Balakr., FJ 2: 390. 1983; Haridasan & Rao, FFM 2: 702-703. 1987.

Coll. No. 151-MPK

LN: Evau (M); Vah-vu (P); Anbong-alenpa (K)

Uses: The leaves are eaten as cooked vegetable along with dried fish, meat or fermented soya bean.

Description: Subscandent or straggling bushy undershrubs/shrubs; leaves elliptic-ovate or lanceolate, acuminate or caudate-acuminate; flowers white, spikes in thyrsoid panicles, axillary or terminal; achenes ovoid, trigonous, black.

47. *Polygonum perfoliatum* Linn., Hook. f., FBI 5: 46. 1886; Kanjilal *et al.*, FA 4: 20. 1940; Balakr., FJ 2: 392. 1983; Haridasan & Rao, FFM 2: 703. 1987.

Coll. No. 170-K

LN: Lingthuh (K)

Uses: Tender leaves are eaten as cooked vegetable.

Description: Climbing herbs; leaves acute at apex, petioles and main nerves armed with recurved prickles, limb of ochreae orbicular; flowers white or pink, racemes simple or branched, terminal or upper axillary; achenes subtrigonous, apiculate, enclosed by fleshy blue-black perianth.

48. *Polygonum alatum* Sprengel, Fl. Bhutan 1(1): 164.1983.

Coll. No. 182-MP

LN: Nobito (M); Houpei-vu (P)

Uses: The leaves are eaten as cooked vegetable or boiled with rice along with other leafy wild vegetables and taken as food.

Description: Prostrate or suberect annual herbs; stem simple or branched, distantly leafy, internodes 3-6 cm; leaves ovate or elliptic, sometimes with a dark blotch near the centre, acute base, glabrous or sparsely pubescent; flowers in globose heads, solitary or several from uppermost leaf axils; perianth pink sometimes white.

49. *Ranunculus sceleratus* Linn., Sp. Pl. 54. 551. 1753; Hook. f. and Thomson in Hook. f., FBI 1: 19. 1872; Kanjilal *et al.*, FA 1: 8. 1934; Deb in BBSI 3: 316. 1961; Rau in Sharma *et al.*, FI 1: 128. 1993, 1:19, 1973.

Coll. No. 006-M

LN: Othukoshi (M)

Uses: Rootstocks are eaten as cooked vegetable.

Description: Erect annual herbs; stem fleshy fistular; radical leaves tripartite, sub-orbicular, reniform, cuneate cut segments, cauline sessile; flowers in diffuse racemes, reflexed, yellow; achenes many in an oblong head small obtuse or apiculate.

50. *Rhus semialata* Murry., in Comm. Soc. Goetting, 5: 27. t, 3. 1784; Hook. f., FBI 2: 10. 1876; Kanjilal *et al.*, FA 1: 331. 1936; Deb in BBSI 3: 306. 1961; *R. javanica* Linn. Sp. Pl. 1: 265. 1953; Banerjee in J. Bombay Nat. Hist. Soc. 55: 154. 1958.

Coll. No. 023-MPK

LN: Omoshi (M); Mosii or Moushi (P); Khongma (K)

Uses: Tender leaves are eaten as cooked vegetable.

Description: A small tree; leaflets 4-6 pairs, coriaceous, sessile, oblong, acuminate, base cuneate; flowers white or pale yellow-green; drupe orbicular, compressed, red, shining, acid.

51. *Rhynchotechum ellipticum* (All. ex D.F. N. Dietr.) A. DC., DC. Prodr. 9: 285. 1845; Clarke in Hook. f., FBI 4: 373. 1884; Kanjilal *et al.*, FA 3: 399. 1939; Haridasan & Rao, FFM 2: 654. 1987.

Coll. No. 175-MPK

LN: Kosabio (M); Theshuvi (P); Chenkup or Chehlep (K)

Uses: Boiled with rice and eaten as cooked vegetable.

Description: Shrubs upto 2 m high; young parts downy tomentose; bark grey or grayish-white with horizontal cuts and rectangular peels; flowers pink, stamen with black anthers at the base of the corolla tube; capsules ovoid, crowned with the persistent style.

52. *Schima wallichii* (DC.) Korth., Dyer in Hook. f., FBI 1: 289. 1874; Kanjilal *et al.*, FA 1: 119. 1934; Haridasan & Rao, FFM 1: 120-121. 1985.

Coll. No. 174-K

LN: Zhokhai-Khaima (M); Khaimasii (P); Khengthing (K)

Uses: The tender leaves are cooked and eaten as vegetable. According to Mao traditional folk tale, flowering of this plant indicates the right time for transplantation of paddy in the wet terrace fields.

Description: Large trees, 15-50 m high; bark reddish-brown, warty or blotched; leaves 8-18 cm x 2.5-6 cm, elliptic-lanceolate, oblong-elliptic, oblanceolate, acute, base cuneate, margin entire, deciduously bulbous hairy beneath, glabrous above; flowers axillary, solitary or paired, white, sepal rounded, ciliate, glabrescent; petals obovate, stamens yellow, nearly free, adnate to base of corolla; ovary hairy at base; fruits grey-pilose, depressed globose.

53. *Schizophyllum commune* Fr.

Coll. No. 171-MPK

LN: Pa-nghii (P); Pashi (K)

Fruiting period: September-April

Uses: Boiled along with dried meat or fish and eaten. It is also used for making chutney.

Description: A cosmopolitan pleurotoid sps. grows gregariously or scattered on trunks or branches of dead deciduous wood; cap is whitish grey when dry, 2-5 cm diam, fan or kidney shape, margin incurved; gills greyish-violet, radiating from a point of attachment of the cap.

54. *Smilax ovalifolia* Roxb. ex D. Don., Prodr. FN 49. 1825; *S. macrophylla* Roxb., FI 3: 793. 1892; Hook. f., FBI 6: 310. 1892; Hajra *et al.*, FS 1: 165. 1996.

Coll. No. 108-MPK

LN: Khekhra (M); Khaodutrah (P); Kangvah or Kangvaling (K)

Uses: Half cooked, chopped into pieces and prepared chutney with dried fish.

Description: Stout scandent, prickly shrubs; leaves orbicular or broadly oblong;

umbels 2-3 on a short peduncle; berries 2-3.7 cm in diameter.

55. *Spilanthes paniculata* Wallich ex DC., Prodr. 5: 625. 1836; Chowdhery in Hajra *et al.*, FI 12: 410. 1995.

Coll. No. 007-MPK

LN: Chiivio (M); Kuvi-vu (P); Ansha (K)

Uses: The leaves are eaten as cooked vegetables along with dried fish or meat.

Description: An erect annual herbs usually found in open grassland, roadsides or forest edges; opposite ovate to ovate-elliptic leaves, obtuse or acute at apex, heads 7-11 mm long with yellow corolla; achenes glabrous, verrucose, 2-2.5 mm long.

56. *Solanum nigrum* Linn., Haridasan & Rao, FFM 2: 648. 1987.

Coll. No. 027-MPK

LN: Ohuphirapro (M); Humarasoupru (P); Anjou (K)

Uses: Tender leaves are eaten as cooked vegetable along with dried fish or meat with chilli.

Description: A suffrutescent annual herbaceous plant; leaves ovate-lanceolate or ovate-oblong, entire, sinuate, acute or acuminate, glabrous; flowers white in sub-umbellate cymes, extra axillary. Fruits berry black, shining globose; seeds discoid, minutely pitted.

57. *Solanum torvum* Swartz., Kanjilal *et al.*, FA 3: 368. 1939; Haridasan & Rao, FFM 2: 648. 1987.

Coll. No. 156-MPK

LN: Ehiishikho-kha (M); Rakhokha (P); Khamchok-raling

Uses: Roasted fruits are use for making chutney.

Description: Shrubs or undershrubs; leaves ovate, lobed, acuminate, base unequal or rounded; flowers white, unarmed cymes; berry fruits globose, glabrous and reddish on maturity.

58. *Trichodesma khasianum* C.B. Clarke in Hook. f., FBI 4: 154. 1883; Kanjilal *et al.*, FA 3: 338. 1939.

Coll. No. 203-MP

LN: Khollo-raghii (M); Rahivuh (P); Lhanglha (K)

Uses: The inflorescences are half cooked, chopped into pieces for making chutney with dried or fermented fish.

Description: Apparently a stout, sparingly setose, shrub; leaves mostly opposite, petioled, scabrous tuberculate above, rugose subglabrate beneath; corymbs, nearly ebracteate, calyx lobes rusty-pubescent, corolla-tube lanceolate, linear; fruits ellipsoid, ridged, etc.

59. *Trichosanthes cordata* Roxb., FI 3: 703. 1832; Clarke in Hook. f., FBI 2: 608. 1879; Balakr., FJ 1: 213. 1981.

Coll. No. 017-MPK

LN: Eleo-vu (M); Loe-vu (P), Anthrul (K)

Uses: Eaten as cooked vegetable with dried fish or boiled along with rice and taken.

Description: Robust climbers with tuberous roots; leaves ovate, subangular or sublobate, cordate at base, membranous, entire, petioles 5-10 cm long, tendrils robust, sulcate, puberulous; flowers yellow; berries fruit globose.

60. *Viola distans* Wall., in Trans. Med. Phys. Soc. Cal. 7: 227. 1835; Hook. f. and Thomson in Hook. f., FBI 1: 183-184. 1973.

Coll. No. 002

LN: Eveikoreio (M);

Uses: Boiled with rice and eaten as cooked vegetable.

Description: Stem usually long and trailing; leaves ovate to reniform, cordate, obtuse to acute, crenate-serrate, glabrous to hirsute; flowers solitary, purplish-blue with dark stripes; style slender, narrowed downwards from the obscurely 3-lobed stgma; capsules ellipsoid-oblong, many seeded.

61. *Wendlandia glabra* DC., Prodr. 4: 411. 1830; Hook. f., FBI 3: 39. 1880; Gamble, Man. Ind. Timb. 408. 1902; Kanjilal *et al.*, FA 3: 34. 1939; Deb in BBSI 3: 313. 1961.

Coll. No. 114-MPK

LN: Houkhusii (M); Ahthiphung or Ahthipah (K)

Uses: Inflorescences eaten as cooked vegetable or half boiled and chopped into pieces for making chutney.

Description: Small tree; leaves ovate-lanceolate, elliptic-lanceolate, acuminate, base cuneate, glabrous; panicles up to 25 cm long; flowers white or yellowish-white; capsule globose.

62. *Zanthoxylum acanthopodium* DC., Hook. f., FBI 1: 493, 1875.

Coll. No. 116-MP

LN: Khemomou (M); Khaongashi (P); Lingnamse/Milongsingjol (K)

Uses: Tender leaves are eaten as cooked vegetable along with rice and dried fish. The fresh or dried fruits are ground and added in chutney preparation. It is also added in meat curry as condiment to give more flavor and palatability to the preparation. The aromatic fruit when taken raw gives a tingling sensation.

Description: Branchlets glabrous or tomentose, leaflets 2-6 pairs lanceolate, petiole and rachis narrowly winged, cymes very short dense, long pubescent.

63. *Zanthoxylum armatum* DC., Prodr. 1: 127. 1824; Narayanan and Nayar in Hajra *et al.*, FI 4: 379. 1997; *Z. alatum* Roxb., FI 3: 768. 1832; Hook. f., FBI 1: 493. 1875; Kanjilal *et al.*, FA 1: 199. 1936; Deb in BBSI 3: 304. 1961; Balakr., FJ 1:

117. 1981.

Coll. No. 123-MP

LN: Ramomoshi (M); Ngache (P); Toikeneo (K)

Uses: Tender leaves are eaten as cooked vegetable along with rice and dried fish. The fresh or dried fruits are ground and added in chutney preparation. It is also added in meat curry as condiment to give more flavor and palatability to the preparation. The aromatic fruit when taken gives a tingling sensation.

Description: Large shrubs or small trees; prickles straight, woody on old stems; leaflets elliptic to oblong-lanceolate or oblanceolate, cuneate at base, serrulate; rachis, winged; cymes paniculate, flowers pale yellow; seeds black, shiny.

6.2. **Wild Edible Fruits**

1. *Amomum dealbatum* Roxb., Fl 1: 42. 1820; Baker in Hook. f, FBI 6: 239. 1892; Hajra *et al.*, Fl. Sikkim 1: 122. 1996.

Coll. No. 180-MPK

LN: Leribou (M); Reivii (P); Aigeju (K)

Uses: Ripe fruits are eaten raw.

Description: Perennial herbs; leaves large oblong-lanceolate pale and pubescent beneath; spike globose short peduncled; outer bracts ovate, lip large obovate-cuneate, white with a yellow line down the centre and radiating red veins, anther-crest small sub-quadrate entire, capsule globose, reddish, with 9 winged crenulate vertical ribs.

2. *Baccaurea sapida* (Roxb.) Muell.-Arg., in DC., Prodr. 15(2): 459. 1866; Hook. f., FBI 4: 371. 1887; Gamble, man. Ind. Timb. 611. 1902; Brandis, Ind. Trees 562. 717. 1906; Kanjilal *et al.*, FA 4: 161. 1940. *Peirardia sapida* Roxb. Fl 2: 254. 1832.

Coll. No. 199-K

LN: Heipan or Theipangkai (K)

Uses: The pulp of the ripe fruits are eaten raw.

Description: Trees; leaves elliptic-oblong or elliptic-lanceolate, cuneate at base, acuminate; racemes panicled, 4-8 cm, on trunks, old leafless portions of branches; capsules ellipsoid, yellowish-brown; seeds flate, suorbicular.

3. *Calamus floribundus* Griff., in Hook. f., FBI 6: 444. 1892; Balakr., FJ 2: 556. 1983.

Coll. No. 115-MPK

LN: Okhrashi (M); Khrashi (P); Ting-ga (K)

Uses: Acidic ripe fruits are eaten alone or sometimes with common salt and dried chilly powder. Tender shoots of the plant are eaten as vegetable.

Description: Scandent, slender with yellowish-brown scales; leaves upto 1 m long, sheaths, rachis, petiole and spathes with scattered spines; male spadix very long with spinescent flagellum; drupe fruits sub-globose.

4. *Castanopsis hystrix* A. DC., in Seem. J. Bot. 1: 182. 1863; Hook. f., FBI 5: 620. 1888; Kanjilal *et al.*, FA 4: 322. 1940.

Coll. No. 150-MPK

LN: Thadziisii (M); Mochuchudu or Mabashi (P); Chongom or Sega or Shething (K)

Uses: The nut cotyledons are eaten raw or after roasting.

Description: A middle size tree; leaves lanceolate or narrow- elliptic, acuminate, entire; cupules congested in spikes covered with pubescent sharp spines; nuts ovoid, conic and smooth.

5. *Castanopsis tribuloides* (Sm.) DC., in Seem. J. Bot. 1: 182. 1863; Gamble, Man.

Ind. Timb. 683. 1902; Brandis, Ind. Trees 634. 1906; Hook. f., FBI 5: 622. 1888; Kanjilal *et al.*, FA 4: 324. 1940.

Coll. No. 157-MPK

LN: Thadziisii (M); Mochuchudu or Mabashi (P); Sega or Shething (K)

Uses: The nut cotyledons are eaten raw or after roasting.

Description: A middle-sized evergreen tree; leaves lanceoate, oblong-lanceolate or ovate-lanceolate, acuminate, entire, coriaceous, glabrous above; flowers solitary; ripe fruits with 1-3 nuts, glabrous; cotyledon ruminated

6. *Debregeasia longifolia* (Burm. f.) Wedd. in DC., Prodr. 16: 235. 1869; Kanjilal *et al.*, FA 4: 295. 1840; Hook. f., FBI. 5: 590. 1888; Balakr., FJ 2: 453. 1983; Haridasan & Rao, FFM 2: 842. 1987.

   Coll. No. 003-MPK

   LN: Madeilo (M); Daolousii or Kowlousii (P); Lingsi (K)

   Uses: Ripe fruits are eaten raw.

   Description: Small trees; leaves acute to subcordate at base, acute to acuminate, crenate-serrate, pale white or ash-tomentose beneath; achenes contained in fleshy perianth arranged in 6-8 mm thick heads, yellow or red.

7. *Diospyros kaki* Linn., Clarke in Hook. f., FBI 3: 555. 1882; Gamble, Man. Ind. Timb. 455. 1902; Brandis, Ind. Trees 432. 1906; Kanjilal *et al.*, FA 3: 200. 1939; Balakr., FJ 1: 295. 1981.

   Coll. No. 121-MP

   LN: Khradashi (M); Khradashi (P); Theipan (K)

   Uses: Cotyledons of ripe fruits are eaten raw.

   Description: Trees, 5-12 m; leaves ovate-elliptic or elliptic-lanceolate, acute or cuneate, pubescent beneath; berries pyriform, 3-4 cm diameter, orange-yellow.

8. *Diospyros lancifolia* Roxb., Fl 2: 537. 1832 (as *lanceoefolia*); Clarke in Hook. f., FBI 3: 562. 1882; Kanjilal *et al.*, FA 3: 203. 1939; Balakr., FJ 1: 296. 1981.

Coll. No. 147-MP

LN: Shiteishi (M); Siiteishi (P)

Uses: Cotyledons of ripe fruits are eaten raw.

Description: A middle-sized evergreen tree; leaves 2-8 by 1-3 in., narrow-elliptic or lanceolate to oblong-acuminate, glabrous, shinning above; flowers sessile, white, 4-5 merous; fruit subglobose or ovoid, .75-1 in. across supported by the spreading accrescent calyx; seeds generally 3.

9. *Docynia indica* (Wall.) Dcne., Hook. f., FBI 2: 369. 1878; Kanjilal *et al.*, FA 2: 210. 1938; Balakr., FJ 1: 190. 1981.

Coll. No. 135-MPK

LN: Chipfoshi (M); Phoshi (P); Theithup (K)

Uses: The acidic fruits are eaten raw or boiled with sugar, dried and taken. It is also used for making pickle or jam by the local people.

Description: A medium-sized tree. Leaves coriaceous, quite glabrous; flowers white, solitary, shortly pedicelled; fruit a nearly spherical yellow green apple with orange spots.

10. *Duchesnea indica* (And.) Focke in Engler and Prantl. Pflanzenfam, 3(3): 33. 1888; *Fragaria indica* Andr. FLB 2: 343. 1878; Kanjilal *et al.*, FA 2: 203. 1938.

Coll. No. 169-MP

LN: Likhodaphru shi (M)

Uses: Ripe fruits are eaten raw.

Description: Perennial creeping herbs with epigeal rooting stolons found in openplaces and wastelands; leaves in rosette, trifoliolate; leaflets obovate, cuneat or acute at base, obtuse, crenate-dentate, white pilose; flowers usually solitary or terminal cymes, yellow; achenes black, resting on bright red receptacle.

11. *Elaeocarpus floribundus* Bl., Bijdr. 120. 1825; Masters in Hook. f., FBI 1: 401. 1874; Kanjilal *et al.*, FA 1(1): 173. 1934; Balakr., FJ 1: 106. 1981; Haridasan & Rao, FFM 1: 167.1985.

    Coll. No. 073-MPK

    LN: Mazheshi or Shikeshi (M); Kieshi (P); Buiehthei or Zonmot (K)

    Uses: Ripe fruits are eaten raw and are prescribed as remedy for dry cough and indigestion.

    Description: Tall tree up to 30 m high, bark gray-brown, vertically fissured, stems often buttressed; leaves 8-16 x 5-8 cm, ovate-elliptic, broadly elliptic-acuminate, base cuneate or narrowed, glabrous, subcoriaceous, serrate; inflorescence glabrescent or glabrous, drupe light-green, acidic, oblong, rounded at both ends, 2.5-4 cm long, rugulose or nearly smooth.

12. *Elaeagnus conferta* Roxb., Fl Ed. Carey 1: 460. 1820; Syn. *E. latifolia* Linn. Hook. f., FBI 5: 202. 1886; Gamble, Man. Ind. Timb. 581. 1902; Brandis, Ind. Trees 547. 1906; Kanjilal *et al.*, FA 4: 114. 1940.

    Coll. No. 193-MPK

    LN: Chishoshi-kajii (M); Shoushi-ajii (P); Buiehthei (K)

    Uses: Ripe fruits are eaten raw.

    Description: A large woody straggling or scandent shrub, often spiny; Leaves altenate, ovate-oblong or elliptic, acute or acuminate, entire, subcoriaceous, glabrescent above; flowers often peduncled, yellowish or pale yellow; fruit pinkish or yellowish, 1-1.5 in. long, ovoid, oblong, re when ripe, succulent.

13. *Elaeagnus pyriformis* Hook. f. in Hook., FBI 5: 202. 1886; Gamble, Man. Ind.

Timb. 580. 1902; Brandis, Ind. Trees 547. 1906; Kanjilal *et al.*, FA 4: 115. 1940.

Coll. No. 177-MP

LN: Chishoshi-kati (M); Shoushi (P)

Uses: Ripe fruits are eaten raw. It is also used for making jam as local drink.

Description: A scandent or straggling woody shrub; leaves elliptic or elliptic-oblong, acuminate, entire, coriaceous, glabrous above, clothed with pale scattered silvery scale beneath; flowers in short axillary clusters; fruit pyriform, .3-.4 in long, red or yellowish when ripe, covery with coppery scales, glabrous.

14. *Emblica officinalis* Gartn., Fruct. 2: 122. t. 108. 1807; Kanjilal *et al.*, FA 4: 159. 1940; *Phyllanthus emblica* Linn. Sp. Pl. 982. 1753; Hook. f., FBI 5: 289. 1887; Gamble, Man. Ind. Timb. 599. 1902; Brandis, Ind. Trees 570. 1906; Balakr., FJ 2: 426. 1983.

Coll. No. 080-MPK

LN: Chohroshi (M); Hrushi or Rihaushi (P); Sohlu (K)

Uses: Mature fruits are eaten raw. The fruits are also cut into pieces, boiled along with sugar and allowed to ferment in tight containers for a week and is then used as local drink.

Description: A small to medium-sized deciduous tree; leaves subsessile, glabrous beneath; flowers yellowish, monoecious in axillary clusters; fruit a drupe, globose, .5-.8 in. across, yellowish on ripening, seeds trigonous.

15. *Ficus auriculata* Lour., Fl. Cochinch. 666. 1790; Balakr., FJ 2: 439. 1983; *F. roxburghii* Miq. Hook. f., FBI 5: 534. 1888; Kanjilal *et al.*, FA 4: 262. 1940.

Coll. No. 082-MPK

LN: Chodoshi (M); Doshi (P); Theichang (K)

Uses: Ripe fruits are eaten raw and also used for making jams as local drink.

Description: Tree found in forest edges; leaves ovate-orbicular, cordate or round at base, serrate-dentate; stipules ovate-lanceolate; peduncles 2-4 cm; achenes minutely tuberculate.

16. *Ficus hispida* Linn., Suppl. 442. 1781; King in Hook. f., FBI 5: 522. 1888; Prain, Bengal Pl. 2: 981. 1903 (Rep. ed. 1963) and in RBSI 3: 280. 1905.

    Coll. No. 191-MP

    LN: Ovachidoshi (M); Radoshi (P)

    Uses: Ripe fruits are eaten raw.

    Description: Large shrub, hispid-pubescent throughout; leaves alternate or opposite, ovate-elliptic, apex acute, serrate-dentate; flowers many, clusters in trunk; gall flowers pedicelled; fruits achene.

17. *Ficus roxburghii* Wall., Hook. f., FBI 5: 534-535. 1888; Kanjilal *et al.*, FA 262-263. 1940.

    Coll. No. 181-MP

    LN: Moboshi (M); Maboushi (P)

    Uses: Ripe fruits are eaten raw.

    Description: A middle-sized tree; leaves 5-14 by 4-11 in. broad, ovate-orbicular, ovate or rounded, acute or mucronate, entire or toothed, subcoriaceous, glabrous or glabrescent above; receptacles purplish-orange when ripe.

18. *Grewia elastica* Royle., Illus. Bot. Himal. 1: 104. T. 22. 1839; Kanjilal *et al.*, FA 1: 103. 1934; Chauhan *et al.*, Fl. Namdapha (edt. Hajra) 121. 1996.

    Coll. No. 145-P

    LN: NR

    Uses: Ripe fruits are edible.

    Description: A deciduous medium-sized tree with greyish-white bark; leaves oblong-ovate or elliptic, closely crenate-serrate, thinly coriaceous; flowers in fascicled or rarely solitary axillary cymes; drupe globose, slightly hairy, blackish when ripe.

19. *Juglans regia* Linn., Kanjilal *et al.*, FA 4: 298.1940.

Coll. No. 162-MPK

LN: Okhusii (M); Khushi (P); Makha (K)

Uses: The lobed cotyledons are eaten raw after breaking the hard shell.

Description: A large deciduous tree; leaves imparipinnate, thickly tomentose when young, leaflets 5-13, , subsessile, elliptic-oblong, often oblique, usually entire, acute or acuminate, coriaceous; fruit 2 in. long, ovoid, glabrous or pubescent, cotyledons irregularly corrugated.

20. *Morus alba* Linn., See SN 35 of 6.1. Wild Edible plants

Uses: Ripe fruits are eaten raw.

21. *Morus australis* Poir., in Lamk. Encycl. Meth. 4: 380. 1797.

Coll. No. 143-MPK

LN: Huhreshi or Kheloshi (M); Thingteimi (K)

Uses: Ripe fruits are eaten raw and also available for selling in the local markets.

Description: Large shrubs or small trees; leaves ovate, cordate at base, caudate-acuminate, serrate; flowers in axillary, solitary, yellowish-green; fruits ovoid, subglobose, black, seeds subglobose.

22. *Myrica farquhariana* Wall., Syn. *Myrica nagi* (non Thunb.) Hook., Balakr., FJ 2: 394. 1983.

Coll. No. 077-MPK

LN: Piyeh-sii (M); Mayeshi or Yaisii or Zheashi (P); Makei or Makingat (K)

Uses: Ripe fruits are eaten raw.

Description: A small or medium sized evergreen tree with grayish-brown bark; leaves lanceolate, oblanceolate or obovate, obtuse or acute, coriaceous, glabrous above; fruits ellipsoid or ovoid, tubercled, reddish or purplish coloured when ripe.

23. *Ophiopogon wallichianus* (Kunth) Hook. f., Hook. f., FBI 6: 268-269. 1892; *Fluggea wallichiana* Kunth, Enum. 5: 303. 1850.

Coll. No. 124-M

LN: Ovopishu (M)

Uses: Ripe fruits are eaten raw.

Description: Stem with tufted root stock, short and stout; leaves often distichous and recurved, nearly quite smooth; the stout scape longer or shorter than the leaves; perianth pale white or lilac.

24. *Phoenix humilis* Royle., Beccari and Hooker in Hook. f., FBI. 6: 426. 1892; Prain, Beng. Pl. 1096. 1903; Balakr., FJ 2: 557-558. 1983. Coll. No. 163-MPK

LN: Chaghashi (M); Lusu (K)

Uses: Ripe fruit cotyledons are eaten raw.

Description: Stem short, tufted, rarely elongate found in open grasslands; leaves subglaucous, petioled broad at base; fruiting spadices on long flattened peduncles; fruit ovoid, orange-red.

25. *Physalis peruviane* Linn., Sp. Pl. ed. 2: 1670. 1753; Clarke in Hook. f., FBI 4: 238. 1883; Kanjilal *et al.*, FA 3: 364. 1939; Chauhan *et al.*, Fl. Namdapha (edt. Hajra) 228. 1996.

Coll. No. 041-MPK

LN: Korelashii or Kilashibou or Napfiinanoshi (M); Khaokhashi or Kobirathou (P); Theisap or Buhkol or Pohkol (K)

Uses: Ripe fruits are eaten raw. It is also roasted and used for making chutney.

Description: Bushy annual herbs; leaves ovate, membranous finely hairy; flowers pale yellow, axillary, solitary, calyx pubescent outside, corolla with 5 large internal purple; Berry fruit ellipsoid.

26. *Prunus cerasoides* D. Don., Prodr. Fl. Nepal 239. 1825; Kanjilal *et al.*, FA 2: 180. 1938; Deb in BBSI 3: 259. 1961; Hara in Hara *et al.*, Enum. Fl. Pl. Nep. 2: 141. 1979. *P. Puddum* Roxb. Hook. f., FBI 2: 314. 1878.

Coll. No. 185-MP

LN: Pfovashi (M); Vashi (P)

Uses: Ripe fruits are eaten raw.

Description: A middle sized deciduous tree; leaves elliptic or ovate-lanceolate, caudate-acuminate, dark-green and shinning above; flowers pink, fading to white, subumbellate, subcorymbose fascicles; drupe fruit .3-.4 in. long, ellipsoid or oblong, yellow sometimes tinged with red.

27. *Prunus cornuta* (Wallich ex Royle) Steud. Hara in j. Jap. Bot. 37: 98. 1962; Ghora & Panigrahi in Fasc. Fl. 18: 28. 1984; *P. cornuta* forma *villosa* (Hara) Hara, Fl. East Himal. 2: 54. 1971. Et En Fl. Pl. Nepal 2: 141. 1979.

Coll. No. 149-MP

LN: Mokhoshi (M); Ngourashi (P)

Uses: Ripe fruits are eaten raw.

Description: A middle sized deciduous tree, twigs glabrous or very finely pubescent; leaves oblong-lanceolate or oblong-ovate, acuminate, closely serrate, glaucescent beneath; flowers white in terminal or axillary drooping racemes; ovary and style glabrous; drupe globose, nearly black when ripe, stone thick, rugose.

28. *Prunus nepalensis* (Ser.) Steud., Balakr., FJ 1: 182. 1981; Kanjilal *et al.*, FA. 3. 178-179. 1939.

Coll. No. 148-MP

LN: Mokhoshi (M); Khashi (P); Molthei (K)

Uses: Ripe fruits are eaten raw. It is also available for selling in the local markets.

Description: A middle sized deciduous tree; leaves 3-6 by 1.2-2.5 in. lanceolate, oblong lanceolate, caudate-acuminate, crenate-serrate; glabrous above, glaucous beneath; flowers white, racemes or axillary; drupe fruit fleshy, black, globose, acid or subacid; stone smooth, about .6 in. long.

29. *Prunus persica* (Linn.) Batsch, Beytr. Pragm. Gesch. Naturr. 1: 30, 1801; Hook. f., FBI 2: 313. 1878.

Coll. No. 049-MPK

LN: Mikriashi (M); Haushi or Krishi or Trushi (P); Vaisohlu

Uses: Ripe fruits are eaten raw.

Description: Small trees, 5-9 m; leaves lanceolate tp broadly oblanceolate, acuminate, serrate, puberulous on midrib beneath; flowers pink to white; drupes succulent, downy pilose; pyrenes rugose

30. *Pyrus pashia* Buch.-Ham. ex. D. Don., Prodr. Fl. Nep. 236. 1825; Hook. f., FBI. 2: 374. 1878; Kanjilal *et al.*, FA 2: 216. 1938; Deb in BBSI 3: 259. 1961; Balakr., FJ 1: 196. 1981.

Coll. No. 25-MP

LN: Chitishi (M); Taoshi (P); Bulthing (K)

Uses: Ripe fruits are eaten raw.

Description: Middle sized deciduous tree. Leaves ovate, ovate-lanceolate or elliptic, acuminate or caudate, base rounded or truncate, finely serrulate; flowers in axillary and terminal umbels; fruits a pome, ellipsoid or globose, depressed at apex, white specked, dark brown when ripe.

31. *Rhus semiliata* Murry, See SN 50 of 6.1. Wild edible plants

Uses: The acidic ripe fruits are boiled with sugar and drink as herbal tea.

32. *Rubus ellipticus* Smith in Hook. f., FBI 2: 336. 1878; Kanjilal *et al.*, FA 2: 196. 1938; Balakr., FJ 1: 184. 1981; Haridasan & Rao, FFM 1: 365. 1985.

Coll. No. 034-MPK

LN: Shiinghoshi (M); Ngushoshi or Traishushi (P); Theimi (K)

Uses: Ripe fruits are eaten raw and also making jams for local drink.

Description: A tall suberect bush. Branches stout, spreading and recurved, hairs red- brown, often very dense, prickles stout, hardly compressed; panicles small, many flowered, pedicels short, bracts setaceous; fruits orange yellow, succulent.

33. *Rubus niveus* Thunb., Diss. Bot. Med de. Rubo 78. 9. f. 3: 1813; Haridasan & Rao, FFM 1: 367. 1985; *R. lasiocarpus* Smith in Rees. Cyclop. 30: *Rubus* no. 6. 1815; Hook. f., FBI 2: 339. 1878; Kanjilal *et al.*, FA 2: 200. 1938; Deb in BBSI 3: 260. 1961.

Coll. No. 033-MPK

LN: Shiingukateishi (M); Chomoushushi (P); Theimivom (K)

Uses: Ripe fruits are eaten raw.

Description: A large rambling plant. Corymbs axillary and terminal, simple or subpanicled, densely tomentoseor villous or merely puberulous on short or long peduncles; fruit globose, hoary, drupes numerous, dry or fleshy and then red or orange; stone pitted.

34. *Rubus rugosus* Smith in Rees, Cyclop. 30: *Rubus* n. 34. 1819; Balakr., FJ 1: 186. 1981. R. *Moluccanus sensu* Hook. f., FBI 2: 330. 1878, non Linn. 1753; Kanjilal *et al.*, FA 2: 194. 1938, p.p.; Deb BBSI 3: 261. 1961; Haridasan & Rao, FFM 1: 368. 1985.

Coll. No.032-MPK

LN: Shiinghokoghoshi (M); Kohamoushushi (P); Kaichim or Naichin (K)

Uses: Ripe fruits are eaten raw.

Description: Straggling or subcandent shrubs; prickles short, straight or slightly curved; leaves suborbicular, cordate with 3-7 orbicular lobes, unequally serrate; panicles terminal and axillary; flowers cream-yellow; fruit globose, red.

35. *Spondias acuminata* Roxb., FI 2: 453. 1832; Hook. f., FBI 2: 42. 1876; *Spondias macrophylla* Wallick ex Hook. f., FBI 2: 43. 1876.

Coll. No. 146-M

LN: Shilasii (M); Lashi (P); Theikhong-chom (K)

Uses: Ripe fruits are eaten raw. It is also cooked with dried meat or fish mixed with chilli and eaten.

Description: Deciduous trees upto 20 m high with lax crown; leaves upto 45 cm long; leaflets oblong-lanceolate; flowers in axillary, large, conical panicles, white or yellow; drupes oblong-ovoid, yellowish when ripe.

36. *Viburnum foetidum* Wall., Clarke in Hook. f., FBI 3: 4. 1880; Gamble, Man. Ind. Timb. 393. 1902; Brandis, Ind. Trees 362. 1906; Kanjilal *et al.*, FA 3: 3. 1939; Balakr., FJ 1: 228.1981.

Coll. No. 050-MP

LN: Shiikreshi (M); Khuashi or Trushi (P); Lingshiga (K)

Uses: Ripe fruits are eaten raw.

Description: Shrubs upto 3-5 m tall; leaves elliptic-lanceolate, rounded or truncate at base, acute-mucronate, glabrous; flowers white in sub-corymbs; fruits drupes, ellipsoid, bright-red when ripe; seeds 3-grooved.

6.3. Ethnomedicinal plants

1. *Achyranthes aspera* Linn., Sp. Pl. ed. 1: 204. 1753; Hook. f., FBI 4: 730. 1885; Watt, Dict. Econ. Prod. 1: 81. 1889; Prain, Bengal Pl. 2: 875. 1903 (Rep. ed. 1963) and RBSI 3(2): 266. 1905; Kanjilal *et al.*, FA 4: 6-7. 1940. (Acanthaceae)

   Coll. No. 086-MPK

   LN: Amapro (M); Hya (P); Selmeibou (K)

   Fls. & Frts.: May-October

   Uses: Bruised leaves paste is applied to relieved tooth ache or massage against certain body swellings.

   Description: An erect undershrubs or herbs; leaves ovate to obovate, acute or obtuse at base, subacute or acuminate; spikes simple or paniculate; seeds orbicular-cochleate, reddish-brown.

2. *Acorus calamus* Linn., Sp. Pl. 324. 1753; Hook. f., FBI 6: 555. 1893; Hajra *et al.*, Fl. Sikkim 1: 185. 1996. (Arecaceae)

   Coll. No. 111-MP

   LN: Donia (M); Vassiipro or Seihraipeu (P); Vohluthao (K)

   Fls. & Frts.: April-September

   Uses: Boiled decoction of the rhizome is prescribed as remedy against epilepsy and stomachache. Crushed rhizome paste is applied to relieved toothache. It is also used to wash head for killing head lice's. Fresh leaves are used as insects repellant such as tick.

   Description: Rhizomes thick, compressed, aromatic; leaves linear, peducles thick; spadix; glaucous-green berries, oblong, reddish.

3. *Adhatoda zeylanica* Medic., Hist. and commentat. Acad. Elect. Sci. Theod.-

Palat. 6: 393.1790; *Justicia adhatoda* Linn. Sp. Pl. 15. 1753; Clarke in Hook. f., FBI 4: 540. 1885. (Acanthaceae)

Coll No. 084-MPK

LN: Khejii or Khriphrongho (M); Kolhou apah-akang (K)

Fls. & Frts.: May-October

Uses: Fresh leaves are dipped in hot boiling water and massage to relieved body ache, chest pain and joint dislocation.

Description: Shrubs with grey or grayish-brown bark; leaves lanceolate, elliptic-lanceolate, acuminate or acute, base cuneate, attenuate, narrowed to the petiole; flowers white or greenish-white; capsules 2 cm long.

4. *Ageratum conyzoides* Linn., Sp. Pl. 839. 1753; Hook. f., FBI 3: 242. 1881; Deb in BBSI 3: 329. 1961; Balakr., FJ 1: 258. 1981; Haridasan & Rao, FFM 1: 516. 1985; Uniyal in Hajra *et al.*, FI 12: 348. 1995. (Compositae or Asteraceae)

Coll. No. 022-MPK

LN: Kolapro (M); Loubong (K)

Fls. & Frts.: Almost round the year

Uses: Bruised leaves paste and extract are applied to cut or other external injury for controlling bleeding and wound healing. Leaves extract is also applied as eye drop against conjunctivitis.

Description: Hairy herbs upto 1 m high; leaves ovate, ovate-rhomboid, obtuse or acute, base subtruncate or acute, crenate, serrate; heads white, bluish or violet; involucral bracts lanceolate; achenes blackish-brown; pappus scales awn-tipped.

5. *Alnus nepalensis* D. Don., Prodr. 58. 1825; Hook. f., FBI 5: 600. 1888; Gamble, Man. Ind. Timb. 670. 1902; Brandis, Ind. Trees 623. 1906; Kanjilal *et al.*, FA 4: 327. 1940; Haridasan & Rao, FFM 2: 853. 1987. (Betulaceae)

Coll. No. 131-M

LN: Oposii (M); Pasii (P); Hengpi/Hengdo (K)

Fls. & Frts.: Nearly throughout the year

Uses: Ground stem bark is applied as paste in cut or injury to control bleeding.

Description: Middle sized trees; bark grey, grayish-brown, warty, horizontally lenticellate; leaves broadly elliptic, obovate-elliptic, obtuse or acute, glaucous beneath; male spikes upto 25 cm long, sleder, panicled, drooping, yellow; female short, cylindric; fruiting spikes 1-1.5 cm long, oblong, blackish-brown when ripe.

6. *Arisaema tortuosum* (Wall.) Schott, Melet. 1: 17. 1832; Hook. f., FBI 6: 502. 1893; Balakr., FJ 2: 562. 1983; *Arum tortuosum* Wall. Pl. As. Rar. 2: 10. 1830. (Araceae)

Coll. No. 061-MP

LN: Shekribirou (M)

Fls. & Frts.: April-October

Uses: Leaves petiole is cut and place at the site of bee sting and snake bite as an antidote to neutralize the poison.

Description: Tuber depressed-globose; leaflets oblong or elliptic, acuminate; peduncles 18-75 cm, spathes lanceolate; spadix 16-30 cm; appendage long, curved, sigmoid, tapering to filiform tail; berries ovoid, red.

7. *Artemesia nilagirica* (Clarke) Pamp., Deb in BBSI 3: 330. 1961; Balakr., FJ 1: 261. 1981; Haridasan & Rao, FFM 2: 518-519. 1987; Naithani in Hajra *et al.*, FI 12: 37. 1995. (Compositae or Asteraceae)

Coll. No. 060-MP

LN: Shipripreikhro (M); Biachii (P); Gamsei (K)

Fls. & Frts.: August-February

Uses: Extract from bruised leaves mixed with little amount of water and drink to control against diarrhea and dysentery.

Description: Bushy aromatic undershrubs up to 3 m high; young parts tomentose; leaves ovate, oblong-ovate, deeply pinnatisect, segments acute, mucronate; heads yellowish-white in paniculate racemes; involucral bracts oblong; achenes minute, oblong, blakish.

8. *Artemesia parviflora* Roxb., Hook. f., FBI 3: 322. 1881; Kanjilal *et al.*, FA 3: 119. 1939; Deb in BBSI 3: 330. 1961; Balakr., FJ 1: 261. 1981; Haridasan & Rao, FFM. 2: 519. 1987. (Compositae or Asteraceae)

Coll. No. 047-MPK

LN: Shipripreimiu (M); Gamsaido/Saido (K)

Fls. & Frts.: August-February

Uses: The bruised leaves paste and extract are applied to cut or injury to control bleeding and wound healing. The paste is also applied to nose to control bleeding.

Description: Undershrubs usually glabrescent; leaves acute, sessile; heads pedicelled, yellow in large leafy pyramidal; involucral bracts ovate, ovate-oblong, margin scarious; achenes minute.

9. *Arundo donax* Linn., Sp. Pl. 81. 1753; Hook. f., FBI 7: 302-303. 1897; Kanjilal *et al.*, FA 5: 89-90.1940. (Gramineae or Poaceae)

Coll. No. 014-M

LN: Okhru (M); Thru (P); Pumpeng (K)

Fls. & Frts.: September-January

Uses: Tender shoot mixed with *Prunus persiaca* leaves, crushed and applied as paste in cattle's wound for killing maggots and wound healing.

Description: Culms 3-6 m, stout, many noded, glabrous and smooth; leaves linear-lanceolate, inflorescence large, terminal, decompounds plumose panicle, erect;

glumes subequal, lanceolate-acuminate, glabrous; lemmas ovate to ovate-lanceolate; lodicules 2, obovate, glabrous.

10. *Asparagus filicinus* Buch.-Ham. ex D. Don., Prodr. FN 1: 49. 1825; Hook. f., FBI 6: 314. 1892; Balakr., FJ 2: 539. 1983; Hajra *et al.*, Fl. Sikkim 1: 145. 1996. (Liliaceae)

Coll. No. 013-MP

LN: Shiipa-patto (M); Koukomanya or Pavoih (P); Deitoh (K)

Fls. & Frts.: May-October

Uses: Boiled decoction of root tubers is prescribed against womb and menstrual disorders.

Description: Rootstock stout, creeping with erect stem common in open forests; branches flexuous, subscandent; perianth subcampanulate, pale yellow; stamens short; anthers minute; berries red.

11. *Bauhinia purpurea* Linn., See SN 6 of 6.1. Wild edible plants

Uses: Boiled decoction of flowers is given as remedy for diabetes. Leaves decoction is prescribed for piles, stomach disorders and constipation. Stem or root bark decoction is given for diarrhea, dysentery, gastritis and checked excesses bleeding during menstruation. Flowers or roasted seeds are taken to remove fish bone that block throat. According to Mao traditional folk tale, the flowering of this plant indicates the right time to starts sowing paddy in the jhum fields or in the field for transplantation in the ensuing season in the rice fields.

12. *Betula alnoides* Buch-Ham. ex D. Don., Prodr. 58. 1825; Hook. f., FBI 5: 599. 1888; Gamble, Man. Ind. Timb. 669. 1902; Brandis, Ind. Trees 622. 1906; Kanjilal *et al.*, FA 4: 328. 1940; Balakr., FJ 2: 455. 1983. (Betulaceae)

Coll. No. 202-P

LN: Opocharisii (M); Raisii (P)

Fls. & Frts.: April-August

Uses: Boiled decoction of stem or root barks is taken against diarrhea and dysentery.

Description: Lofty trees with pale brown bark peeling off in horizontal rolls; leaves ovate, ovate-lanceolate, acuminate, cuspidate serrate, male spikes long, slender greenish-yellow, female equaling males, fascicled; fruiting spikes 3-8 cm long.

13. *Bidens pilosa* Linn *var. minor* (Bl.) Scherff. B. Gaz. 80: 387. 1925; Balakr., FJ 1: 257. 1981; Haridasan & Rao, FFM 2: 519. 1987; Chowdhery in Hajra *et al.*, FI. 12: 372. 1995. (Compositae or Asteraceae)

Coll. No. 029-MPK

LN: Siiriisiichopro or Chaghapitei (M); Ghapitei (P); Manchep or Ponkap (K)

Fls. & Frts.: August-January

Uses: Extract from leaves and paste is applied to cut or injury to control bleeding and wound healing. Boiled decoction is prescribed against uncontrolled bleeding after delivery.

Description: Herbs or undershrubs; branches angular; leaflets ovate, ovate-lanceolate, orbicular or elliptic, acute, obtuse-acuminate, sharply crenate-serrate, glabrous; heads with white ray florets and yellow disc florets, involucral bracts spathulate; achenes ribbed, narrowly oblong, black.

14. *Blumeopsis flava* (DC) Gagnep., Bull. Hist. Nat. Paris 26: 76. 1920; Kumar in Hajra *et al.*, FI 13: 145. 1995; *Blumea flava* DC. Prodr. 5: 439. 1836; Balakr., FJ 1: 274. 1981. (Compositae or Asteraceae)

Coll. No. 085-MPK

LN: Napupro (M); Baopu or Deidopeumanu (P); Puhlou (K)

Fls. & Frts.: Almost round the year

Uses: Boiled decoction of leaves is given for fevers, high BP and dry cough. Tender leaves warm from fire and massaged to relieved chest pain and bodyache. The extract and bruised leaves paste is also applied to cut or injury to control bleeding and wound healing, skin diseases, etc. It is also mixed with ground Napthalene ball powder and applied to cattle's wound for killing maggots.

Description: An erect annual herbs glabrous or puberulous, 0.45-0.75 m tall; leaves radical or alternate, tomentose, ovate-lanceolate, obvate or sometimes spathulate, oblong-cordate; capitula in axillary or terminal panicled cymes; achenes very small, ribbed; pappus white.

15. *Bombax ceiba* Linn., Sp. Pl. 1: 511. 1753; Nayar and Biswas in Sharma *et al.*, FI 3: 398. 1993; Singh *et al.*, FM 1: 174. 2000; *B. malabaricum* D.C., Masters in Hook. f., FBI 1: 349. 1874; Kanjilal *et al.*, FA 1: 147. 1934. (Bombacaceae)

Coll. No. 201-MP

LN: Pekribou (M)

Fls. & Frts.: February-June

Uses: Crushed stem bark is applied as paste to relieved toothache.

Description: Large deciduous trees, trunk armed with conical prickles; leaves spirally alternate, digitately compound, leaflets elliptic,. oblong-elliptic, acuminate, glabrous, glaucous beneath; flowers showy red in the axils of fallen leaf; ovary woolly; fruit capsule, oblong-ovoid, pubescent, silky within; seeds many, obovoid, covered with white cotton.

16. *Bryophyllum pinnatum* (Lam.) Kruz., Oken, Allgem, Naturgesh 3(3): 1966. 1841; Berger in Engler, Pflanzenfam. ed. 2. 18a: 410. 1930; Ohba in Hara *et al.*, Enum. Fl. Pl. Nepal 2: 159. 1979; Naskar, Pl. Wlth. L. Ganga Delta 317. 1993.

Kalanchoe pinnata (Lam.) Pers., Syn. 1: 446.1805; Banerjee *et al.*, Diversity Coast. Pl. Comm. India 232. 2002. (Crassulaceae)

Coll. No. 107-MP

LN: Kathetobo (M)

Fls. & Frts.: October-January

Uses: Ground leaves are applied as paste to burns and inflammation to relieve pain. Extract from ground leaves mixed with little amount of water and drink to relieved gastritis and other stomach complaints.

Description: An erect succulent glabrous herb; leaves opposite, simple, 3-5 foliolate; elliptic or ovate-oblong, subincised crenate; flowers pendulous in terminal paniculate cymes, calyx segments ovate, acute, purplish, corolla tubular, reddish purple; seeds oblong, small.

17. *Calamintha umbrosa* (Bieb.) Benth., in DC. Prodr. 12: 1848; Hook. f., FBI 4: 650. 1885; Prain, Beng. Pl. 853. 1903; Duthie, Fl. Upp. Gang. Pl. 2: 244. 1911; Mukerjee in RBSI 14(1): 98. 1940. (Labiatae or Lamiaceae)

Coll. No. 196-M

LN: Ezhupro (M)

Fls. & Frts.: July-November

Uses: Juice extracts and bruised leaves are applied as paste to control bleeding in cut or injury and wound healing.

Description: Slender herbs; leaves ovate, rounded or cuneate at base, acute to subobtuse, serrate at upper margins; verticillasters in dense subcapitate whorls; bracts 2-4, subulate-filiform; nutlets subglobose.

18. *Cannabis sativa* Linn., Sp. Pl. 1027. 1753; Hook. f., FBI 5: 487. 1888; Kanjilal *et al.*, FA 4: 278. 1940; Haridasan & Rao, FFM 2: 810. 1987. (Cannabinaceae)

Coll. No. 158-K

LN: Gangja (K)

Fls. & Frts.: August-December

Uses: Boiled decoction of tender leaves is given for diarrhea and dysentery. Leaves are cooked along with pig foodstuff and given against swine fever.

Description: A strong smelling annual shrubs or undershrubs; leaflets linear-lanceolate, oblong-lanceolate, acuminate, sharply repand, serrate; flowers greenish-yellow, drooping; achenes small, angular, brownish-yellow when ripe.

19. *Carica papaya* Linn., Sp. Pl. 1036. 1753; Masters in Hook. f., FBI 2: 599. 1879; Watt, Dict. Bot. Prod. 2: 158. 1889; Fischer in RBSI 12: 97. 1938; Deb in BBSI 3: 285. 1961. (Caricaceae)

Coll. No. 093-PK

LN: Siiphrosii (M); Siitou (P); Thingchangmai (K)

Fls. & Frts.: Almost round the year

Uses: Boiled decoction of unripe fruit is taken as remedy for gastritis and other stomach complaints, diabetes, etc. Ground seed powders mixed with water and drinks for expulsion of intestinal worms and also have abortificent properties.

Description: Small trees with milky latex; leaves alternate usually forming a crown at apex, long petioled, palmately lobed; flowers greenish white polygamodioecious; fruits large, 1-celled berry, globose; seeds, many, ovoid, ellipsoid, wrinkled, black.

20. *Catharanthus roseus* (Linn.) G. Don., Syst. Gard. 4: 95. 1837; Hook. f., FBI 3: 640.1882; RBSI 3(2): 236. 1905; Haridasan & Rao, FFM 2: 612. 1987; Diversity Coast. Pl. Comm. India 280. 2002. (Apocynaceae)

Coll. No. 162-PK

LN: NR

Fls. & Frts.: Almost round the year

Uses: Boiled decoction of tender leaves is prescribed for fevers and dry cough.

Description: Erect annual or perennial herb; leaves obovate-oblanceolate, opposite decussate shining, entire, base narrowed; flowers reddish, pink or white, axillary, solitary or grouped into 2-3, salver-shaped; fruits a pair of follicles linear; seeds cylindric, blackish.

21. *Cedrela serrata* Royle, Bot. Himal. 144. T. 25. 1839; RBSI 3: 363. 1908. (Meliaceae)

Coll. No. 200-P

LN: Khezhusii (M); Viesii (P)

Fls. & Frts.: May-October

Uses: Hot infusion of the leaves is massage against joint dislocation and sprain.

Boiled decoction of root bark is taken to relieved high BP.

Description: A moderate-sized deciduous tree; leaves long usually imparipinnate, midrib reddish, leaflets opposite, elliptic-oblong or oblong-lanceolate, acutely acuminate, serrate, base oblique, glabrous or pubescent, emit a foetid smell when bruised; flowers pink to nearly white in large drooping subterminal panicles; capsule ovoid, reddish-brown.

22. *Centella asiatica* (Linn.) Urb., See SN 11 of 6.1. Wild edible plants

Uses: Extract from fresh leaves is applied as eye drop against conjunctivitis.

Whole plant is eaten as cooked vegetable to relieve gastritis and other gastro-intestinal disorders.

23. *Chenopodium ambrosiodes* Linn., Sp. Pl. ed. 1: 219. 1753; Hook. f., FBI 5: 4. 1886; Watt, Dict. Econ. Prod. 2: 267. 1889; Datta and Majumdar in BBSB 20(2):

50. 1966; Banerjee *et al.*, Diversity Coast. Pl. Comm. India 333. 2002; Kanjilal *et al.*, FA 4: 10.1940. (Chenopodiaceae)

Coll. No. 011-M

LN: NR

Fls. & Frts.: Almost round the year

Uses: Grouned leaves mixed with Naphthalene ball powder and applied as paste in cattle's wound against killing maggots and wound healing.

Description: Strongly scented erect undershrubs or perennial herbs; leaves oblong or lanceolate, obtuse, sinuate-toothed; flowers greenish, minute, sessile; panicles axillary or terminating the branchlets or peduncled spikes; utricle enclosed by the persistent perianth; seed brown.

24. *Clerodendrum colebrookianum* Walp., See SN 15 of 6.1. Wild edible plants (Verbenaceae)

Uses: Tender leaves are eaten as cooked vegetable as medicinal food against high blood pressure.

25. *Conyza viscidula* Wallich ex DC. Prodr. 5: 383. 1836; Hooker, FBI 3: 258. 1881; Deb in BBSI 3: 331. 1961. (Compositae or Asteraceae)

Coll. No. 094-M

LN: Lokaipro (M)

Fls. & Frts.: July-December

Uses: Boiled decoction of leaves mixed with sugar cube is prescribed against kidney and gall bladder stones.

Description: Annual-biennial herbs; leaves shortly petiolate or sessile, lanceolate or slightly elliptic, entire or serrulate; capitula in terminal panicles; flowers white; achenes small, flat, obvate-lanceolate, glabrate; pappus white.

26. *Costus speciosus* (Koening) Sm., in Trans. Linn. Soc. 1: 249. 1791; Baker in Hook. f., FBI 6: 249. 1892; Prain, Bengal Pl. 2: 786. 1903 (Rep. ed. 1963); Holttum in Gard. Bull. Singapore 13: 242. 1950. (Zingiberaceae)

Coll. No. 076-MP

LN: Kathemeionghobu or Orachidu (M); Laroubi (P); Aijon (K)

Fls. & Frts.: July-November

Uses: Extract from crushed stem is applied as ear drop against infection.

Description: A large annual herbs; leaves oblanceolate to obovate, caudate-acuminate, silky pubescent beneath; flowers in spikes terminal, petals white, bracts ovate, reddish; capsules globose-oblong, red; seeds black, arillate.

27. *Crassocephalum crepidioides* (Benth.) Moore in J. Bot. 50: 211. 1912; *Gynura crepidioides* Benth. in Hooker Niger. Fl. 438. 1849; Kanjilal *et al.*, FA 3: 127.1939; Balakr., FJ 1: 270.1981. (Compositae or Asteraceae)

Coll. No. 083-MPK

LN: Mozhatobo (M); Labo or Lahrapoupa or Popaghidu or Poubvie (P); Hamdong (K)

Fls. & Frts.: July-February

Uses: Boiled decoction of tender leaves is given against gastritis and constipation. It is also prescribed as remedy for diabetes and relieved high blood pressure. Flower paste is applied to cut or injury to control bleeding and wound healing.

Description: Herbs upto 1.5 m high; leaves obovate-elliptic, oblong-elliptic, acute, dentate, membranous, glabrous; corymbs drooping when young, head deep-red at tip; involucral bracts oblong-linear; achenes minute, blackish.

28. *Curculigo orchioides* Gaertn., Fruct. 1: 63.t. 13. 1788; Hook. f., FBI 6: 278. 1892; Prain, Bengal Pl. 2. 796. 1903 (Rep. ed. 1963); Balakr., FJ 2: 532. 1983.

(Hypoxidaceae)

Coll. No. 195-M

LN: Epovii (M); Taziipishu (P); Aidel (K)

Fls. & Frts.: June-October

Uses: The rhizomes are crushed and applied as paste against controlling bleeding in cut or injury and wound healing.

Description: Rootstock tuberous common in grassy slopes, wasteland in open or partially shaded places, crowned with fibrous remains of old sheaths; leaves linear-lanceolate, acuminate; flowers subsessile, distichous, yellow or orange; perianth-lobes oblong; fruits capsule, oblong with a minute beak; seeds with deep wavy grooves, shiny-black.

29. *Curcuma aeruginosa* Roxb., Asiat. Res. 11: 335. 1810; Hook. f., FBI 6: 212. 1890. (Zingiberaceae)

Coll. No. 092-MPK

LN: Mosalakatei (M); Igivou-atei (P); Aivom (K)

Fls. & Frts.: April-July

Uses: The aqueous extract from crushed rhizome is taken to relieve from stomachache and fevers. A piece of the rhizome is also carry in pocket during travelling, attending funeral or going in the jungle to protects against harms from Witchcrafts and evil spirits.

Description: Leaves large oblong with a broad purple-brown cloud down the middle, glabrous beneath, petiole long green; spike produced, dense, 5-6 by 2.5-3 in. diam.; flowers bracts green, ovate; flowers pale yellow; lip broad, obscurely 3-lobed, midlobe emarginated; rhizome pale blue in the centre.

30. *Curcuma longa* Linn., Sp. Pl. 1: 2. 1753; Hook. f., FBI 6: 214. 1890; Balakr., FJ 2: 520. 1983. (Zingiberaceae)

Coll. No.155-MP

LN: Mosalakava (M); Igivou-avah (P); Aieng (K)

Fls. & Frts.: July-October

Uses: Fresh rhizome is crushed and applied as paste to cut or injury to control bleeding and wound healing.

Description: A perennial herb; rhizomatous tubers, brightly yellow to golden yellow, aromatic and cultivated as spices; leaves oblong, caudate-acuminate; entire, long-sheathed, glabrous; plume-bracts pinkish-white, corolla-lobes white; lip orbicular, 3-lobed, creamy-white with yellow median band.

31. *Cuscuta reflexa* Roxb., Clarke in Hook. f., FBI 4: 225. 1883; Prain, Bengal Pl. 2: 537. 1903 (Rep. Ed. 1963) and in RBSI 3(2): 243. 1905; Kanjilal *et al.*, FA 3: 362. 1939; Banerjee *et al.*, Diversity Coast. Pl. Comm. India 293. 2002. (Cuscutaceae)

Coll. No. 037-MK

LN: Mochokrue (M); Khaogui (K)

Fls. & Frts.: June-October

Uses: Whole plant is boiled and massage against bodyache, sprain and joint dislocation.

Description: A twining parasite; stem fleshy, usually forming dense masses on low trees and shrubs; flowers white, waxy, about .35 in. long and .3 in across, solitary or in irregular cymose clusters, sometimes racemed; capsule globose, ovoid, irregularly verrucose.

32. *Cynodon dactylon* (Linn.) Pers., Hook. f., FBI 7: 288. 1896; Prain, Bengal Pl.

2. 925. 1903 (Rep. ed. 1963); Kanjilal *et al.*, FA 5: 125-126.1940; Banerjee *et al.*, Diversity Coast. Pl. Comm. India 402. 2002. (Gramineae or Poaceae)

Coll. No. 100-MP

LN: Piprii (M); Mophrii (P)

Fls. & Frts.: May-October

Uses: Plant juice extract is used as eye drop against conjunctivitis.

Description: A perennial creeping rhizomatous grass; leaves conspicuously distichous on the barren shoots and lower part of the culms; inflorescence fascicled spikes, spikelets light green or purplish in colour.

33. *Datura arborea* Linn., Sp. Pl. 179. 1753; Deb in J. Econ. Tax. Bot. 1: 37. 1980; Chithra in Fl. Tamil Nadu 2: 112. 1987. (Solanaceae)

Coll. No. 046-MP

LN: Emetobo or Tobobu (M); Kolathroudupa or Raboh (P); Sumkonpah (K)

Fls. & Frts.: April-September

Uses: The tender stem is cut and placed at the site of snake bite as an antidote to absorb and neutralized the poison. Fresh leaves are dip in hot water and massage against bodyache, joint dislocation, sprain, etc.

Description: A large shrub; leaves simple, large, ovate, glabrous above, entire; flowers large and long, white, drooping; fruit top-shaped, 3.5 inches long.

34. *Debregeasia longifolia* (Burm. f.) Wedd., See SN 7 of 6.2. Wild edible fruits (Urticaceae)

Uses: Boiled decoction of tender leaves is prescribed to relieved diabetes.

35. *Desmodium triquetrum* DC., Kanjilal *et al.*, FA 2: 56. 1938. (Leguminosae or Fabaceae)

Coll. No. 101-MP

LN: Shingou (P)

Fls. & Frts.: October-May

Uses: Boiled decoction of leaves mixed with sugar cube and drink to remove urinary bladder stone.

Description: A suberect herb or undershrub; leaves winged, leaflets oblong-lanceolate, entire, subcoriaceous, sub-glabrous or scaberulous above; racemes long, axillary or terminal and sometimes panicled; pod clothed throughout with matted hairs.

36. *Dicentra scandens* (D. Don.) Walp., Hook. & Thomson in Hook. f., FBI 1: 121. 1872; Ellis & Balakrishnan in Sharma *et al.*, FI 2: 79. 1993. (Fumariaceae)

Coll. No. 160-M

LN: Reimupro (M)

Fls. & Frts.: June-September

Uses: Root tuber is crushed mixed with water and drink against fevers, stomach-ache and high blood pressure.

Description: Climber with perennial tuberous roots; stem slender, flexuous, angled; leaves alternate, oval oblong or orbicular; flowers golden yellow; peduncle; capsules pendulous, laceolate; seeds finely granulate at the back.

37. *Drymaria cordata* (Linn.) Roem. & Schult., Syst. Veg. 5: 406. 1819; Edgeworth & Hook. in Hook. f., FBI 1: 244. 1874; Balakr., FJ 1: 84. 1981. (Caryophyllaceae)

Coll. No. 015-MPK

LN: Nineopro or Ozhechagha or Pfiipfiipro (M); Pipihou (P); Thoukih (K)

Fls. & Frts.: June-October

Uses: Bruised leaves paste is applied to forehead against headache, cut or injury and snake bite. It is also warm near the fire and placed on the eyes against conjunctivitis. Leaves extract is also applied as nasal drop against sinusitis.

Description: Glandular pubescent or glabrate annuals common in wasteland, roadsides and gardens; prostrate or spreading, rooting at nodes; leaves orbicular to reniform or deltoid-ovate, truncate or obtuse at base, obtusely paniculate at apex; cymes dichasial, terminal or axillary; capsules ovoid; seeds dark brown.

38. *Elaeocarpus floribundus* Bl., See SN 12 of 6.2. Wild edible fruits (Elaeocarpaceae)

Uses: Fermented fruit juice extract is prescribed as remedy for dry cough and indigestion.

39. *Eleutherococcus aculeatum* (Ait.) Seem., Clarke in Hook. f., FBI 2: 726. 1879; Kanjilal *et al.*, FA 2: 357. 1938. (Araliaceae)

Coll. No. 112-M

LN: Kosapetsii (M)

Fls. & Frts.: July-November

Uses: Ground leaves paste is applied to ringworm. The extract from leaves is also used as ear drop against Otitis and other ear infections.

Description: Prickly glabrous straggling shrubs; spines short, broad based often deflexed; leaves 3-5 foliolate, leaflets oblanceolate or lanceolate-elliptic, denticulate; flowers in globose usually solitary, zxillary or terminal umbels; fruits compressed, styles persistent.

40. *Elsholtzia blanda* Benth., Lab. Gen. Sp. 162. 1833; Hook. f., FBI 4: 643. 1885; Burkill in RBSI 4: 126. 1910; Kanjilal *et al.*, FA 3: 516. 1939; Balakr., FJ 2: 379. 1983; Haridasan & Rao, FFM 2: 696. 1987. (Labiatae or Lamiaceae)

Coll. No. 048-MPK

LN: Khollo (M); Lou or Khollo (P); Thallou (K)

Fls. & Frts.: September-March

Uses: The extract from fresh leaves is prescribed for diarrhea, dysentery and stomachache. It is also given for carminative and flatulence.

Description: Undershrubs or shrubs up to 2.5 m high, branches angular, greenish, aromatic; leaves elliptic, elliptic-lanceolate, acuminate, base narrowed, crenate serrate, gland punctuate, puberulous above; spikes close, rect, panicled, axillary and terminal, usually one sided; flowers greenish-white.

41. *Emblica officinalis* Gaernt., See SN 15 of 6.2. Wild edible fruits (Euphorbiaceae)

Uses: Boiled decoction of stem bark is given for gastritis, vomiting, diarrhea and dysentery. The mature fruits mixed with sugar cube in airtight containers and allowed to ferment for over a period of month. The fermented extract is then given against dry cough and bodyache.

42. *Entada phaseoloides* (Linn.) Merr., in Philip. J. Sc. 9: 86. 1914; Balakr., FJ 1: 180. 1981; *Entada scandens* (Linn.) Benth in Hook. f., J. Bot. 4: 332. 1841; Baker in Hooker, FBI 2: 287. 1878; Kanjilal *et al.*, FA 2: 149. 1938. (Mimosaceae)

Coll. No. 159-P

LN: Kakabu (M); Zhalu (P); Kang (K)

Fls. & Frts.: February-December (primary forests)

Uses: Paste of grouned cotyledons is applied to relieved toothache.

Description: A gigantic lianas, 30-150 m; leaves bipinnate, leaflets 2-5 pairs, obovate to oblong, obtuse at base; flowers pale yellow; pods woody, breaking up into 1-seeded segments; seeds lenticular, 4-5 cm diameter, shiny brown.

43. *Erythrina arborescens* Roxb., Baker in Hook. f., FBI 2: 190. 1876; Kanjilal *et*

al., FA 2: 72. 1938; Balakr., FJ 1: 170. 1981; Haridasan & Rao, FFM 1: 300-301. 1985.

Coll. No. 098-K

LN: Litousii (M); Songkokang (K)

Fls. & Frts.: July-November

Uses: Boiled decoction of stem bark is given to treat stomachache caused due to spell of Witchcrafts and or evil's spirit. Also a piece of the plant is tight around the wrist or wist as necklaces to ward off against harms caused by Witchcrafts or evil's spirit.

Description: Small or midlle-sized trees with greyish-brown bark; leaflets broadly triangular, ovoid or rhomboid, acuminate, base broadly cuneate, glabrous; racemes axillary; flowers red (rarely white); pods long, blackish-brown when dry; seeds black, shinning.

44. *Eupatorium adenophorum* Spreng., Syst. 3: 420. 1826; Rao & Rao, Proc. Indian Natn. Sci. Acad. B 46(4): 589. 1980; Haridasan & Rao, FFM 2: 522. 1987. (Compositae or Asteraceae)

Coll. No. 045-MPK

LN: Japanpro (M); Japanpro (P); Loubong (K)

Fls. & Frts.: March-July

Uses: Extract from bruised leaves and paste is applied to cut and injury to control bleeding. The leaves extract is also given to control diarrhea, dysentery and have abortifacient property.

Description: Undershrubs or herbs; leaves ovate, ovate-trinagular, rhomboid, acute or acuminate, base cuneate or truncate; heads in dense corymbs, in leafy panicles; involucral bracts oblong-lanceolate, florets white; achense 5-angular, black; pappus hairs twice as long as achenes.

45. *Eupatorium riparium* Regel. Gaertn., FI 15: 324-325. 1866; Rao & Rào in Proc. Indian. Natn. Sci. Acad. B46 (4): 591. 1980; Haridasan & Rao, FFM 2: 523. 1987. (Compositae or Asteraceae)

Coll. No. 063-MP

LN: Okhenakoropro or Japanpro-katina (M); Japanpeu-atei (P)

Fls. & Frts.: March-July

Uses: Ground leaves paste is applied externally against skin diseases. Bruised leaves paste is applied externally to fresh cut or injury to control bleeding and wound healing. Leaves decoction is prescribed for gastritis and diarrhea.

Description: Perennial herbs; leaves lanceolate, elliptic-lanceolate, acuminate, base narrowed to the petiol, dentate-serrate, glabrous or glabrescent; heads long in dense corymbs; involucral bracts elliptic-lanceolate; florets white; achenes minute, pappus white.

46. *Ficus auriculata* Lour., See SN 16 of 6.2. Wild edible fruits (Moraceae)

Uses: Immature fruits are taken raw against diarrhea and dysentery.

47. *Fragaria nilgerrensis* Schldl., Hook. f., FBI 2: 344; Kanjilal *et al.*, FA 2: 203-204. 1938. (Rosaceae)

Coll. No. 005-MP

LN: Likhodaphrushi (M)

Fls. & Frts.: March-August

Uses: Boiled decoction of leaves or whole plant is given against painful urination, diarrhea, dysentery, blood vomiting, bleeding nose and flatulence.

Description: A stouter herb with perennial rootstock and long runners clothed with long spreading hairs; leaves digitately 3-foliolate; petiole long with more or less sheathing base; leaflets obovate, coarsely and sharply toothed, undersurface densely pubescent; flowers white, few cymosely arraged on a stout peduncle; fruit white with pinkish tinge, achenes reddish-brown.

48. *Geranium nepalense* Sw., Geran. 1. t. 12. 1820; Don Prodr. Fl. Nepal, 208. 1825; Hook. f., FBI 1: 430. 1875; Balakr., FJ 1: 108-109. 1981. (Geraniaceae)

Coll. No. 198-M

LN: Ezhupro (M)

Fls. & Frts.: July-October

Uses: Bruised leaves paste is applied to cut or injury and wound healing.

Description: Decumbent-ascending herbs usually found roadsides, forest edges and grasslands; leaves orbicular, 3-5 partite, palmately; flowers pale purple, axillary, solitary or paired on peduncles; capsules ellipsoid or subglobose, hairy; seeds black.

49. *Gymnopetalum cochinensis* (Lour.) Kurz., J. Asiat. Soc. Bengal 40: 57. 1871; Clarke in Hook. f., FBI 2: 611. 1879; Deb in BBSI 3: 283. 1961; Balakr., FJ 1: 214. 1981. (Cucurbitaceae)

Coll. No. 078-MPK

LN: Nameitou (P); Kelchangmei (K)

Fls. & Frts.: June-October

Uses: Whole aerial parts of the plant are boiled and drink as a prescription against jaundice, fevers and painful urination.

Description: Creeping or climbing herbs with scandent stem found in wasteland and forest edges; leaves ovate, palmately 3-5 angular, lobed or partite; fruits ovoid, acuminate and ribbed; seeds compressed, oblong and brown, distinctly marginate.

50. *Gynura bicolor* (Roxb. ex Willd.) DC., Prodr. 6: 299. 1838; Mathur in Hajra *et*

al., FI 13: 218. 1995. (Compositae or Asteraceae)

Coll. No. 091-MP

LN: Tobou-vu (M); Bokriitai (P)

Fls. & Frts.: july-February

Uses: The extract from fresh leaves mixed with little amount of water and drink or cooked as medicinal foodstuff against gastritis and other stomach disorders.

Description: Succulent herbs; leaves sessile or subsessile, spirally arranged, obovate or elliptic-lanceolate or oblong, acuminate; capitula in large terminal panicles, involucral bracts linear-lnceolate, corolla orange yellow; achenes, pappus white, copious.

51. *Glochidion oblatum* Hook. f., Kanjilal *et al.*, FA 4: 184.1940. (Euphorbiaceae)

Coll. No. 088-M

LN: Lokhrotoudugho (M)

Fls. & Frts.: May-October

Uses: Boiled decoction of tender leaves is given during diarrhea and dysentery.

Description: A shrub or small tree; leaves 5-7 in. long, elliptic-oblong or oblong or oblong lanceolate, coriaceous, densely and softly white or rusty-tomentose beneath; capsule, globose, obscurely lobed, not deeply intruded at base and apex.

52. *Hydrocotyle sibthorpioides* Lam., Encycl. 3: 153. 1789; Deb in BBSI 3: 328. 1961; FT 2: 196. 1981. (Umbelliferae or Apiaceae)

Coll. No. 069-M

LN: Litekorei (M)

Fls. & Frts.: March-June

Uses: Paste of ground whole plant is applied for removing thorns.

Description: Perennial creeping herbs; leaves suborbicular-cordate, crenate, glabrous and shiny; flowers sessile or with peduncles, glabrous; fruits orbicular, smooth or punctuate, compressed, primary ridges very prominent.

53. *Imperata cylindrica* (Linn.) P. Beauv., Agrost. 165. 1812; Bor, Grasses Burma. Ceyl. Ind. & Pak. 169. 1960; Naskar, Pl. Wlth. L. Ganga Delta 722. 1993; Banerjee *et al.*, Diversity Coast. Pl. Comm. India 410. 2002. (Gramineae or Poaceae)

Coll. No. 069-M

LN: Shi-ngai (M); Ngai (P)

Fls. & Frts.: April-August

Uses: Boiled decoction of root is prescribed for worm expulsion.

Description: Perennial herb; culms solid; leaves linear, acuminate, glabrous, margin scabrid; sheaths loose, ligule hairy; panicles spiciform, soft, silvery-white; spikelets linear-lanceolate, lower glume ovate-lanceolate, upper glume oblong-lanceolate; caryopsis small.

54. *Jatropha curcas* Linn., Sp. Pl. ed. 1: 1006. 1753; Hook. f., FBI 5: 383. 1887; Watt, Dict. Econ. Prod. 4: 545. 1890; Prain, Bengal Pl. 2: 941. 1903 (Rep. ed. 1963) and in RBSI 3(2): 273. 1905; Kanjilal *et al.*, FA 4: 190.1940. (Euphorbiaceae)

Coll. No. 176-MK

LN: Thingnai-wong (K)

Fls. & Frts.: June-January

Uses: Juice released from cut branches is applied to burns due to fire or steam to relieved from pain and inflammation.

Description: A soft-woody deciduous shrub or small tree; leaves su-orbicular, ovate, broadly cordate, usually 3-5 lobed, glabrous; flowers greenish-yellow often in panicled pubescent cymes; fruit ovoid-oblong, seeds oblong, dark-brown.

55. *Juglans regia* Linn., See SN 20 of 6.2. Wild edible fruits (Juglandaceae)

Uses: Ground leaves are applied as paste against skin diseases like scabies. Paste of stem or root bark is applied to relieved toothache. Crushed leaves are also traditionally used as fish poison for catching fish.

56. *Lantana camara* Linn., Clarke in Hook. f., FBI 4: 562. 1885; Santapau in BBSI 3: 18. 1962; Haridasan & Rao, FFM 2: 681. 1987; Naskar, Pl. Wlth. L. Ganga Delta 523. 1993. (Verbenaceae)

Coll. No. 072-MPK

LN: Bokhashu or Osopa (M); Poupashubi (P); Houtholing (K)

Fls. & Frts.: Nearly throughout the year

Uses: Tender leaves decoction is taken against fevers and dry cough. Boiled extract of flowers is given as remedy for jaundice. Ground leaves paste is applied for joint dislocation and sprain. Tender leaves warm near the fire and the fume is blow against eye infections.

Description: Prickly shrubs often straggling bark grey or grayish-brown, peeling off in long strips; leaves ovate, acute or acuminate, cuneate, scabrous, crenate; spikes capitates; flowers usually orange, sometimes white or pinkish; fuits shining purplish-blue when ripe.

57. *Leucus indica* Linn. R. Br. Ex Vatke, Oesterr. Bot. Z. 25: 95. 1875; EFPN 3: 156. 1982. (Labiatae or Lamiaceae)

Coll. No. 004-M

LN: Pfobvokromii or Okhro-ezhupro (M); Litai (P)

Fls. & Frts.: August-December

Uses: Juice extract from crushed leaves and paste is applied to cut and injury to control bleeding and wound healing, killing maggots in cattle's wound. It is also applied to control bleeding piles.

Description: An erect, pubescent or hispid annual herb; hairs spreading defluxed or express, leaves sub-sessile linear or linear-lanceolate, obtuse, pubescent; flowers white and hispid.

58. *Litsea cubeba* (Lour.) Pers., Syn. *Litsea citrata* Bl., See SN 32 of 6.1. Wild edible plants (Lauraceae)

Uses: Boiled decoction of stem bark is prescribed against vomiting, diarrhea and dysentery.

59. *Lygodium japonicum* (Thunb.) Sw., in Schrad. J. Bot. 1800 (2): 7. 106. 1801; Beddome, Handb. Ferns Brit. India 452. 1883; Baishya and Rao, Ferns and Ferns Allies, Meghalaya 37. 1982. (Lygodiaceae)

Coll. No. 164-M

LN: Orapfochou (M); Deitoh (K)

Uses: Boiled decoction of leaves is taken to relieved jaundice.

Description: Twining ferns; rhizome creeping; sterile pinnates 3-5 lobed, central lobe much elongated; sori finger like, sporangia arranged in 2-rows.

60. *Mahonia manipurensis* Takeda, in Notes R. Bot. Gard. Edinb. 6: 22. 1917; Deb in BBSI 3: 318. 1961; Guha Bakshi in Sharma *et al.*, FI 1: 410. 1993. (Berberidaceae)

Coll. No. 188-M

LN: Bovasii (M)

Fls. & Frts.: February-May

Uses: Decoction of stem bark or root is prescribed against fevers and jaundice.

Description: Leaves oblong, leaflets 7-10 pairs, overlapping, ovate to broadly ovate, coriaceous, glabrous above, dull beneath; racemes 4-8 cm long in 3-5 fascicles; petals oblong, bilobed at apex; ovules 1-2, style short.

61. *Melia composita* Willd., Sp. Pl. 2: 509. 1799; Kanjilal *et al.*, FA 1: 228. 1936. (Meliaceae)

Coll. No. 090-M

LN: Zhathosii (M); Thosii (P); Sasan (K)

Fls. & Frts.: March-December

Uses: Leaves decoction is prescribed as remedy during intermittent fever. The aqueous extract of fruit pulp or decoction is also prescribed as remedy for fevers, anthelmintic and stomachache.

Description: A fairly large deciduous tree; leaves 1-2 ft, long, rachis terete, leaflets 5-11, ovate-lanceolate to ovate round, serrate or entire, membranous; flowers white or or light mauve, inodorous; drupe smooth but speckled with raised round dark-brown dots; seeds lanceolate, with a dark shinning testa.

62. *Melothria maderaspatana* (Linn.) Cogn., in DC. Monogr. Phan. 3: 623. 1881; Deb in BBSI 3: 284. 1961; Chakrav. in Fasc. FI 11: 83. 1982. (Cucurbitaceae)

Coll. No. 172-MPK

LN: NR

Fls. & Frts.: July-October

Uses: Boiled decoction of leaves and fruits is prescribed against fevers, jaundice and bodyache.

Description: An annual herbs; stems scandent, sulcate; leaves membranous, ovate, angular or 3-5 lobed; Flowers solitary or fascicled, yellow; fruits 6-12 mm thick, brownish yellow, globose.

63. *Mentha arvensis* Linn., Sp. Pl. 577. 1753; Hook. f., FBI 4: 648. 1885; Mukerjee in RBSI 14(1): 86. 1940. (Labiatae or Lamiaceae)

Coll. No. 167-MP

LN: Pudina (M); Phaosopou or Kolapoungu (P); Pudina (K)

Fls. & Frts.: July-October

Uses: Abdomen is massage with bruised leaves to relieved flatulence and removed gas.

Description: Erect to decumbent herbs; leaves ovate, cuneate, entire towards the base, serrate at margins towards apex; flowers white in axillary capitates, pubescent clusters.

64. *Mimosa pudica* Linn., Sp. Pl. ed. 1: 518. 1753; Baker in Hook. f., FBI 2: 291. 1878; Watt, Dict. Econ. Prod. 5: 248. 1892; RBSI 3(2): 207. 1905; Banerjee *et al.*, Diversity Coast. Pl. Comm. India 230. 2002. (Leguminosae or Fabaceae)

Coll. No. 187-MPK

LN: Ahripro (M); Noh-Nom (K)

Fls. & Frts.: July-November (Wastelands and forest edges)

Uses: Leaves are boiled along with *Eupatorium adenophorum* leaves and mixed with sugar and drink to relieved gastritis and womb problems, piles or heamorrhoid. Root decoction is prescribed for painful urination.

Description: Shrubby, the copious bristly hairs of the branchlets and petioles deflexed, pinnae of the leaves 3-4, nearly sessile, leaflets 24-40, glabrous, subcoriaceous; flowers in small peduncled heads, 1-2 from each axil; pod 3-4 seeded with abundant weak prickles from both sutures.

65. *Mirabilis jalapa* Linn., Sp. Pl. ed. 1: 177. 1753; Watt, Dict. Econ. Prod. 5: 255. 1891; Prain, Bengal Pl. 2: 644. 1903 (Rep. ed. 1963); Banerjee *et al.*, Diversity Coast. Pl. Comm. India 326. 2002. (Nyctaginaceae)

Coll. No. 031-P

LN: Chiikro-bvupa or Sokro pa (M); Ngaibo or Ngaibvii (P); Niheipah (K)

Fls. & Frts.: Almost throughout the year, more common from October-July.

Uses: The root is crushed and applied as paste to controlled bleeding in cut or other external injuries and wound healing.

Description: Glabrous annual or biannual herb or undershrub with stem swollen above node; leaves ovate-lanceolate, apex acute, entire, base truncate or cordate; flowers rose- pink, yellow, white with terminal or axillary inflorescence; fruit ovoid, ellipsoid, often ribbed or rugose, wrinkled, dark brown or nearly black when ripen.

66. *Myrica farquhariana* Wall., Syn. *Myrica nagi* (non Thunb.), See SN 23 of 6.2. Wild edible fruits (Myricaceae)

Uses: Boiled decoctions of stem or root bark is taken orally during diarrhea and dysentery.

67. *Nicotiana tabacum* Linn., Kanjilal *et al.*, FA 3: 374. 1939. (Solanaceae)

Coll. No. 054-MPK

LN: Mikhepro (M); Khaopu or Khopube (P); Dumphol (K)

Fls. & Frts.: July-December

Uses: Ground leaves are applied as paste to relieved tooth ache, scabies and in cattle's wound for killing maggots. Fresh leaves are warm from fire and massage anus to relieved pain from piles.

Description: An erect glandular pubescent herb; leaves large, ovate-oblong or elliptic, acuminate, pubescent; flowers 1.5-2 in. long, rosy or reddish, bracteates in panicled racemes; capsule .6-.7 in. long with slightly accrescent calyx.

68. *Ocimum basilicum* Linn., Sp. Pl. ed. 1: 597. 1753; Hook. f., FBI 4: 608. 1885; RBSI 3(2): 262. 1905; Mukherjee in RBSI 14(1): 63. 1940; Kanjilal *et al.*, FA 3:

501.1940. (Labiatae or Lamiaceae)

Coll. No. 168-MPK

LN: Napio-katei (M); Poungu-tei or Napia-tei (P); Bangzangpa (K)

Fls. & Frts.: September-February

Uses: Leaves decoction is given as remedy for carminative or flatulence, fever, etc.

Description: A slender scented herb generally purple coloured; stems glabrous or more or less pubescent, hairy at the nodes; leaves .5-1.5 by .2-.5 in., ovate, acute, entire or more or less lobed or toothed, glandular; flower pale purple in nearly single raceme; nutlets .07 in. across, ellipsoid, black.

69. *Ocimum sanctum* Linn., Kanjilal *et al.*, FA 3: 500. 1939. (Labiatae or Lamiaceae)

Coll. No.: 132-MPK

LN: Napio-katei (M); Napeo (P)

Fls. & Frts.: August-February

Uses: Boiled decoction of leaves is given for fevers and dry cough.

Description: A perennial with woody root-stock; leaves 1-2 by .5-1 in., ovate or ovate-oblong or elliptic-oblong, crenate or entire, pubescent; flowers purplish or crimson in racemed; nutlets reddish, ellipsoid.

70. *Oenanthe stolonifera* (Wall.) DC., See SN 39 of 6.1. Wild edible plants (Umbelliferae or Apiaceae)

Uses: Whole plant is cooked as medicinal food to relieved gastritis and other gastro-intestinal disorders and also prescribed against low blood pressure.

71. *Oroxylon indicum* (Linn.) Vent., See SN 40 of 6.1. Wild edible plants (Bignoniaceae)

Uses: Stem or root bark is crushed, boiled and drink against fevers, gastro-intestinal disorders such as gastritis, liver disorder, high blood pressure and cancer. Ground barks mixed with common salt is also applied to cattle's wound for killing maggots and healing wounds.

72. *Osbeckia stellata* Buch.-Ham. ex. Don., in Bot. Reg. 8: t. 674. 1822; Deb in BBSI 3: 297. 1961; Balakr., FJ 1: 206. 1981; *O. crinite* Naud., in Ann. Sci. Nat. Bot. ser. 3. 14. 72. 1850; Clarke in Hook. f., FBI 2: 517. 1879; Kanjilal *et al.*, FA 2: 293. 1938. (Melastomataceae)

Coll. No. 130-M

LN: Litsiikri (M)

Fls. & Frts.: June-October

Uses: Tender leaves are taken raw or root decoction is given to control diarrhea and dysentery.

Description: Erect slender shrubs up to 1.5 m; stem obscurely quadrangular, scabrous; leaves broadly ovate-lanceolate or oblong-lanceolate to elliptic lanceolate, cordate to rounded at base, acute or subacute, subsessile, pilose; flowers white to purple in terminal or upper corymbose cymes; capsules campanulate, truncate, densely scaly.

73. *Oxalis corniculata* Linn., Sp. Pl. 1: 435. 1753; Hook. f., FBI 1: 436. 1874; Watt, Dict. Econ. Prod. 5: 658. 1891; Prain, Bengal Pl. 1: 294. 1903 (Rep. ed. 1963) and in RBSI 3(2): 183. 1905; Banerjee *et al.*, Diversity Coast. Pl. Comm. India 185. 2002. (Oxalidaceae)

Coll. No. 008-MK

LN: Ozhepitou (M); Nameimata (P); Vakhumitbeh (K)

Fls. & Frts.: March-August

Uses: Used as washing soap for glossy hair, gold and silver. Bruised leaves paste is applied to relieved tooth ache and control bleeding in cut or injury. Decoction is prescribed for dysentery.

Description: An herbaceous weed, abundant in cultivated places; Leaves long-petioled, leaflets obcordate; flowers subumbellate, Sepals obtuse, bracts setaceous. Petals yellow, obcordate; Capsule tomentose, subcylindric, cells many seeded with longitudinally ribbed.

74. *Paederia foetida* Linn., See SN 41 of 6.1. Wild edible plants (Rubiaceae)

Uses: Boiled decoction of tender leaves is taken against stomachache, diarrhea, dysentery and gastritis. Hot infusion is used for massaging to relieved bodyache. The crushed root is wrapped and bandage with cotton against joint dislocation and bone fracture.

75. *Panax psuodoginseng* Wall., in Trans. Med. Phys. S. Calc. 4: 117. 1829; Deb in BBSI 3: 273. 1961; *Aralia pseudo-ginseng* (Wallich) Benth. ex. C.B. Clarke in Hook. f., FBI 2: 721. 1879; Kanjilal *et al.*, FA 2: 346. 1938. (Araliaceae)

Coll. No. 165-P

LN: Eveh-vo (M); Vou-voh or Deivou (P)

Fls. & Frts.: April-August

Uses: The rhizome is taken raw in small pieces or the juice extract from the rhizome is given as remedy for gastritis and other gastro-intestinal problems, high BP, energysier, etc.

Description: Herbs with perennial horizontal, tuberuous to tuberniferous roots; stem smooth, erect, terminated in a whorl of leaves, leaflets lanceolate with scattered bristles on the upper surface, acuminate or caudate, serrate margins or doubly serrate; flowers polygamo-monoecious; fruits compressed, red or blackish red.

76. *Paris polyphylla* Sm., in Rees. Cyclop. 26: Paris n. 2. 1813; Hook. f., FBI 6:

362. 1892; Hajra *et al.*, Fl. Sikkim 1: 156. 1996. (Trilliaceae)

Coll. No. 120-MP

LN: Kutupa or Rekrii-ridziipa (M); Koubi or Orabi or Riasa (P)

Fls. & Frts.: April-August

Uses: Crushed rhizome is applied as paste for controlling bleeding in cut or injury and wound healing. Dried rhizome powder mixed with water and drink for gastritis and sleeplessness. It is also prescribed for fevers. Also the rhizome is cut and paste to relieved toothache.

Description: Erect unbranched glabrous herbs with annulate rootstock; leaves dark green, 4-9 petioled, whorled, oblong or oblanceolate, acuminate; flowers yellow-green, sepals ovate-lanceolate, petals yellow; fruits 3-6 valved, testa pulpy.

77. *Parkia roxburghii* G. Don., Gen. Syst. 2: 397. 1832; Baker in Hook. f., FBI 2: 289. 1878; Kanjila *et al.*, FA 2: 151. 1938; Haridasan & Rao, 1: 340. 1985. (Leguminosae or Fabaceae)

Coll. No. 099-MPK

LN: Zhongcha (M); Zonglha (K)

Fl & Fr.: August-February

Uses: The skin cover of the fruit pods is peeled off and dried. Boiled decoction of this dried skin cover is given against gastritis, diarrhea and dysentery. The paste is also applied for piles.

Description: An erect large tree with grayish-brown bark; leaves bipinnate, leaflets oblique-oblong, acute, glabrous, tomentose along rachis; flowers dull white, turbinate heads 2-3 in. long; pod 1 ft. by 1-1.5 in., flat, dropping from the peduncle.

78. *Passiflora edulis* Sims., Mag. T. 1949. 1818; Kanjilal *et al.*, FA 2: 323. 1938;

Chakrav., in Bull. Bot. Soc. Bengal 3: 61. 1949; Deb BBSI 3: 282. 1961. (Passifloraceae)

Coll. No. 104-MPK

LN: Leboshi (M); Stabol (P)

Fls. & Frts.: May-October

Uses: Tender leaves are taken as cooked vegetable to relieved gastro-intestinal problems like stomachache, gastritis and dysentery.

Description: Perennial climbers, profusely branching, glabrous; leaves subcoriaceous, 3-lobed, serrate, stipules linear, subulate; flowers showy, bluish-white; fruits globose, turn into dark purple when ripe; seeds oval, reticulate.

79. *Phlogacanthus curviflorus* Nees., See SN. 42 of 6.1. Wild edible plants (Acanthaceae)

Uses: Boiled decoction of leaves is prescribed for gastritis, fevers, headache and high blood pressure. It is also used for massaging to relieved bodyache, joint dislocation and sprain, etc.

80. *Phoenix humilis* Royle., See SN 25 of 6.2. Wild edible fruits (Palmae or Arecaceae)

Uses: Bruised leaves paste is applied to control bleeding due to leech bite.

81. *Physalis peruviane* Linn., See SN 26 of 6.2. Wild edible fruits (Solanaceae)

Uses: Decoction of leaves is given for stomachache and dysentery.

82. *Phyllanthus fraternus* Web., Contr. Gray Herb. No. 176: 53. 1955 and in J. Arn. Arb. 38: 309. 1957; *P. niruri* auct. Plur. (non. Linn.); Hook. f., FBI 5: 298. 1887; Prain, Bengal Pl. 2: 701. 1903 (Rep. ed. 1963). (Euphorbiaceae)

Coll. No. 122-P

LN: Katheimei-hroshi (P)

Fls. & Frts.: April-August

Uses: Whole plant decoction is prescribed for diarrhea and kidneystone.

Description: Erect annual herb; leaves elliptic oblong, obtuse, entire, rounded base, glabrous; flowers yellowish white, axillary, short pedicelled; fruits capsule, depressed globose, smooth; seeds trigonous.

83. *Plantago erosa* Wall., See SN 43 of 6.1. Wild edible plants (Plantaginaceae)

Uses: Whole plant decoction is given for dry cough.

84. *Potentilla fulgens* Wall. ex Hook., in Bot. Mag. 53: t. 2700. 1826; Hook. f., FBI 2: 349. 1878. (Rosaceae)

Col. No. 059-MP

LN: Ojiipan (M); Chiishuthai (P); Kaichin (K)

Fls. & Frts.: June-October

Uses: Ground root paste is applied to burns to relieved pain or inflammation and wound healing. It is also used as paste against toothache.

Description: Perennial herbs, softly silky; leaflets pair elliptic oblong or obovate obtuse sharply serrate clothed beneath with silvery hairs; flowers panicled or corymbose; achenes small, smooth.

85. *Pouzolzia bennettiana* Wight, Icon. 6. T. 1978. 1853; Hook. f., FBI 5: 585. 1888; Kanjilal *et al.*, FA 4: 291. 1940. (Urticaceae)

Coll. No. 003-MP

LN: Hophirei (M)

Fls. & Frts.: June-October

Uses: The roots are crushed and applied as paste to cut and injury to control bleeding and wound healing.

Description: Herbs; young parts pubescent; leaves lanceolate, acuminate, puberulous, rounded base; flowers minute in axillary clusters, white or greenish-white; fruit costate.

86. *Pratia begonifolia* (Wall.) Lindl., in Edw. Bot. Reg. 15: t. 1373. 1830; Clarke in Hook. f., FBI 3: 422. 1881; Haridasan & Rao, FFM 2: 534. 1987. (Lobeliaceae)

Coll. No. 089-M

LN: Sinuspro (M); Voravupro (P); Gulkhi (K)

Fls. & Frts.: October-May

Uses: The whole plant is warm from the fire and the fume is inhale through nose to relieved sinusitis.

Description: Prostrate creeping or trailling herbs common in shady places; rooting at nodes; leaves alternate, rounded to ovate or reniform, cordate at base, acute or rounded crenate-dentate; flowers axillary, solitary, corolla pink or pale purple; fruits ellipsoid, purplish berries.

87. *Prunus persiaca* (Linn.) Batsch, Beytr. Entw. Pragm. Gesch. Natur. Reich. 1: 30. 1801; Hook. f., FBI 2: 313. 1878; Kanjilal *et al.*, FA 2: 182. 1938; Deb in BBSI 3: 259. 1961. (Rosaceae)

Coll. No. 049-MPK

LN: Mikriashi (M); Haushi or Krishi or Kushi (P); Vaisohlu

Fls. & Frts.: February-August (Open places and forest edges)

Uses: Ground fresh leaves mixed with common salt or tobacco and applied to cattle's wound for killing maggots and wound healing. It is used against skin diseases of domestic animals. Extract from fresh leaves is applied as ear drop against infections. The branch twist is traditionally used by Mao tribe as tooth brush. According to Mao traditional folk tale, the flowering of this plant indicates the right time to starts sowing paddy seeds for transplantation in the ensuing season.

Description: Small trees, 5-9 m; leaves lanceolate tp broadly oblanceolate, acuminate, serrate, puberulous on midrib beneath; flowers pink to white; drupes succulent, downy pilose; pyrenes rugose.

88. *Psidium guyava* Linn., Sp. Pl. ed. 1: 470. 1753; Duthie in Hook. f., FBI 2: 468. 1878; Watt, Dict. Econ. Prod. 6(1): 361. 1892; Rec. Bot. Surv. India 3(2): 211. 1905; Kanjila *et al.*, FA 2: 287. 1938; Haridasan & Rao, FFM 1: 391. 1985. (Myrtaceae)

Coll. No. 081-MPK

LN: Amboshi (M); Pondol (P); Pumton (K)

Fls. & Frts.: May-November (Cultivated)

Uses: Decoction of tender leaves or immature raw fruit is taken to control vomiting, diarrhea and dysentery.

Description: A small tree, pubescent on the young branches. Leaves ovate or oblong and usually acuminate, glabrous; peduncles axillary, 1-3 flowered; fruit globose or pear-shaped.

89. *Punica granatum* Linn., Sp. Pl. ed. 1: 472. 1753; Clarke in Hook. f., FBI 2: 581. 1879; Watt, Dict. Econ. Prod. 6(1): 368. 1892; Kanjilal *et al.*, FA 2: 315. 1938; Naskar, Pl. Wlth. L. Ganga Delta 355. 1993. (Punicaceae)

Coll. No. 194-MPK

LN: Meishi or Radoshi (P); Theichang-chang (K)

Fls. & Frts.: March-October

Uses: Decoction of crushed root bark is prescribed against blood dysentery.

Description: Large shrubs and is cultivated; leaves oblong or obovate, acute, entire, glaucous; flowers bright red; fruits ovoid-globose, reddish brown; seeds many, angled with pinkish-juicy acidic aril.

90. *Quercus serrata* Thunb., Hook. f., FBI 5: 601. 1888; Gamble, Man. Ind. Timb. 673. 1902; Brandis, Ind. Trees 626. 1906; Kanjilal *et al.*, FA 4: 307. 1940; Balakr., FJ 2: 456. 1983; Haridasan & Rao, FFM 2: 863. 1987. (Fagaceae)

Coll. No. 117-MP

LN: Ophrii-sii (M); Chesii (P); Gangpi (K)

Fls. & Frts.: June-December

Uses: Ground stem bark is applied to cut or injury to control bleeding and wound healing. Decoction is given for diarrhea and dysentery. Also juice released from cut branches is collected and used as remedy for dysentery, vomiting and dry cough. It is also applied as analgesic against bee stink.

Description: A middle-sized or large deciduous tree; leaves 3-8 by 1-3 in., lanceolate, oblong-lanceolate or elliptic-lanceolate, acute or acuminate, serrate, thinly coriaceous, glabrous and shinning when mature.

91. *Ranunculus sceleratus* Linn., See SN 49 of 6.1. Wild edible plants (Ranunculaceae)

Uses: Crushed root paste is applied against boils. Rootstocks are eaten as cooked vegetable.

92. *Rhododendron arboreum* Sm., Clarke in Hook. f., FBI 3: 465. 1882; Gamble, Man. Ind. Timb. 433. 1902; Kanjilal *et al.*, FA 3: 152. 1939; Balakr., FJ 1: 1981; Haridasan & Rao, FFM 2: 537-538. 1987. (Ericaceae)

Coll. No. 044-MP

LN: Lidainipa (M); Daipa (P); Ngeisoh (K)

Fls. & Frts.: March-August

Uses: Flower petals are eaten to remove fish bone blocking the throat.

Description: Middle-sized trees, trunk usually crooked, crown oval bark reddish-brown with rectangular flakes and fissures; leaves oblong, oblong-oblanceolate, acute or subacute; corymbs terminal, dense, subglobose, bracts silky, corolla with 5 black patches at base within; capsules oblong, cylindric, obscurely angled; seeds numerous, brown.

93. *Rhus semialata* Murry, See SN 50 of 6.1. Wild edible plants (Anacardiaceae)

Uses: Boiled decoction of ripe fruits mixed with honey or sugar is given for dry cough, vomiting, stomachache, diarrhea and dysentery. The plant is also used to performed traditional ritual by the Mao Naga tribe. On the first day of rice plantation, two small branches of the plant along with two leaves of *Musa paradisiaca* is planted at one corner of the field and a ritual was performed so that when the paddy plant growth up and bear fruits like the fruit bunch of this plant. The ritual is also performed after plantation imploring God blessing to get good harvest.

94. *Ricinus communis* Linn., Sp. Pl. ed. 1: 1007. 1753; Hook. f., FBI 5: 457-458. 1887; Watt, Dict. Econ. Prod. 6(1): 506. 1892; Pax and Hoffmann in Engler, Pflanzenreich 68. 119. 1919; Kanjilal *et al.*, 4: 221.1940; Airy Shaw in Kew Bull. 37(1): 34. 1982. (Euphorbiaceae)

Coll. No. 055-MPK

LN: Shehriibou (M); Hraibou or Khohribou or Soumahrai (P); Muthido (K)

Fls. & Frts.: Almost throughout the year

Uses: Fresh leaves are dip in hot boiled water and massage against certain bodyswelling, bodyache, joint and chest pains, joint dislocation and sprain.

Description: An evergreen soft-wooded shrub; leaves alternate, palmately lobed, peltate, serrate, membranous; petiole stout, hollow; flowers monoecious; capsule globose, echinate, echinate, splitting into three 2-valved dehiscent cocci, seeds caruncle.

95. *Rubus ellipticus* Smith, See SN 33 of 6.2. Wild edible fruits (Rosaceae)

Uses: Decoction of root bark is prescribed for blood dysentery and diarrhea.

96. *Rubus niveus* Thunb., See SN 34 of 6.2. Wild edible fruits (Rosaceae)

Uses: Decoction of root is prescribed for blood dysentery and diarrhea.

97. *Sambucus javanica* Bl., Bijdr. 657. 1826; Hook. f., FBI 3: 2. 1880; Gamble, Man. Ind. Timb. 393. 1902; Brandis, Ind. Trees 364. 1906; Kanjilal *et al.*, FA 3: 1.1939; Balakr., FJ 1: 228. 1981. (Caprifoliaceae)

Coll. No. 138-MP

LN: Ovothabu or Veinii (M); Rah-bo (P)

Fls. & Frts.: June-November

Uses: Fresh leaves are warmed from fire and massage against bodyache and joint dislocation. Extract from fresh leaves is applied for skin allergy caused by touching *Rhus succedanea* Linn.

Description: Shrubs or small trees up to 5m tall; leaflets lanceolate, oblong-lanceolate or obovate, serrate, glabrous; flowers yellowish-white or white; berry fruits globose, black when ripe.

98. *Sapindus mukorossi* Gaertn., Kanjilal *et al.*, FA. 1: 320-321.1934. (Sapindaceae)

Coll. No. 152-MP

LN: Khrotou (M); Khashi or Khrotou (P); Bulung or Ponshopmu (K)

Fls. & Frts.: May-January

Uses: Ground seed cotyledons are applied as paste for toothache. The ground powder mixed with water and drink as remedy for epilepsy and constipation. Fruit pulp is traditionally used as washing soap for glossy hair and remove dandruff. Decoction is given against fevers and stomachache.

Description: A middle-sized deciduous tree with dark-greenish-brown bark; leaves long parapinnate, glabrous, leaflets generally alternate, lanceolate or oblong, entire, acuminate, coriaceous; compound terminal panicle, flowers polygamous; fruits a globose 1-seeded drupe, globose, black.

99. *Saussurea deltoidea* (DC.) Sch.-Bip., in Linnaea 19: 331. 1846; Hook. f., FBI 3: 374. 1881; Bull. Dept. Med. Pl. Nep. 2; 65. 1969; Hajra *et al.*, FI 12: 197. 1995. (Compositae or Asteraceae)

Coll. No.: 052-M

LN: Kobobu (M)

Fls. & Frts.: September-December

Uses: Extract from fresh leaves mixed with little amount of water and drink against gastritis and stomachache.

Description: Stem tall simple below branched above, leaves petioled membranous, glabrous or scaberulous beneath white-tomentose, lower lyrate-pinnatifid terminal lobe very large deltoid lateral variable; heads very broad nodding panicled or racemose on the branches of a terminal leafy panicle.

100. *Schima wallichii* (DC.) Korth., See SN 52 of 6.1. Wild edible plants (Theaceae)

Uses: Crushed stem bark applied as paste against cut or injury.

101. *Scutellaria discolor* Coleb., Kanjilal *et al.*, FA 3: 519. 1939. (Acanthaceae)

Coll. No. 075-P

LN: Rakipro or Zhupu (P); Louphengsan (K)

Fls. & Frts.: March-August

Uses: Boiled decoction of fresh or dried leaves is given during intermittent fever.

Description: A pubescent annual herbs; leaves 1-3 by .5-1.5 in., orbicular or oblong or elliptic, crenate, pubescent; flowers trumpet shaped, bluish-purple on erect racemes; lip of corolla whitish above; nutlets 4, granulate, turbinate.

102. *Smilax ovalifolia* Roxb., See SN 54 of 6.1. Wild edible plants (Smilaxcaceae)

Uses: Juice released from cut tender shoot is applied to cut or injury to control bleeding and wound healing. Root decoction is given against arthritis and rheumatism.

103. *Solanum kurzii* Br., Haridasan & Rao, FFM 2: 648. 1987; Kanjilal *et al.*, FA 3: 368. 1939. (Solanaceae)

Coll. No. 058-MP

LN: Orashikhokha (M); Rakhaokha (P); Anjangngat or Anja-kha (K);

Fls. & Frts.: July-March

Uses: Raw fruits are taken to relieve high blood pressure. The fruit boiled along with other vegetable stuff and taken to relieved headache.

Description: A shrubs, 3-5 ft. high; leaves densely stellate-tomentose, ovate, entire, more or less irregularly lobed; flowers pubescent sub-terminal racemose cymes; berry fruits globose, glabrous and bitter.

104. *Solanum khasianum* Clarke in Hook. f. FBI 4: 234. 1883; Kanjilal *et al.*, FA 3: 371. 1939. (Solanaceae)

Coll. No. 042-MP

LN: Prebvushobu (M); Koka (P); Hanalou (K)

Fls. & Frts.: July-March

Uses: The crushed fruits are traditionally used as soap for washing hair. The extract from crushed fruits mixed with little amount of water and applied as nasal drop to remove leech from cattle's nose.

Description: Spiny undershrubs, bark grey, hirsute, recurved prickly; leaves broadly ovate, ovate-orbicular in outline, variously shallowly lobed and angled, acute, base truncate, cuneate or subcordate, hirsute on both surfaces; flowers greenish- white or greenish-yellow; berries brightly yellow when ripe.

105. *Solanum nigrum* Linn., See SN 56 of 6.1. Wild edible plants (Solanaceae)

Uses: Crushed fruits mixed with chicken feed is given for mouth and nose diseases of chicken. Decoction is prescribed for kidney disorders.

106. *Solanum spirale* Roxb., Kanjilal *et al.*, FA 3: 367-368. 1939. (Solanaceae)

Coll. No. 057-MP

LN: Kokiu-vu (M); Kivu (P); Kolhou (K)

Fls. & Frts: May-December

Uses: Cooked leaves mixed with some chilly is taken as vegetable to relieved headache.

Description: An undershrub; leaves 2-7 by .8-3 in., elliptic, entire, acute, membranous, glabrous; flowers white in dense spirally arranged racemose extra axillary inflorescence; berry fruit globose, oranged-red on ripe; seeds smooth.

107. *Sonchus asper* (Linn.) Hill., Hook. f., FBI 3: 414. 1881; Shukla & Baishya in J. Bombay Nat. Hist. Soc. 76: 225. 1977; Mangain & Rao in Hajra *et al.*, FI 12: 318. 1995. (Compositae or Asteraceae)

Coll. No. 053-MP

LN: Oshiamalipro (M)

Fls. & Frts.: November-April

Uses: Extract from fresh leaves mixed with little amount of water and drink against stomachache and gastritis.

Description: Erect annual, glabrous or laxly glandular herbs, up to 60 cm; leaves entire or runcinate, lanceolate or ovate-lanceolate; capitula in terminal panicles; achenes compressed, pappus white.

108. *Spilanthes acmella* Linn., Kanjilal *et al.*, FA 3: 118. 1939; *S. acemella* (Linn.) Murr. Var. *oleracea* C.B. Clarke, Comp. Ind. 138. 1876; Hook. f., FBI 3: 307. 1881. (Compositae or Asteraceae)

Coll. No. 097-K

LN: Ansha (K)

Fls. & Frts.: May-September

Uses: The inflorescence is applied as paste against toothache. Inflorescences are mixed with cooked rice and eaten for expulsion of hook worm.

Description: A trailing herb or with erect stem somewhat succulent; leaves .5-2.2 by .3-1.2 in., opposite, ovate or lanceolate, distantly serrate, acute; heads yellow, or reddish brown, solitary or in long terminal panicles; involucres ovoid or campanulate; fruit of disc flowers usually compressed.

109. *Spilanthes paniculata* Wallich ex DC., See SN 55 of 6.1. Wild edible plants (Compositae or Asteraceae)

Uses: The bruised leaves and leaves extract is given to control diarrhea and dysentery. It is also boiled and taken as vegetable food to relieved high BP.

110. *Swertia bimaculata* (Sieb.et Zucc.) Hook.f. et Thomson ex C.B. Clarke in J. Linn. Soc. Bot. 14: 449. 1875; C.B. Clarke in Hook. f., FBI 4: 123. 1883. (Gentianaceae)

Coll. No. 129-MP

LN: Pekriu (M); Rachipeu (P)

Fls. & Frts.: August-November

Uses: Leaves decoction is given for intermittent fever, relieved bodyache, etc.

Description: Herbs, upto 2 m high; stem stout, quadrangular, branches corymbose upward; leaves elliptic-lanceolate, 3-nerved; flowers panicles, white with black spots; capsules oblong, seeds subglobose, obscurely reticulate.

111. *Swertia pulchella* (D. Don) Clarke in Hook. f., FBI 4: 125. 1883; Balakr., FJ 2: 324. 1983. (Gentianaceae)

Coll. No. 068-MP

LN: Litepro (M); Hipou (P)

Fls. & Frts.: August-December

Uses: Boiled decoction of whole plant is given for fever and abdominal flatulence.

Description: Erect herbs upto 50 cm common in open grasslands; leaves sessile, narrowly lanceolate; flowers in terminal panicle of cymes; corolla lobes ovate-lanceolate with pale cream or pale blue colour.

112. *Thalictrum foliolosum* DC., Syst. Nat. 1: 175. 1817; Hook. f., FBI 1: 14. 1872; Kanjilal *et al.*, FA 1: 7. 1934; Deb in BBSI 3: 316. 1961; Rau in Sharma *et al.*, FI 1: 136. 1993. (Ranunculaceae)

Coll. No. 001-MP

LN: Gesinii-siikha or Pfolekriu (M); Beibei or Haopipi or Shukivu (P)

Fls. & Frts.: June-September

Uses: Boiled decoction of rootstock is given for fevers, stomachache and high blood pressure. Paste of crushed root is applied against toothache. Ground leaves paste is applied against scabies.

Description: Tall glabrous stem; leaves pinnately decompounds, sheaths, auricled; panicle much branch; flowers polygamous, white pale green or dingy purple; achenes usually 2-5, small, oblong.

113. *Thunbergia coccinea* Wall., Clarke in Hook. f., FBI 4: 393. 1884; Gamble, Man. Ind. Timb. 518. 1902; Kanjilal *et al.*, FA 3: 411. 1939; Balakr., FJ 2: 349. 1983; Haridasan & Rao, FFM 2: 669-670. 1987. (Acanthaceae)

Coll. No. 028-MP

LN: Mozhuakhraeri or Ohunakurei (M); Kovomotsiipa (P)

Fls. & Frts.: November-May

Uses: Ground leaves paste is applied in cut or injury to control bleeding and wound healing.

Description: Extensive climbers with pendent branches; leaves ovate-lanceolate, ovate-elliptic, long-acuminate, base truncate or subcordate, 3-5 nerved, glabrous, remotely toothed or subentire; racemes up to 40 cm long, flowers orange red, 3-4 cm long; capsules 4-5 cm long.

114. *Thysanolaena maxima* (Roxb.) Kuntz., Rev. Gen. Pl. 2: 794. 1891; FA 5: 176. 1940; Balakr., FJ 2: 602. 1983. (Gramineae or Poaceae)

Coll. No. 186-P

LN: Laphaibu (M); Muntheh (K)

Fls. & Frts.: September-March

Uses: Root decoction is prescribed for expulsion of gastro-intestinal worms.

Description: Leaves lanceolate, subamplexicaul at base, sheath, acuminate at apex, scabrid at margins; ligules truncate, cartilaginous; spikelets ovate-lanceolate, acuminate; glumes ovate.

115. *Tithonia diversifolia* (Hemsl.) A. Gray in Proc. Amer. Acad. 19: 5. 1883; Balakr., FJ 1: 262. 1981. (Compositae or Asteraceae)

Coll. No. 096-MP

LN: Chighiipa (M); Chivou (P) Niheipah (K)

Fls. & Frts.: October-January

Uses: Leaves warm from the fire and massage anus to relieved pain against heamorrhoids. Ground leaves paste is applied against skin diseases, controlling bleeding in cut or injury.

Description: Shrubs or undershrubs; leaves ovate, ovoid-rhomboid often 3-7 lobed, base narrowed to the petiole; involucral bracts ovate, ovate-oblong, florets brightly yellow, ray florets 3-5 cm long; achenes brown.

116. *Verbena officinalis* Linn., Hook. f., FBI 4: 565-566. 1885; Kanjilal *et al.*, FA 3: 462. 1939. (Acanthaceae)

Coll. No. 105-M

LN: Mokrobu (M)

Fls. & Frts.: July-March

Uses: Juice extract from fresh leaves is given to relieved stomachache.

Description: Erect or decumbent herbs with woody rootstock; stems 4-angled; leaves simple, 3-partite or variously pinnately lobed and coarsely toothed; flowers pale purple, spike terminal, slender; nutlets with few longitudinal ribs.

117. *Viburnum foetidum* Wall., See SN 37 of 6.2. Wild edible fruits (Caprifoliaceae)

Uses: Ground tender leaves are applied as remedy against heamorrhoids.

118. *Viscum articulatum* Burm. f., FI 311. 1768; Hook. f., FBI 5: 226. 1886; Kanjilal *et al.*, FA 4: 119.1940; Balakr., FJ 2: 412. 1983. (Loranthaceae)

Coll. No. 051-MPK

LN: Kheka or Tusho katena (M); Chushou (P); Sahei or Heibom (K)

Fls. & Frts.: July-January

Uses: Whole plant is crushed and the paste is applied covered with bandage for setting fractured bone. Boiled decoction is used to massage bodyache and joint dislocations.

Description: A green shrubs; branches pendulous, 2 or 3-chotomously branched; internodes flattened, disarticulating at nodes; leaves bract-like; sessile cymes; fruits globose, yellowish-green, glossy, smooth, wrinkle when dry.

119. *Zanthoxylum armatum* DC., See SN 63 of 6.1. Wild edible plants (Rutaceae)

Uses: Raw fruits are taken against carminative and flatulence. Dried fruit powder mixed with water is applied as paste to relieved inflammations due to burns.

120. *Zanthoxylum rhetsa* (Roxb.) DC., Prodr. 1: 728. 1824; Hook. f., FBI 1: 495. 1875; Kanjilal *et al.*, FA 1: 197. 1936; Haridasan & Rao, FFM 1: 193. 1987. (Rutaceae)

Coll. No. 010-MP

LN: Ngothe (M); Ngatheh (P); Toikepi (K)

Fls. & Frts.: May-October

Uses: Raw fruit is taken as carminative and flatulence. Tender leaves are cooked as spices or as vegetable in meat to neutralized harmful effect such as indigestion and gas formation.

Description: A tree with corky bark and spreading leafy branches, prickles straight or incurved; leaves equally or unequally pinnate, leaflets opposite, ovate-oblong or lanceolate, caudate-acuminate; cymes, bracts minute, caduceus; flowers yellow, 4-merous; seed subglobose, blue-black.

121. *Zingiber purpureum* Rosc., in Trans. Linn. Soc. 8: 348. 1807; *Z. cassumunar* Roxb. In Asiat. Res. 11: 347.t.5. 1810; Baker in Hook. f., FBI 6: 248. 1892; Hajra *et al.*, Fl. Sikkim 1: 134. 1996. (Zingiberaceae)

Coll. No. 139-P

LN: Deivou (P)

Fls. & Frts.: July-September

Uses: Crushed rhizome mixed with water is applied to head for removing or killing lice's.

Description: Rhizome aromatic, bright yellow inside; leaves sessile, lanceolate to linear, acuminate, pubescent along midrib beneath; flowers yellow; spikes ellipsoid; bracts broadly ovate, obtuse or subacute, scarlet-red to greenish-red; capsules globose.

CHAPTER-VII

7. RESULTS

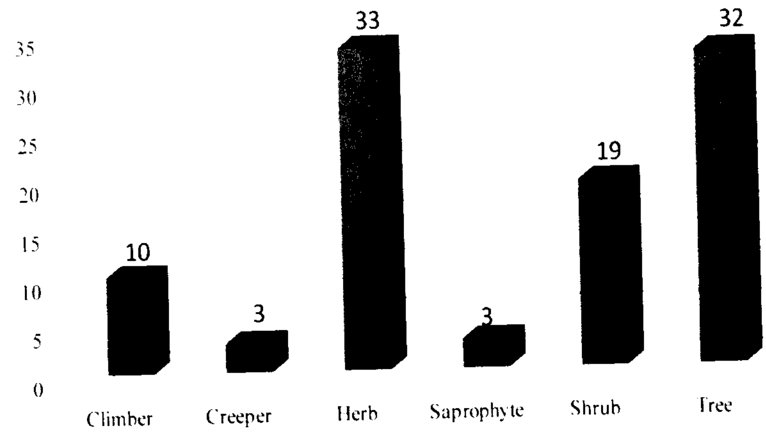
7.1. Wild edible plants and fruits

7.1.1. **Taxonomic diversity:** The present study revealed a rich floral diversity and traditional knowledge on uses of wild edible plant resources by both the Naga and the Kuki communities in the district. During ethnobotanical field surveys to different villages and local markets in the district, about 100 different species of wild edible plants and fruits including 3 species of edible mushrooms were recorded to be used for consumption by both the communities. These total edible species reported were arranged together (Tables- 17 & 18) for analysis of its taxonomic richness and was found to be distributed in 60 families and 83 genera. Of this, 63 species belong to the category of wild edible plants and 37 species form edible fruits. Three different species viz. *Bryonopsis heterophylla* (Lour.) Cogn., *Morus alba* Linn. and *Rhus semialata* Murry. DC. are used both as edible plants and fruits. Of the total 100 plants documented from the present work, it was recorded that 82 species belong to dicots, 13 are monocots, 2 pteridophytes viz. *Diplazium esculentum* (Retz.) Sw. and *Diplazium pseudosetigerum* (Ching.) Fras.-Jenk. and 3 edible mushrooms namely *Auricularia delicata* (Fr.) P. Henn., *Lentinula lateritia* (Berk.) Pegler and *Schizophyllum commune* Fr. are also popularly consumed by both the communities in the district. The families Rosaceae, Zingiberaceae and Polygonaceae had the highest number of edible plants and fruits each recorded with 11, 5 and 4 species respectively.

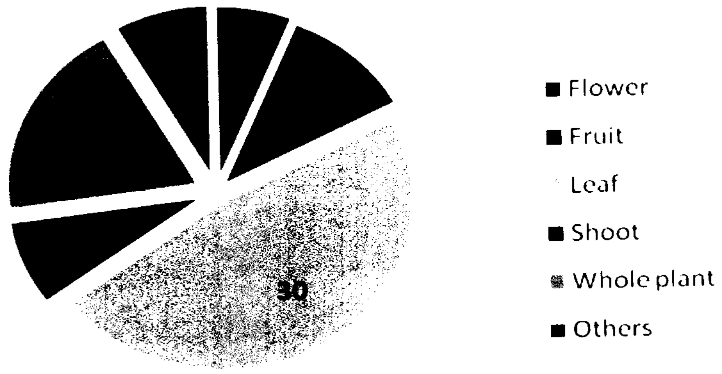
7.1.2. **New records from the state:** Although most of the edible species recorded in the present study have been reported earlier by other workers from the state (Singh and Singh, 1985; Singh *et al.*, 1988; Elangbam *et al.*, 1989; Elangbam, 2002; Chakraborty, 2003; Devi *et al.*, 2010; Salam *et al.*, 2010) however, about 29 species

(46.03%) of edible plants and 11 species (29.73%) of edible fruits (mark in*, Tables- 17 & 18) are a new record which has not been reported from the state. Further, similar reports on the use of most of these edible plants recorded in the present investigations are also reported by other workers from different tribal communities in different parts of Northeast India (Sundriyal *et al.*, 2004; Gajurel *et al.*, 2006; Angami *et al.*, 2006; Sawian *et al.*, 2007; Kayang 2007; Mozhui *et al.*, 2011).

7.1.3. **Growth forms, edible parts and availability status:** The growth forms of the different plant species include tree, shrub or under shrub, herb, climber, creeper and saprophytes. Herbs and trees make up the highest proportion each comprising 33 and 31 species from a total of 100 different plant species. Within the edible parts of the wild food plant, leaves with 30 species (47.62%) follow by whole plant 12 (19.04%) and tender fruits or pods with 7 species (11.11%) were the plant parts most widely used (Fig.9). These edible plant parts were collected from the wild and consumed in different times of the year. List of all the recorded plant species and its uses are presented (Tables- 17 & 18). Further, assessment of the local availability status (surveyed sites) of 22 different species of selected wild edible food plants (11 species of edible plants and 11 species of edible fruits) showed that the maximum number of 12 species (54.55%) was graded to the category of not so common, follow by common and rare or scanty category with 4 species each. Remaining two species namely *Centella asiatica* Linn. and *Rhus semialata* Murry. DC. belongs to the category of abundant (Tables-9 & 10).



(a)



(b)

Fig.9.Distribution of wild edible plants according to (a) growth forms (b) edible parts

Table-9: Assessment of local availability status of selected wild edible plants according to Informants or Collectors perception

Village	*Chimonobambusa callosa*	*Centella asiatica*	*Curcuma angustifolia*	*Elatostema sessile*	*Houttuynia cordata*	*Impatiens annulifera*	*Musa sps.*	*Rhynchotecum ellipticum*	*Oenanthe stolonifera*	*Solanum torvum*	*Trichosanthes cordata*
Changlobung	Nr	Co	Nc	Nr	Nc	Nr	Nc	Ra	Nc	Nc	Ra
Chowainu	Nr	Ab	Co	Nr	Co	Nc	Nc	Nr	Co	Nc	Nc
Emeifiithumei	Ab	Ab	Co	Co	Ab	Co	Co	Nc	Ab	Nc	Co
Karong	Nr	Co	Co	Nc	Ra	Ra	Ra	Nc	Ra	Nc	Nr
Kayinu	Co	Ab	Nc	Co	Ab	Co	Co	Nr	Ab	Ra	Co
Liyai Khullen	Ab	Ab	Nc	Ab	Ab	Co	Co	Co	Ab	Nc	Co
MaoPondung	Ab	Ab	Co	Co	Ab	Co	Co	Nc	Ab	Nc	Co
Motbung	Nr	Co	Co	Nr	Nc	Nr	Ra	Nr	Ra	Nc	Nr
Paomata Centre	Co	Ab	Co	Nc	Co	Nc	Co	Nc	Co	Nc	Co
Phaijang	Nc	Co	Co	Nr	Nc	Nc	Nc	Nc	Nc	Nc	Nc
Phoibung	Nc	Co	Co	Nc	Co	Nc	Co	Co	Nc	Nc	Co
Rukhumei Taphou	Nr	Co	Nc	Nr	Nc	Nr	Nc	Nr	Ra	Nc	Ra
Upper Khabung	Nc	Co	Ab	Nc	Nc	Nc	Nc	Co	Co	Nc	Nc
Status	**Nc**	**Ab**	**Co**	**Nc**	**Co**	**Nc**	**Nc**	**Nc**	**Co**	**Nc**	**Nc**

NB: Ab = Abundant, Co = Common, Nc = Not so common, Ra = Rare or scanty, Nr = Not reported.

Table-10: Assessment of local availability status of selected wild edible fruits according to Informants or Collectors perception

Village	*Baccuria sapida*	*Castanopsis tribuloides*	*Docinea indica*	*Eleocarpus floribundus*	*Emblica Officinalis*	*Ficus auriculata*	*Juglan regia*	*Melia birmanica*	*Prunus nepalensis*	*Rhus semialata*	*Prunus persiaca*
Changlobung	Ra	Nr	Ra	Nr	Nc	Nc	Ra	Nr	Nr	Co	Nc
Chowainu	Nr	Co	Co	Ra	Co	Co	Ra	Nc	Nr	Co	Co
Emeifiithumei	Nr	Nc	Co	Ra	Nc	Nc	Ra	Nc	Nr	Ab	Co
Karong	Nr	Nc	Ra	Nr	Co	Co	Ra	Nr	Nr	Co	Nc
Kayinu	Nr	Co	Co	Ra	Nr	Ra	Nr	Nc	Nr	Co	Co
Liyai Khullen	Nr	Nc	Nc	Ra	Co	Nc	Nr	Nc	Nc	Ab	Co
Mao Pondung	Nr	Nc	Co	Ra	Nc	Nc	Ra	Nc	Nr	Ab	Co
Motbung	Nr	Nr	Nr	Nr	Nc	Nc	Nc	Nr	Nr	Co	Nc
Paomata Centre	Nr	Co	Co	Nc	Co	Co	Ra	Nc	Nc	Co	Co
Phaijang	Ra	Ra	Nr	Nr	Co	Co	Ra	Ra	Nr	Co	Nc
Phoibung	Nc	Nc	Nc	Nr	Co	Co	Nc	Ra	Nr	Co	Nc
Rukhumei Taphou	Nr	Nr	Ra	Nr	Nc	Nc	Nr	Nr	Nr	Co	Nc
Upper Khabung	Ra	Co	Nc	Ra	Co	Co	Ra	Nc	Nc	Co	Nc
Status	**Ra**	**Nc**	**Nc**	**Ra**	**Co**	**Nc**	**Ra**	**Nc**	**Ra**	**Ab**	**Nc**

NB: Ab = Abundant; Co = Common; Nc = Not so common; Ra = Rare or Scanty; Nr =Not recorded

7.1.4. **Most frequently used wild edible vegetables:** It has been observed that during field survey to different villages (Table-19) and local markets in the district, a wide variety of edible wild plants about 100 different species are recorded to be used by the hill tribal communities of the district. Some of these edible plants are used not only for household consumption but a significant amount of the collection of these plants (Table-11 & 12) are sold to local vegetable sellers or vendors thereby contributing some amount to their household income. There are certain factors which influence the large scale collection of some of these edible plants such as (a) local availability status (b) good palatability taste (c) easy accessibility of the species (d) proximity to local markets and (e) high demand from local consumers. Based on number of informants who mentioned the plant for food purposes in different villages and also from local vegetable sellers or vendors during surveyed to different market places in the district, the following were the most utilized plants cited by more than 75% of the total number of informants who reported a plant for any food use. Important among them are *Auricularia delicata* (Fr.) P. Henn., *Arundinaria callosa* Munro., *Centella asiatica* (Linn.) Urbane, *Clerodendrum colebrookianum* Walp., *Curcuma angustifolia* Roxb., *Elatostema sessile* Frost, *Hedychium coronarium*, *Houttuynia cordata* Thumb., *Lentinula lateritia* (Berk) Pegler, *Musa* sps., *Oenanthe stolonifera* (Wall.) DC., *Schizophyllum commune* Fr., *Trichosanthes cordata* Roxb., *Wendlandia glabra* DC., etc. All these edible plant species are reported to have been used traditionally in all the surveyed villages.

7.1.5. **Wild edible plants as food medicines:** From a total of 100 wild edible plants and fruits recorded in the present investigation, about 23 plant species are used as medicinal food remedy (Tables- 17 & 18). Although in facts there exist no clear distinction between food and medicinal plants uses among indigenous traditional communities, however still certain wild edible plants are used as medicinal foods because of their assumed health benefits. In other words often there exist overlapping between wild edible food plants and medicine in traditional societies (Pieroni and Price, 2005). Thus food plants can be used as medicine and vice versa. For example, the tender leaves of *Clerodendron colebrookianum* Walp. is often consumed as leafy vegetable by the Kukis tribal community of the district because it is perceived by this local people to relieve from high blood pressure. Similarly, plants like *Centella asiatica* (Linn.) Urbane, *Oenanthe stolonifera* (Wall.) DC., *Spilanthes paniculata* Wall. ex DC., etc. are frequently consumed as leafy vegetable by the local tribal people to relieved gastro-intestinal problems and high blood pressure. Other important medicinal food plants used by the local people in the district include fruit of *Rhus semialata* Murry. DC., inflorescences of *Trichodesma khasianum* C.B Clarke and *Wendlandia glabra* DC., flowers of *Phlogacanthus curviflorus* Nees, whole plant of *Plantago erosa* Wall., fruits of *Litsea citrata* Bl. and *Solanum nigrum* Linn., etc.

7.1.6. **Wild edible plants available for selling in the local markets:** A total of about 43 different edible food plants (28 edible plants or 44.44% and 15 edible fruits or 40.54%) are documented to be available for selling in the local markets. Also in addition, a number of edible mushrooms particularly species belonging to the genera *Auricularia*, *Lentinula*, *Pleurotus*, *Schizophyllum*, *Termitomycetes*, etc. are also found selling in the markets during the growing seasons. Of these, the three most important species of edible mushrooms are *Auricularia delicata* (Fr.) P. Henn., *Lentinula lateritia* (Berk.) Pegler and *Schizophyllum commune* Fr. These edible mushrooms are frequently found selling in the local markets at exorbitant prices during the growing seasons and thus formed important sources of income both for the collectors as well as the local vegetable sellers and vendors (Table-11).

Table-11: List of wild edible plants available for selling in the local markets in Senapati district, Manipur

Name of edible plant species	No. of collector interview	Collectors selling rates Rs.kg^{-1}			Variaible of collector selling rates & frequency (f)			Mean value Rs. kg^{-1}	No. of sellers interview	Sellers selling rates Rs. Kg^{-1}			Variable of seller selling rates & frequency (f)			Mean value Rs. kg^{-1}	CSCoR (%)	SSCoR (%)
		A	B	C	f_a	f_b	f_c			A	B	C	f_a	f_b	f_c			
Alpinia nigra (Gaertn.) Burtt.	4	15	18	0	3	1	0	15.75	5	20	24	0	2	3	0	22.4	70.31	29.69
Arundinaria callosa Munro.	5	13	15	30	1	3	1	17.6	6	20	25	0	3	3	0	22.5	78.22	21.78
Auricularia delicata (Fr.) P. Henn.	4	300	350	0	1	3	0	337.5	5	450	500	0	3	2	0	470	71.80	28.20
Centella asiatica Linn.	8	25	28	30	3	3	2	27.37	6	35	40	45	1	3	2	40.83	67.03	32.97
Chenopodium album Linn.	4	8	10		1	3	0	9.5	4	15	18	0	2	2		16.5	57.57	42.43
Chimonobambusa callosa (Munro) Nakai	5	6	8	0	2	3	0	7.2	6	10	12	15	2	3	2	12.28	58.63	41.37
Curcuma angustifolia Roxb.	5	10	12	0	3	2	0	10.8	5	15	16	0	3	2	0	15.4	70.13	29.87
Diplazium esculentum (Retz.) Sw.	4	12	15		3	1	0	12.75	5	18	20	0	3	2	0	18.8	67.82	32.18
Elastostema sessile Forst.	6	10	12	15	3	2	1	11.5	8	20	22	25	5	2	1	21.12	54.45	45.55
Eurya acuminata DC.	5	8	9	10	1	1	3	9.4	9	15	20	0	6	3	0	16.66	56.42	43.58
Houttuynia cordata Thunb.	5	25	30	0	2	3	0	28	8	40	45	50	2	2	4	46.25	60.54	39.46
Lentinula lateritia (Berk.) Pegler	6	160	170	180	2	3	1	168.33	6	220	230	250	1	2	3	238.33	70.62	29.38
Litsea citrata Bl.	4	80	90	0	2	2	0	85	6	120	130	0	3	3	0	125	68	32
Musa sps.	8	4	5	0	3	5	0	4.62	10	8	9	10	2	3	5	9.3	49.67	50.33
Oenanthe stolonifera Wall.	9	8	10	0	3	5	0	8.22	12	15	18	2	3	2	7	18.42	44.62	55.38
Rhynchotechum ellipticum (Wall. ex Dietr.) DC.	5	8	10	0	3	2	0	8.2	5	15	18	0	3	2	0	16.2	50.61	49.39

Schizophyllum commune Fr.	5	170	185	200	2	1	2	185	5	280	300	0	2	3	0	292	63.35	36.65
Trichosanthes cordata Roxb.	4	15	18	0	3	1	0	15.75	7	20	25	0	4	3	0	21.14	74.50	25.50
Wendlandia glabrata DC	6	35	40	0	3	3	0	37.5	8	50	55	60	2	4	2	55	68.18	31.82

Table-12: List of wild edible fruits available for selling in the local markets in Senapati district, Manipur

Name of edible plant species	No. of collectors interview	Collector selling rates Rs. Kg^{-1}			Variable of collector selling rates & frequency (f)			Mean value Rs. Kg^{-1}	No. of vendors or sellers interview	Vendor or seller selling rates Rs. Kg^{-1}			Variable of sellers selling rates & frequency (f)			Mean value Rs. Kg^{-1}	CSCoR (%)	SSCoR (%)
		A	B	C	f_a	f_b	f_c			A	B	C	f_a	f_b	f_c			
Baccaurea sapida (Roxb.) Muell.	4	12	15	0	2	2	0	13.5	5	22	25	0	3	2	0	23.2	58.18	41.82
Calamus floribundus Griff.	4	13	15	0	2	2	0	14	4	22	25	0	3	1	0	22.75	61.53	38.47
Docynia indica Dcne.	8	4	5	6	3	3	2	4.87	9	8	10	12	3	5	2	10.88	44.76	55.24
Eleocarpus floribundus Blume	3	12	14	0	2	1	0	12.66	4	20	25	0	3	1	0	21.25	59.57	40.43
Emblica officinalis Gaernt.	6	10	12	15	3	2	1	11.5	10	20	23	25	3	2	5	23.1	49.78	50.22
Ficus auriculata Lour.	5	8	10	12	2	2	1	9.6	7	15	18	20	2	3	2	17.71	54.20	45.80
Juglan regia Linn.	6	9	12	15	2	4	1	13.5	8	18	20	25	2	5	1	20.12	67.09	32.91
Spondias acuminata Roxb.	4	8	9	0	3	2	0	10.5	5	12	15	0	3	2	0	13.2	79.54	20.46
Prunus nepalensis (Ser.) steud.	6	10	12	14	3	2	1	11.33	9	25	28	30	2	3	5	31.55	35.91	64.09
Prunus persiaca (Linn.)Batsch	5	7	8	0	2	3	0	7.5	5	12	14	0	3	2	0	12.8	58.59	41.41
Rhus semialata Murry. DC.	6	30	35	40	2	3	1	34.16	9	50	65	70	3	4	2	61.11	55.89	44.11

7.1.7. **Assessment of local dependency on selected edible plants:** A case study to assess and evaluate the local dependency on selected wild edible plants and fruits was conducted in three different localities from two villages' viz., Kayinu and Emeifiithumei of the Mao Naga tribal communities and observed that there is a high dependency of the local people on the wild resources (Tables-13A, B & C). Observation of the household percent involved in extraction or collection on few selected edible plants and fruits showed that the dependencies varies significantly from species to species in the two villages under study and in case of species like *Oenanthe stolonifera* Wall., *Musa* sps., etc. 100% of the household surveyed in all the three localities were recorded for collection (Fig.10 & 11). In the case of wild edible fruits the value ranges from 9.52% to 57.14% for *Juglan regia* Linn. and *Prunus persiaca* (Linn.) Batsch respectively. Similarly, from the total number of households recorded for collection about 19.15% - 42.10% for edible plants and 16.57%-61.40% for edible fruits used the collection both for household consumption as well as for selling in the local markets. These households are mostly from low economic profile and marginalised families whose main occupation is the traditional agricultural farming. Similar reports are also available for Amazonian forests (Browder, 1990; Phillips, 1993). The marketed quantity of the collection in percent also varies considerably from species to species and ranges from 35.2%-66.43% for edible plants and 38.55%-90.3% for edible fruits (Tables-11 & 12). The remaining percent of the households used the collection only for domestic consumption. The collectors sell their collection either directly in the local markets such as Mao Gate, Tadubi and in some cases to middleman who buy the collections in bulk from different collectors and sell the same to nearby towns like Kohima (state capital of Nagaland state), Senapati (district headquarter) and Imphal (state capital of Manipur). Moreover, taking an average of the different species collected a small quantity of the collection, about 9.9% (edible plants) and 4.8% (edible fruits) were recorded to be used for other purposes like offering to their relatives or neighbours and also used for animal's feed e.g. *Musa* sps.

Table-13: Assessment of local dependency on selected wild edible plants and fruits (A) in Okhro-Ekhro

Name of the plant	No. of HH recorded for extraction	HH %	Quantity extracted (kg)	Quantity for HH use (kg)	% HH use	No. of HH recorded for marketing	HH %	Quantity marketed (kg)	% Marketed	Monetary mean value (Rs./kg)	Total income generated (Rs.)	Quantity for other purpose (kg)	%	Total monetary value
Chimonobambusa callosa (Munro) Nakai.	24	57.14	123	56.5	45.93	5	20.83	66.5	54.1	7.2	478.8	----	----	885.6
Elatostema sessile Forst.	23	54.76	91	48	52.74	7	30.43	43	47.25	11.5	494.5	----	----	1046.5
Houttunyia cordata Thunb.	42	100	105	63	60	9	20	42	40	28	1174	----	----	2940
Lentinula lateritia (Berk.) Pegler	9	21.42	39	14.5	37.17	3	33.33	24.5	62.82	168.33	4124	----	----	6564.87
Musa sps.	42	100	1210	162	13.39	11	24.44	628	51.90	4.62	2901.36	420	34.71	5590.2
Oenanthe stolonifera Wall.	42	100	213	105.5	49.53	13	28.89	107.5	50.47	8.22	883.65	----	----	1750.86
Trichosanthes cordata Roxb.	21	50	124	43	34.68	9	42.85	81	65.32	15.75	1275.75	----	----	1953
Wild edible fruits														**20731.03**
Castanopsis tribuloides (Smith) A. DC.	15	35.71	13	13	100	----	----	----	----	22.5	----	----	----	292.5
Docynia indica Dcne.	21	46.67	428	62	14.48	13	61.90	366	85.51	4.87	1782.42	----	----	2084.36
Elaeocarpus floribundus Blume	9	21.43	39.5	13	32.91	3	33.33	26.5	67.1	12.66	335.49	----	----	500.07
Emblica officinalis Gaernt.	13	30.95	65	31	47.69	7	53.85	29	44.61	11.5	333.5	5	7.69	747.5
Ficus auriculata Lour.	15	35.71	94.5	51	53.96	5	33.33	43.5	46.03	9.6	417.6	----	----	907.2
Prunus persiaca (Linn.) Batsch.	22	52.38	68	20	29.41	3	13.16	48	70.59	7.5	360	----	----	510
Actual household (HH) number in the village = 78, Number of household surveyed in the presence study = 42, Percent of household surveyed = 53.84%														**5041.63**

Table-13: (B) in Kayinu

Name of the plant	No. of HH recorded for extraction	HH %	Quantity extracted (kg)	Quantity for HH use (kg)	% HH use	No. of HH recorded for marketing	HH %	Quantity marketed (kg)	Marketed %	Monetary mean value (Rs./kg)	Total amount generated (Rs.)	Quantity for other purposes (kg)	%	Total monetary value
Chimonobambusa callosa (Munro) Nakai	28	66.67	95	61	64.21	4	14.28	28	29.47	7.2	201.6	6	6.31	684
Elatostema Sessile Forst.	19	45.24	63.5	34	53.54	9	47.37	27.5	43.31	11.5	316.25	2	3.15	730.25
Houttunyia cordata Thunb.	31	73.81	78.5	52.5	66.88	11	35.48	20.5	26.11	28	574	5.5	7	2198
Lentinula lateritia (Berk.) Pegler	11	26.20	56	22	39.28	5	45.45	31	55.36	168.33	5218.23	3	5.35	9426.48
Musa sps.	42	100	1028.5	175.5	17.06	21	48.84	586	56.97	4.62	2707.32	267	25.96	4751.67
Oenanthe stolonifera Wall.	42	100	168	91.5	54.46	15	34.88	76.5	45.53	8.22	628.83	----	----	1380.96
Trichosanthes cordata Roxb.	18	42.85	69.5	31	44.60	8	44.44	38.5	55.39	15.75	606.37	----	----	1094.62
Wild edible fruits														**20265.98**
Castanopsis tribuloides (Smith) A. DC.	24	57.14	16	9	37.5	3	12.5	7	43.75	22.5	157.5	----	----	360
Docynia indica Dcne	13	30.95	271	63	23.25	9	69.23	208	76.75	4.87	1319.77	----	----	1319.77
Elaeocarpus floribundus Blume	9	21.42	21.5	21.5	100	----		----	----	12.66	----	----	----	272.19
Emblica officinalis	11	26.19	32.5	15	46.15	3	27.27	17.5	53.84	11.5	373.75	----	----	373.75
Ficus auriculata Lour.	18	42.86	84	59	70.24	2	11.11	25	29.76	9.6	806.4	----	----	806.4
Prunus persiaca	27	64.28	103.5	46.5	44.93	5	18.51	56.5	54.59	7.5	776.25	----	----	776.25
N.B: Actual household (HH) number in the village = 95, Number of household surveyed in the presence study = 42, Percent of household surveyed = 44.21%														**3908.36**

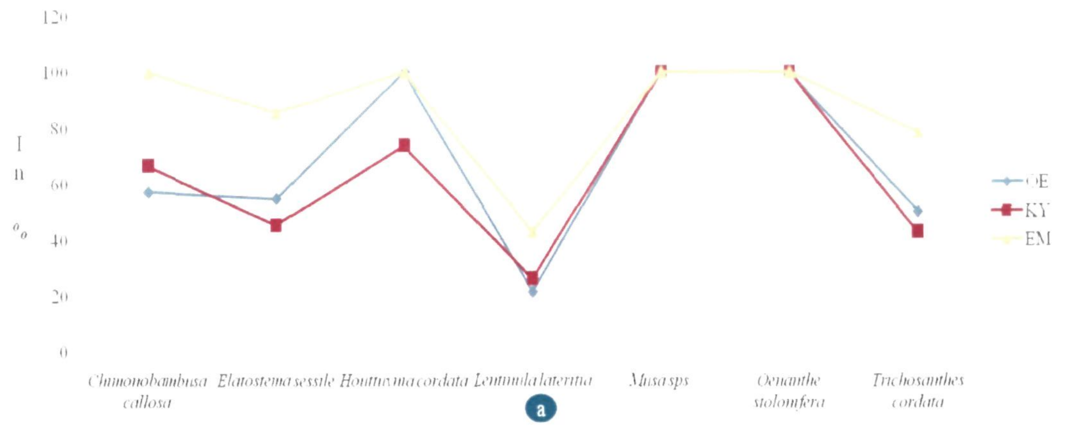
Table-13: (C) in Emeifiithumei

Name of the plant	No. of HH recorded for extraction	HH %	Quantity extracted (kg)	Quantity for HH use (kg)	% HH use	No. of HH recorded for marketing	HH %	Quantity marketed (kg)	Marketed %	Monetary mean value (Rs./kg)	Total income generated (Rs.)	Quantity for other purpose (kg)	%	Total monetary value
Chimonobambusa callosa (Munro) Nakai	42	100	180	78	43.33	9	21.43	103	57.22	7.2	741.6	----	----	1296
Elatostema Sessile Forst.	36	85.71	223	72	32.29	17	47.23	145.5	65.25	11.5	1673.25	5.5	2.46	2564.[illegible]
Houttunyia cordata Thunb.	42	100	109	63	57.80	12	28.57	46	42.20	28	1288	----	----	3052
Lentinula lateritia (Berk.) Pegler	18	42.85	186.5	48	25.73	8	44.44	131.5	70.51	168.33	22135.4	7	3.75	31393.55
Musa sps.	42	100	1527.5	250.5	16.40	7	16.67	111	7.27	4.62	512.82	1174	76.85	7057.05
Oenanthe stolonifera Wall.	42	100	161	83.5	51.86	13	30.95	77.5	48.14	8.22	637.05	----	----	1323.42
Trichosanthes cordata Roxb.	33	78.57	113.5	51	44.93	6	18.18	58.5	51.54	15.75	921.37	4	3.52	1787.63
Wild edible fruits														**48474.15**
Castanopsis tribuloides (Smith) A. DC.	15	35.71	101	19	18.81	6	40	82	81.19	22.5	1845	----	----	2272.5
Docynia indica Dcne	23	54.76	539	86	15.95	13	56.52	451	83.67	4.87	2196.37	2	0.37	2624.93
Elaeocarpus floribundus Blume	5	11.90	33	13	39.39	3	60	20	60.61	12.66	253.2	----	---	417.78
Emblica officinalis Gaertn.	25	59.52	202.5	104	51.36	11	44	88.5	43.70	11.5	1017.75	10	4.94	2328.7[illegible]
Ficus auriculata Lour.	32	76.20	160	88	55	6	18.75	62	38.75	9.6	595.2	4	2.5	1536
Juglan regia Linn.	12	28.57	144	14	9.72	4	33.33	130	90.28	13.5	1755	----	----	1944
Prunus persiaca(Linn.) Batsch	23	54.76	119.5	28.5	23.85	5	21.74	90	75.31	7.5	675	----	-----	896.25
N.B: Actual household (HH) number in the village = 45, Number of household surveyed in the presence study = 42, Percent of household surveyed = 93.33%														**12020.21**

Table-14: Overall assessment of local dependency for the three localities namely Okhro-Ekhro, Kayinu and Emeifiithumei

Name of the plant	No. of HH recorded for extraction	HH %	Quantity extracted (kg)	Quantity for HH use (kg)	% HH use	No. of HH recorded for marketing	HH %	Quantity marketed (kg)	Marketed %	Monetary mean value ($Rs.kg^{-1}$)	Total income ($Rs.Year^{-1}$)	Quantity for other purpose (kg)	%	Total monetary value
Chimonobambusa callosa (Munro) Nakai	90	71.43	398	195	49	18	20	197.5	49.6	7.2	1422	5.5	1.4	2865.6
Elatostema Sessile Forst.	75	59.52	377.5	154	40.8	30	40	216	57.22	11.5	2484	7.5	2	[illegible]
Houttunyia cordata Thunb.	114	90.5	292.5	178.5	61	31	27.2	108.5	37.1	28	3038	5.5	1.9	8190
Lentinula lateritia (Berk.) Pegler	37	29.36	281.5	84.5	30	16	43.24	187	66.43	168.33	31477.71	10	3.55	47384.9
Musa sps.	126	100	3766	588	15.61	39	30.9	1325	35.2	4.62	6121.5	1853	49.20	17398.92
Oenanthe stolonifera Wall.	126	100	542	280.5	51.75	41	32.5	261.5	48.25	8.22	2149.53	----	----	4455.24
Trichosanthes cordata Roxb.	72	57.14	307	125	40.72	23	31.9	178	58	15.75	2803.5	4	1.3	4835.25
Mean value		**72.56**			**41.26**		**32.25**		**50.26**				**9.9**	**89471.16**
							Wild edible fruits							
Castanopsis tribuloides (Smith) A. DC.	54	42.86	130	41	31.54	9	16.67	89	68.46	22.5	2002.5	----	----	2925
Docynia indica Dcne.	57	45.24	1238	211	17.04	35	71.43	1027	82.95	4.87	5001.49	----	----	[illegible]
Elaeocarpus floribundus Blume	23	18.25	94	47.5	41.12	6	27.27	60.5	52.38	12.66	765.93	7.5	6.5	1190.04
Emblica officinalis Gaertn.	49	38.89	300	150	50	21	37.5	135	45	11.5	1552.5	15	5	3450
Ficus auriculata Lour.	65	51.59	338.5	198	54.5	13	20	130.5	38.55	9.6	1252.8	10	2.9	3249.6
Juglan regia Linn.	12	9.52	144	14	9.72	4	33.33	130	90.3	13.5	1755	----	----	1944
Prunus persiaca (Linn.) Batsch	72	57.14	291	95	32.64	13	18.05	194.5	66.84	7.5	1458.75	----	----	2182.5
Mean value		**37.64**			**33.80**		**32.04**		**63.07**				**4.8**	**20970.2**

N.B: Actual household (HH) number in the two villages = 218; Number of households surveyed in the presence study = 126; Percent of household surveyed = 57.8



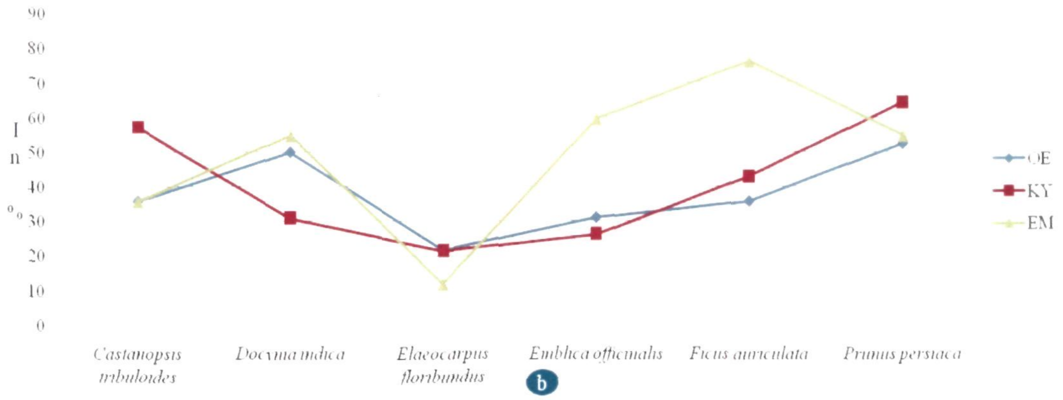
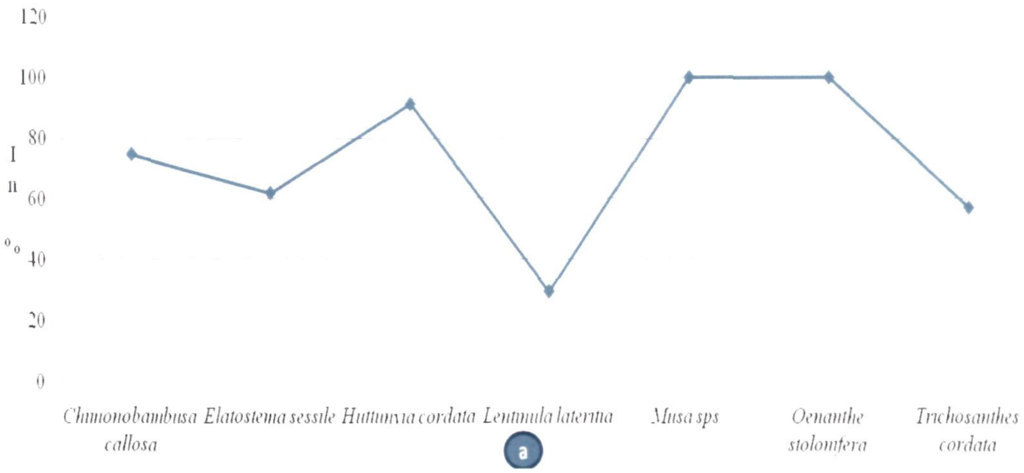


Fig.10. Comparison of household percent involved in collection of selected wild (a) edible plants and (b) fruits per annum in three different localities



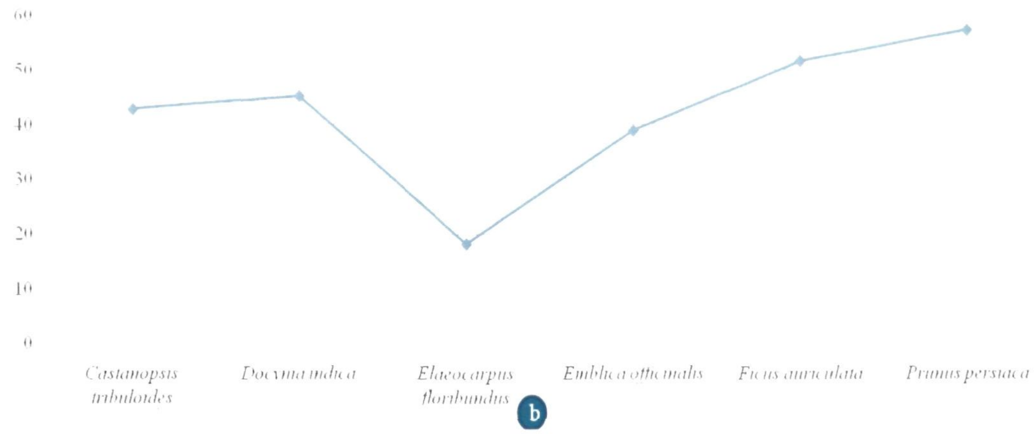
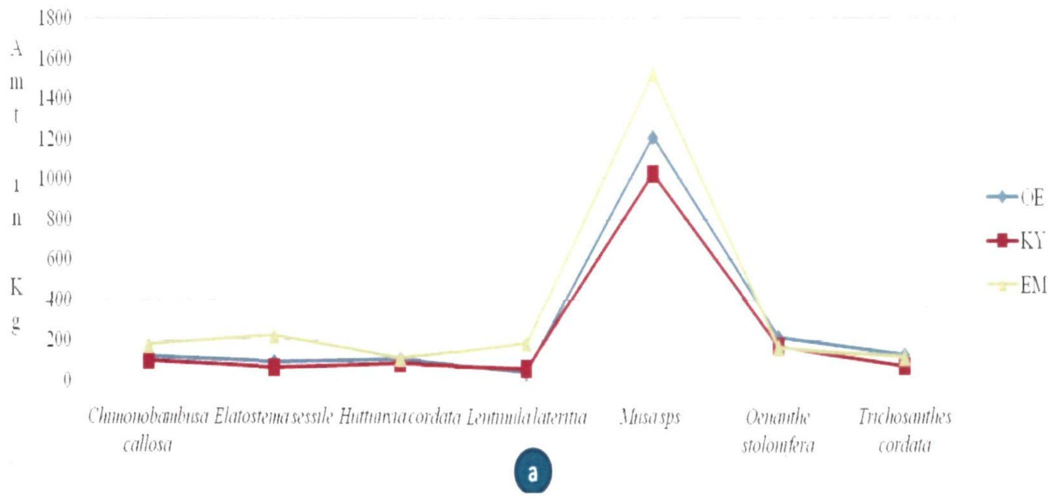


Fig.11. Overall household percent involved in collection of selected wild (a) edible plants and (b) fruits in three different localities



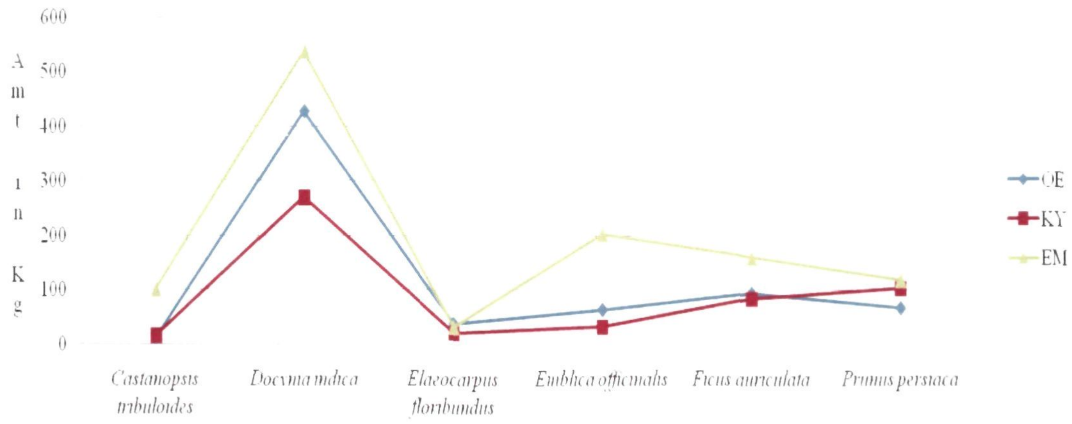


Fig.12. Comparison of quantum of collection (in kg) of selected wild (a) edible plants and (b) fruits per annum in three different localities

Also, comparing to the gross income generated per annum (i.e. 2009) for the three different localities (Fig.12) in terms of monetary value of the total collection in rupee showed that Emeifiithumei has generated the highest gross income with Rs. 48,474 and Rs. 12,020 for edible plants and fruits respectively. This is because of the proximity and easy accessibility by the villagers to forest areas where resources are more available. Also the village is further away (about 13 km) from national highway NH-39 which in turn leads to less dependent from outside vegetable products due to less accessibility to local markets. Further, comparison of the percent of gross income generated per annum among the different wild edible plants and fruits selected in this study showed that *Lentinula lateritia* (Berk.) Pegler with 52.96% and *Docynia indica* Dcne. with 28.75% contributed the highest gross income (Fig.13 & 14).

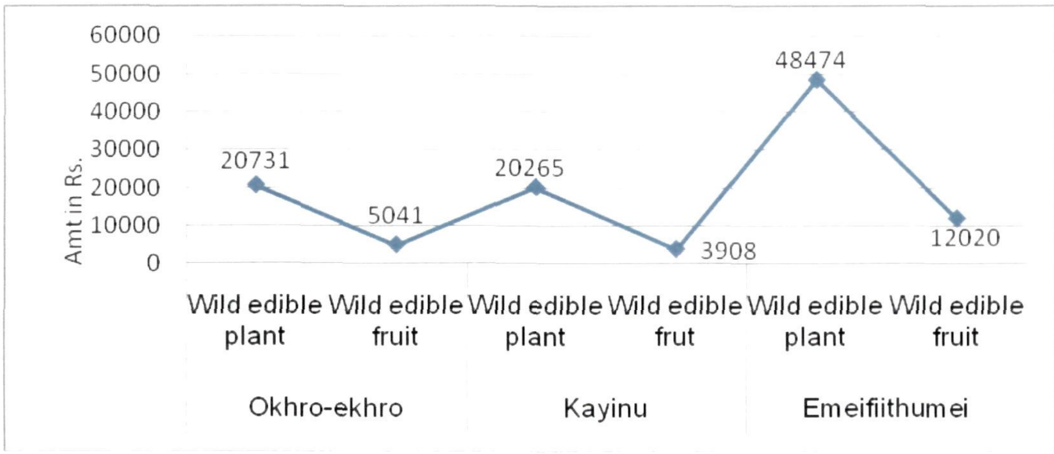


Fig.13. Total monetary value (in Rs.) of selected wild edible plants and fruits in three different localities

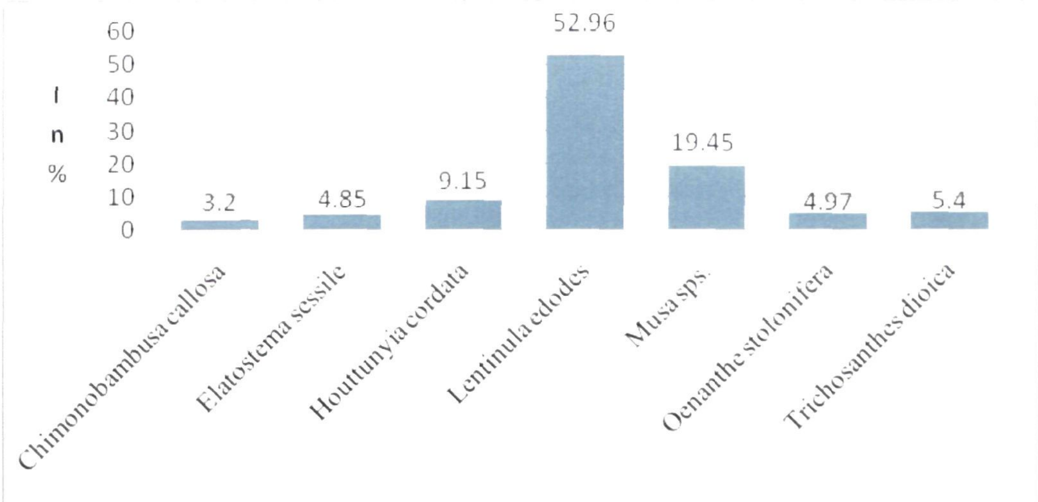


Fig.14. Percent of total monetary valued per annum on selected wild edible plants

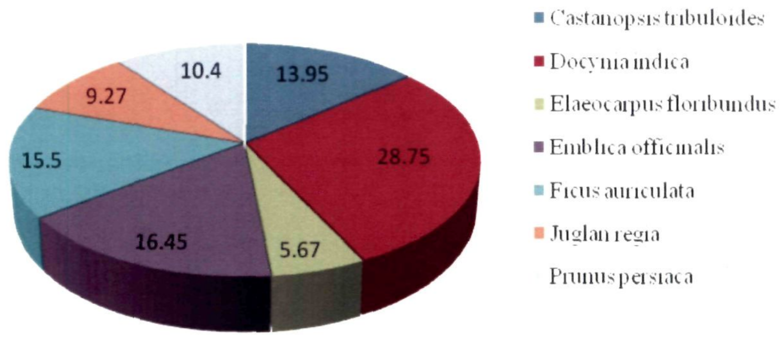


Fig.15. Percent of total monetary valued per annum on selected wild edible fruits

7.1.8. **Data analysis on Percent of CSCoR and SSCoR:** Although the present data collection method did not observe the quantum of collection available in the local markets, however analysis of the data per unit in Kg revealed that the collectors generate some amount of income by selling part of the collection in the local markets. A case study on the assessment and evaluation of local dependency on some selected wild edible plants and fruits (Tables-13A, B, C & 14) further support the findings of this investigation that the tribal people in the district has a high dependency on these wild resources. They collect these wild plants and fruits not only for household consumption but also a fairly good amount of the collection were sold to local vegetable sellers or vendors thereby helping them to generate some household income. Calculation of percent profit sharing on the sale of some selected wild edible plant resources between the collectors and sellers on the consumer rupee was done following the method (Bisht *et al.*, 2005). Although the percent of profit sharing varied significantly from species to species (Table-11 & 12) as expected between the collectors and sellers, however after analysed and calculation of the data recorded, it has been observed that on an average the percent of collectors shared on consumer rupee is found to be 63.29 % on edible plants and 56.82 % on edible fruits while the share of sellers is 36.71% and 43.08% respectively. This observation showed that both the collectors and sellers fairly shared reasonable profits on consumer's rupee which is indicated by the prevailing sell of wild edible plants and fruits in the local markets and the sustainability of this business over the years.

7.1.9. **Preference and quantum of extraction:** Although our present data collection methods on market survey did not show why local people prefer to extract more in selected species and the quantum of collection available in the local markets. However, observation during field surveys and discussion with the local informants (collectors and village elders) and vegetable sellers revealed that the quantum of extraction of any given species depends mainly on the following criteria:

1. Duration and local availability status
2. Economic status of the family
3. Easy accessibility of the resources
4. Good palatability taste and
5. Less accessibility to local markets for outside vegetable products

Because of good palatability taste or flavour and assuming nutritious food values, there is a high local demand for edible mushrooms like *Lentinula lateritia* (Berk.)

Pegler, *Auricularia delicata* (Fr.) P. Henn., *Schizophyllum commune* Fr., etc. and are sold in the local markets at an exorbitant prices. However, because of the short growth duration coupled with less accessibility to common people and limited growth habitats as it is mostly found in the forest areas on dead wood of certain plant species like *Alnus nepalensis* D.Don, *Quercus serrata* Thunb., *Quercus griffithii* Hk.f.Th. and species of *Castanopsis*. As such, it cannot meet the supply of the local demands. It was also observed during market surveys that a number of wild edible species and fruits such as *Elastostema sessile* Forst., *Musa* sps. (*M .paradisiaca* Linn., *M. sapientum* Linn.), *Oenanthe stolonifera* Wall., *Arundinaria callosa* Munro., *Docynia indica* Dcne., *Emblica officinalis* Gaernt., *Prunus nepalensis* (Ser.) Steud., *Rhus semialata* Murry DC., etc. were commonly found selling in all the surveyed market places during the growing seasons. Very few species like pseudostems of *Musa sapientum* Linn., *Musa paradisiaca* Linn., etc. are extracted not only for household consumption or sold in the local markets but also a significant amount of the collection is used as animal feed like pig foodstuff. Also interview and discussion with the local informants further revealed that with few exceptions like collection of wild edible mushrooms found in the forest areas, the collections were mainly carried out by womenfolk and was done mostly during their field work operations. The collections are mainly from their natural habitats of forest areas (private forests, community forests, natural forest) and agricultural farmlands.

7.1.10. **Threats and conservation status:** All the species of edible plants and fruits listed (Tables-15 & 16) are collected from their natural habitats. At present there is no conservation or protection measures taken up in the areas neither from the Government or NGOs nor local communities on these important wild edible resources. Also during interview and discussion with the local informants, it was revealed that there has been tremendous pressure in recent time from various anthropogenic activities like lack of sustainable harvesting practices, expansion of agricultural land, practise of traditional shifting cultivation, forest fires and excessive extraction of some plants both for household consumption or sale in the local markets for household income generation. Further, it was informed by the local communities that collection of wild edible plants is a free access without paying any royalty to the state Government and thus partly contributed opportunities for overexploitations of some species. Therefore proper identification and prioritization of potential species and explore the possibility of integrating it into agro-forestry system by the local communities will be a reliable strategy for bringing about conservation and maintenance of the region's biodiversity resources. Moreover derivation of economic benefits from cultivation of such potential species will definitely encourage the interest of the local communities to conserve and manage their resources (Balemie and Kebebew, 2006).

7.1.11. LIST OF WILD EDIBLE PLANTS AND FRUITS

Table-15: List of wild edible plants reported by the Nagas and the Kukis tribal communities from Senapati district, Manipur

Botanical name	Family	Habit	Phenology and fruiting period	Edible part	Nature of use	Locally used as medicine/ new record (Yes/*)	Availability status in the local markets
Acacia oxyphylla Graph. ex Benth .	Leguminosae	Climber	May-September	Tender pods	Half boiled pods are slices into pieces for making chutney	Yes/*	
Alpinia nigra (Gaertn) Burth.	Zingiberaceae	Herb	May-August	Whole plant	Tender shoot and leaves are eaten as cooked vegetable		Yes
Amaranthus viridis Linn.	Amaranthaceae	Herb	July-October	Leaves	Leaves are eaten as cooked vegetable		Yes
Commelina bengalensis Linn.	Commelanaceae	Herb	July-September	Root	Root stock eaten as cooked vegetable	*	
Arundinaria callosa Munro.	Bambusoideae	Shrub	July-September	Tender shoot	Eaten as cooked vegetable		Yes
Auricularia delicata (Fr.) P. Henn.	Auriculariaceae	Saprophyte	April-July	Whole plant	Eaten as cooked vegetable either in fresh or dried forms		Yes
Bauhinia purpurea Linn.	Leguminosae	Tree	March-September	Flower	Eaten as cooked vegetable	Yes/*	
Begonia picta Sm.	Begoniaceae	Herb	July-September	Leaf petiole	The skin is peeled off and eaten raw	*	
Begonia roxburghii (Miq.) DC.	Begoniaceae	Herb	June-November	Tender leaves	Eaten as cooked vegetable	*	
Cardamine hirsuta Linn.	Brassicaceae	Herb	July-September	Whole plant	Eaten as cooked vegetable	*	
Cassia laevigata Willd.	Leguminosae	Shrub	April-December	Tender pods	Eaten as cooked vegetable	*	

Centella asiatica (Linn.) Urban	Apiaceae	Creeper	March-June	Whole plant	Eaten as cooked vegetable or chopped into pieces for making Sinju or chutney	Yes	Yes
Chenopodium album Linn.	Chenopodiaceae	Herb	June-September	Tender leaves	Eaten as cooked vegetable		Yes
Chimonobambusa callosa (Munro) Nakai	Bambusoideae	Shrub	Not recorded	Tender shoot	Eaten as cooked vegetable	*	Yes
Cinnamomum tamala Fr. Nees.	Lauraceae	Tree	April-October	Leaves	Added to curry to give more flavour and test		Yes
Clerodendrum colebrookianum Walp.	Verbenaceae	Shrub	July-December	Tender leaves	Eaten as cooked vegetable	Yes	
Commelina bengalensis Linn.	Commelinaceae	Herb	July-September	Root stocks	Eaten as cooked vegetable	*	
Crawfurdia speciosa Wall.	Gentianaceae	Climber	January-April	Leaves and flowers	Cook along with rice and eaten	*	
Curcuma angustifolia Roxb.	Zingiberaceae	Herb	March-June	Inflorescences	Eaten as cooked vegetable		Yes
Dioscorea pentaphylla Linn.	Dioscoreaceae	Climber	July-November	Bulbils	Roasted bulbils is eaten	*	
Diplazium esculentum (Retz.) Sw.	Athyriaceae	Herb	July-January	Fronds	Eaten as cooked vegetable		Yes
Diplazium pseudosetigerum (Ching) Fras.-Jenk.	Athyriaceae	Herb	August-January	Fronds	Eaten as cooked vegetable	*	
Elatostema lineolatum Wight	Urticaceae	Herb	June-October	Leaves	Eaten as cooked vegetable		Yes
Eryngium foetidum Linn.	Apiaceae	Herb	June-September	Whole plant	Added to meat curry to give more flavour and test. Also used for making chutney		Yes

Eurya acuminata DC.	Theaceae	Small tree	August-November	Leaves	Eaten as cooked vegetable		Yes
Fagopyrum dibotrys (D.Don) Hara.	Polygonaceae	Herb	June-September	Tender leaves	Boiled with rice and eaten as cooked vegetable	*	
Globba clarkei Baker.	Zingiberaceae	Herb	July-October	Tender shoot	Eaten as cooked vegetable or boiled with rice and eaten	*	
Gnaphalium luteo-album Linn.	Asteraceae	Herb	April-October	Tender plant	Boiled with rice and eaten as cooked vegetable	*	
Hedychium coronarium Koening	Zingiberaceae	Herb	July-October	Tender shoot	Tender shoots are eaten as cooked vegetable		Yes
Houttuynia cordata Thumb.	Saururaceae	Herb	May-September	Whole plant	Eaten as cooked vegetable or used for making chutney		Yes
Impatiens annulifera Linn.	Balsaminaceae	Herb	July-September	Leaves	Boiled with rice and eaten as food	*	Yes
Lentinula lateritia (Berk.) Pegler	Polyporaceae	Saprophyte	February-April	Whole plant	Whole plant body, fresh or dried form is taken as vegetable food		Yes
Litsea citrata Bl.	Lauraceae	Tree	November-June	Fruit	Roasted fruits are use in making chutney	Yes	
Maesa chisia (non D. Don) Clarke	Myrsinaceae	Shrub	June-October	Tender leaves	Tender leaves is boiled with rice and taken	*	
Momordica dioica Roxb. ex Willd.	Cucurbitaceae	Climber	June-September	Tender leaves	Tender fruits and leaves is boiled with rice and taken	*	
Morus alba Linn.	Moraceae	Small tree	March-July	Tender leaves	Leaves are eaten as boiled vegetable	*	
Musa sapientum Linn.	Musaceae	Herb	Not recorded	Tender shoot or pseudostem	Tender part of the pseudostem is eaten as cooked vegetable		Yes
Nasturtium montanum Willd.	Brassicaceae	Herb	May-September	Whole plant	Tender plants are eaten as cooked vegetable	*	
Oenanthe javanica (Blume) DC.	Apiaceae	Herb	June-September	Whole plant	Tender plants are eaten as cooked vegetable or eaten raw as salad		Yes

Oenanthe stolonifera (Wall.) DC.	Apiaceae	Herb	July-September	Whole plant	Tender plants are eaten as cooked vegetable	Yes	Yes
Oroxylum indicum (Linn.) Vent.	Bignoniaceae	Tree	June-February	Pods	Tender pods are half boiled for making chutney		
Paederia foetida Linn.	Rubiaceae	Climber	July-October	Tender leaves	Tender leaves is boiled with rice and eaten as vegetable food	Yes	
Phlogacanthus curviflorus Nees	Acanthaceae	Shrub	January-April	Flowers	The flowers are cooked with rice and eaten as vegetable food	Yes	Yes
Plantago erosa Wall.	Plantaginaceae	Herb	June-October	Whole plant	Tender plants are eaten as cooked vegetable		Yes
Pogostemon elsholtzoides Benth	Lamiaceae	Herb	October-February	Tender leaves	Tender leaves is boiled with rice and eaten as vegetable food	*	
Polygonum chinense Linn.	Polygonaceae	Herb	April-December	Tender leaves	Tender leaves is boiled with rice and eaten as vegetable food		
Polygonum molle D. Don.	Polygonaceae	Us	August-February	Tender leaves	Tender leaves is boiled with rice and eaten as vegetable food	*	
Polygonum perfoliatum Linn.	Polygonaceae	Climber	June-October	Tender leaves	Tender leaves is boiled with rice and eaten as vegetable food	*	
Polygonum runcinatum Ham.	Polygonaceae	Herb	July-October	Tender leaves	Tender leaves is boiled with rice and eaten as vegetable food	*	
Ranunculus sceleratus Linn.	Rananculaceae	Herb	April-October	rootstock	Boiled with rice and eaten as cooked vegetable		
Rhus semialata Murry. DC.	Anacardiaceae	Small tree	August-December	Tender leaves	Boiled with rice and eaten as cooked vegetable	Yes/*	
Rhynchotechum ellipticum (Wall. ex Dietr.) DC.	Gesneriaceae	Herb	June-September	Leaves	Boiled with rice and eaten as cooked vegetable		Yes
Schima wallichii (DC.) Korth.	Theaceae	Tree	February-April	Tender leaves	Boiled with rice and eaten as cooked vegetable	*	

Schizophyllum commune Fr.	Schizophyllaceae	Saprophyte	September-April	Whole plant	Boiled along with dried meat or fish and taken		Yes
Smilax ovalifolia Roxb.	Smilaxcaceae	Climber		Tender shoot	Half cooked and prepared chutney with dried fish	*	
Spilanthes paniculata Wall. ex DC.	Asteraceae	Herb	June-October	Leaves	Eaten as cooked vegetable along with dried meat	Yes/*	
Solanum nigrum Linn.	Solanaceae	Herb	August-December	Leaves	Eaten as boiled vegetable or along with rice and taken	Yes	
Solanum torvum Swartz.	Solanaceae	Shrub	May-October	Fruit	Roasted fruits are use for making chutney		
Trichosanthes cordata Roxb.	Cucurbitaceae	Climber	July-September	Leave	Eaten as boiled vegetable or along with rice and taken as food		Yes
Trichodesma khasianum C.B. Clarke	Boraginaceae	Shrub	December-April	Tender inflorescences	Cooked inflorescences is chopped into pieces for making chutney with dried or fermented fish	Yes/*	Yes
Viola distans Wall.	Violaceae	Herb	March-July	Tender leaves	Boiled with rice and eaten as cooked vegetable	*	
Wendlandia glabra DC	Rubiaceae	Small tree	February-April	Tender inflorescences	Cooked inflorescences is chopped into pieces for making chutney with dried fish		Yes
Zanthoxylum acanthopodium DC.	Rutaceae	Shrub	March-July	Tender leaves and fruit	Fresh or dried fruits are use for making chutney along with dried fish or meat. Leaves eaten as cooked vegetable along with rice		
Zanthoxylum armatum	Rutaceae	Shrub	May-October	Fruit	Dried or powder fruits are used for making chutney with dried fish or meat	Yes	Yes

Table-16: List of wild edible fruit plants reported by the Nagas and the Kukis tribal communities from Senapati district of Manipur

Botanical name	Family	Habit	Phenology and fruiting period	Nature of use	Locally used as medicine (Yes/No)	Availability status in the local markets
Amomum dealbatum Roxb	Zingiberaceae	Herb	May-September	Ripe fruit eaten raw		
Baccaurea sapida (Roxb.) Muell.-Arg.	Euphorbiaceae	Tree	April-July	Ripe fruit eaten raw		Yes
Bryonopsis heterophylla (Lour.) Cogn.	Cucurbitaceae	Climber	May-September	Ripe fruit eaten raw	*	
Calamus floribundus Griff.	Arecaceae	Shrub	August-March	Ripe fruit eaten raw		Yes
Castanopsis hystrix A. DC.	Fagaceae	Tree	June-November	Nuts are roasted or eaten raw		Yes
Castanopsis tribuloides (Sm.) DC.	Fagaceae	Tree	May-November	Nuts are roasted or eaten raw		Yes
Debregeasia longifolia (Burm.f.) Wedd.	Urticaceae	Small tree	June-October	Ripe fruits are eaten raw	Yes/*	
Diospyros lanceoefolia Roxb.	Ebenaceae	Tree	June-December	Cotyledon of ripe fruits are eaten raw	*	
Diospyros kaki Linn.	Ebenaceae	Tree	April-November	Cotyledon of ripe fruits are eaten raw	*	
Docynia indica Dcne.	Rosaceae	Tree	March-November	Ripe fruits are eaten raw and for making pickles		Yes
Duchesnea indica (And.) Focke	Rosaceae	Creeper	April-September	Ripe fruits are eaten raw		
Elaeocarpus floribundus Bl.	Elaeocarpaceae	Tree	March-December	Ripe fruits are eaten raw	Yes	Yes
Elaeagnus latifolia Linn.	Elaeagnaceae	Shrub	April-September	Ripe fruits are eaten raw		
Elaeagnus pyriformis Hk. f.	Elaeagnaceae	Shrub	April-July	Ripe fruits are eaten raw and for making jams		
Emblica officinalis Gartn.	Euphorbiaceae	Small tree	May-December	Fruits are eaten raw and for making jams or pickles	Yes	Yes
Ficus auriculata Lour.	Moraceae	Tree	May-October	Ripe fruits are eaten raw and for making jams		Yes

Ficus hispida Linn.	Moraceae	Tree	June-November	Fruits are eaten raw	*	
Ficus roxburghii Wall.	Moraceae	Tree	July-October	Ripe fruits are eaten raw		
Fragaria indica Andr.	Rosaceae	Creeper	April-August	Ripe fruits are eaten raw		
Grewia elastica Royle.	Tiliaceae	Tree	May-October	Ripe fruits are eaten raw	*	
Juglans regia Linn.	Juglandaceae	Tree	May-November	Lobed cotyledons are eaten raw	Yes	Yes
Melia birmanica Kurz.	Meliaceae	Tree	March-December	Ripe fruits are eaten raw	*	Yes
Morus alba Linn.	Moraceae	Small tree	March-July	Ripe fruits are eaten raw		
Myrica nagi (Thunb.) Hook.	Myricaceae	Tree	February-May	Ripe fruits are eaten raw	Yes	Yes
Ophiopogon wallichianus Hk. f.	Haemodoriaceae	Herb	May-September	Ripe fruits are eaten raw	*	
Phoenix humilis Royle.	Arecaceae	Shrub	July-November	Cotyledon of ripe fruits are eaten raw		Yes
Physalis peruviane Linn.	Solanaceae	Herb	April-October	Ripe fruits are eaten raw or for making chutney	Yes/*	
Prunus cornuta (Wallich ex Royle) Steud.	Rosaceae	Tree	March-October	Ripe fruits are eaten raw	*	
Prunus cerasoides D. Don.	Rosaceae	Tree	March-August	Ripe fruits are eaten raw		
Prunus nepaulensis (Ser.) Steud.	Rosaceae	Tree	March-October	Ripe fruits are eaten raw		Yes
Prunus persiaca (Linn.)Batsch	Rosaceae	Small tree	February-August	Ripe fruits are eaten raw	Yes	Yes
Pyrus pashia D. Don	Rosaceaae	Tree	February-November	Ripe fruits are eaten raw	*	
Rhus semialata Murry. DC.	Anacardiaceae	Small tree	August-December	Ripe fruit boiled with sugar and drink as herbal tea	Yes	Yes
Rubus ellipticus Smith	Rosaceae	Shrub	February-May	Ripe fruits are eaten raw	Yes	
Rubus lasiocarpus Smith.	Rosaceae	Shrub	May-September	Ripe fruits are eaten raw	Yes/*	
Rubus rugosus Smith	Rosaceae	Shrub	May-September	Ripe fruits are eaten raw	*	
Viburnum foetidum Wall.	Caprifoliaceae	Shrub	May-September	Ripe fruits are eaten raw	*	

7.2. Ethnomedicinal plants

7.2.1. **Informant selection:** A total of 139 elders (98 men and 40 females) from 14 different villages of both the Nagas and the Kukis ethnic communities were participated in the present study. The age of the informants ranged from 18-78 with an average of 56.04 years for man and 48.80 years for female (Table-17). Most of the selected informants belonged to those people who have a strong connection with traditional agriculture farming for their day-to-day needs. In most cases selection of the informants were identified by local community members on those elders who are more knowledgeable about the use of local flora including traditional or folk medicine.

Table-17: List of villages, number of informants and average age (in year)

SN	Name of the village	Number of people interviewed	Male	Female	Average age	
					Male	Female
1	Changloubung	14	9	5	61.75	56.89
2	Chowainu	2	1	1	18	50
3	Emeifiithumei	9	9	0	50.75	0
4	Karong	2	1	1	49	45
5	Kayinu	26	11	15	50.75	67.6
6	Liyai Khullen	7	7	0	41.71	0
7	Maopondung	33	29	4	50.85	45.75
8	Motbung Bazaar	5	5	0	63.6	0
9	Poamata Centre	9	9	0	41.61	0
10	Phaijang	5	3	2	64	41
11	Phoibung	6	2	4	42.2	39.51
12	Rikhumei Taphou	5	1	4	50	59.75
13	S. Bungnong	3	3	0	63.5	0
14	Upper Khabung	12	8	4	51.8	38.25
Total		**139**	**98**	**41**	**56.04**	**48.8**

About 111 (80.43%) informants utilized medicinal plants and prepared only when require for themselves, 11 (7.97%) informants not only utilized for themselves when required but also prepared for other peoples on demand as requested, 3 persons are

regular practitioners and treated as professional as they treat patients in full time while the remaining 13 (9.42%) informants reported that they do not utilized medicinal plants.

7.2.2. **Taxonomic diversity:** During the survey, a total of 120 different species of medicinal plants belonging to 56 families and 109 genera (Table-21) are reported to have been used for treating 53 different diseases or ailments of both human and animal. In terms of number of medicinal plant diversity, the family Asteraceae with 14 species is the highest follow by Solanaceae 7. Lamiaceae and Leguminosae 6 species each, Acanthaceae, Euphorbiaceae and Rosaceae each with 5 different species respectively. Also from the total number of species recorded, 105 are dicots and the remaining 14 species are from monocots including 1 species of pteridophyte i.e. *Lygodium japonicum* (Thunb.) Sw. The majority of the plants were wild 102 (85%) followed by cultivated 12 (10%) species while about 6 (5%) were recorded as wild or cultivated.

7.2.3. **Medicinal plant parts, habits and uses reported by the informants:** Different plant parts both underground and above ground such as leaf, root, barks, rhizome, flowers, shoot, fruits and whole plant are used to treat different ailments. From a total of 137 plant parts used as medicine, use of above ground plant parts is 99 (72.26%), underground plant parts 26 (18.98%) and whole plant with 12 (8.76%) species. Of the above ground parts, leaf is used in the majority of cases with 41 (46.1%) species follow by whole plants and fruit each with 11 (12.36%) species. The uses of underground plant parts include root, root bark, tuber and rhizome. Figure 16 showed an outline of the different plant parts used. Also in terms of plant habits, herbs with 49 (40.83%) species constitute the largest number of species follow by trees 26 (21.67%) species (Fig.17). Removal of leaves is more sustainable (Giday *et al.*, 2003) as compared to the used of whole plant, root, fruit or seeds for preparation of medicine as this will caused an adverse negative effect on plant population growth which in turns will lead to decline of populations in nature (Ghimire *et al.*, 2008). A total of 84 informants (60.34%) mentioned *Phlagocanthus curviflorus* Nees used as medicine for the treatment of various ailments such as gastritis, fevers, headache, high blood pressure, body ache, joint dislocation and sprain, etc. and this species was recorded as the most popular remedy in the present study. This was followed by *Oroxylon indicum* (Linn.) Vent 58 (41.73%), *Rhus semialata* Murry. and *Artemesia parviflora* Roxb. each with 57 (41%) used citations, *Eupatorium adenophorum* Spreng. 56 (40.28%) and *Thalictrum foliolosum* DC. 54 (38.85%) respectively.

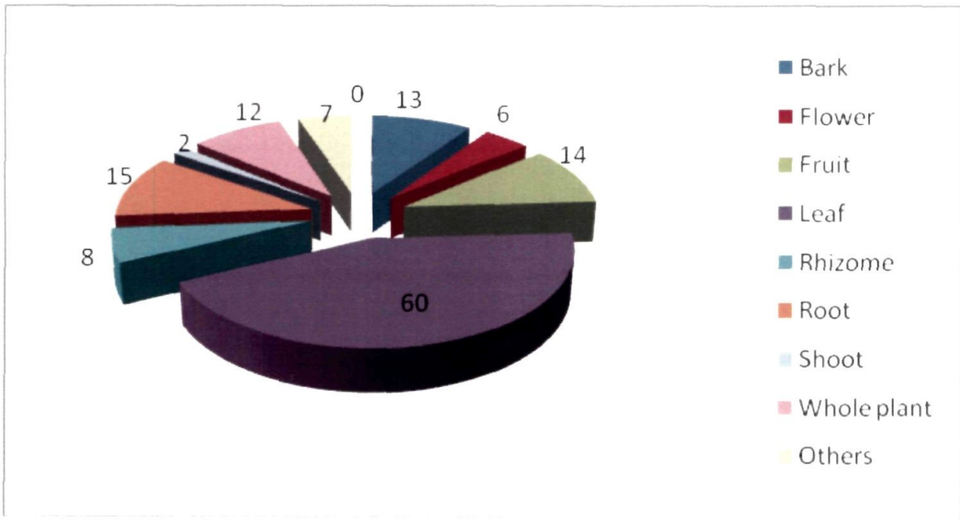


Fig.16. Showing different plant parts used.

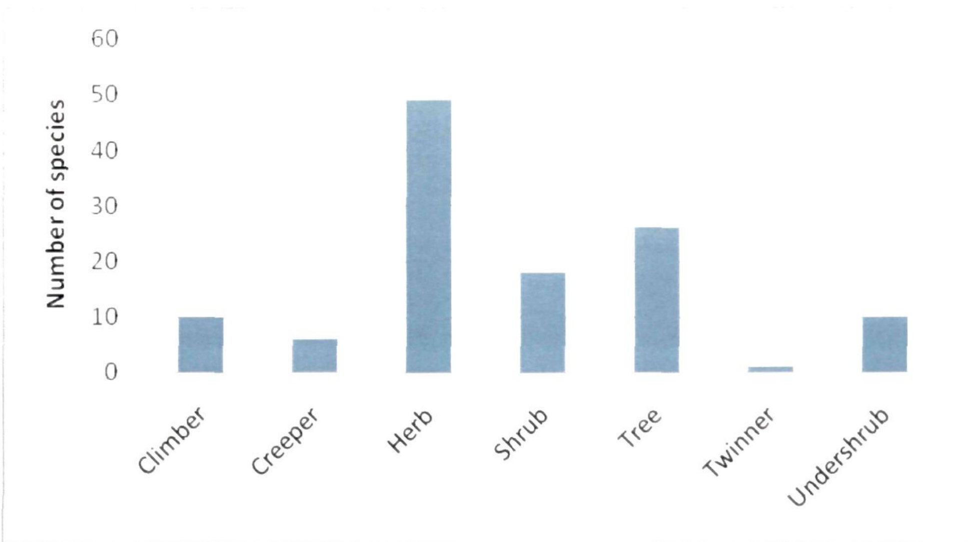


Fig.17. Number of species in terms of plant habits.

7.2.4. **Importance of ailments indicated:** About 53 different ailments have been recorded in the present investigation. Out of this, the importance of only 10 most common or important ailments in the areas are evaluated based on the number of used citations made by the informants during survey to different villages as shown in the (Table-19). Figure 18 illustrates the relative importance of the specific ailment recorded: cut or injury and wound healing (15.47%), gastritis (9.29%), dysentery

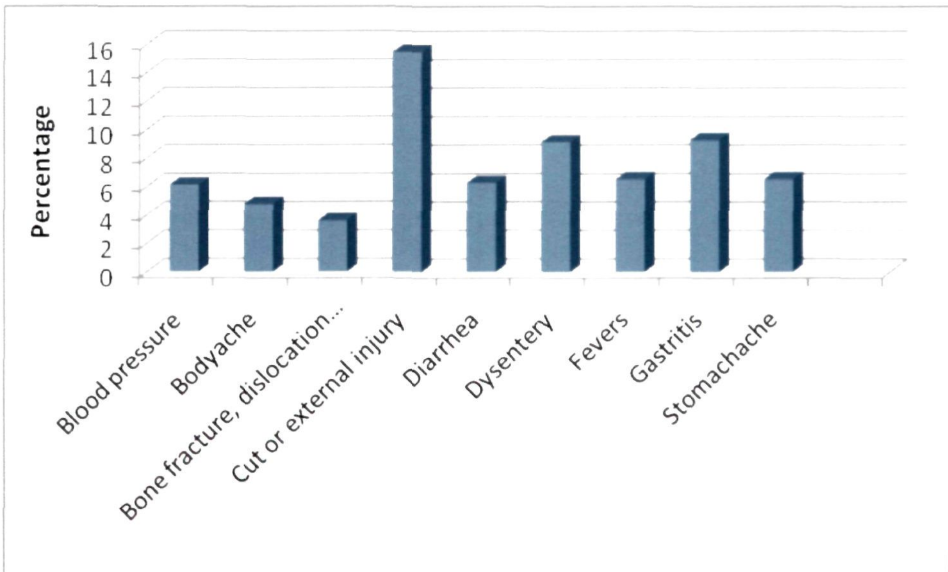


Fig.18. Relative importance of the specific ailments

(9.14%), stomachache (6.54), fevers (6.54%), diarrhea (6.28%), blood pressure (6.12%), bodyache (4.77%), killing maggots and wound healing (4.20%), bone fracture, dislocation or sprain (3.63%), etc. Further in terms of ailment categories, gastro-intestinal disorders with 50 species constitute the highest number follow by fevers and circulatory system disorders with 22 species each.

7.2.5. **Veterinary use of medicinal plants:** About 8 different species belonging to 6 families and 7 genera are reported to have veterinary applications. The veterinary diseases or an ailment treated includes killing maggots and wound healing, leeches expulsion from cattle's nostril and also as insects repellent e.g. ticks. The plant species recorded during survey are *Arundo donax* Linn., *Artemesia parviflora* Roxb., *Chenopodium ambrosioides* Linn., *Nicotiana tabacum* Linn., *Oroxylon indicum* (Linn.) Vent., *Prunus persiaca* (Linn.) Batsch, *Solanum khasianum* Clarke and *Solanum nigrum* Linn. With the exception of *Artemesia parviflora* Roxb. where it is used in fresh or dry form as insects repellent, in all other species the remedies are prepared from fresh plant parts either by crushing or ground and applied as paste.

7.2.6. **Mode of preparation:** The local people employed variety of methods such as decoction, infusion, crushing or grounding, squeezing or extraction and other unspecific methods to prepared remedies for treating different diseases or ailments. Boiled decoction and crushing or grounding is the predominant methods of preparation. Squeezing or extraction of juice from fresh plants parts particularly from the leaves is also not less common and were used mainly to treat ear, eye or nostril ailments as well as controlled bleeding and wound healing due to cut and other external injuries. The ground plant parts are usually applied as paste on affected areas. The most frequently used form of preparations were decoction 62 (41.61%)

followed by crushing or grounding 41 (27.52%), extraction or squeezing 24 (16.11%), hot infusion 5 (3.35%) and others 17 (11.41%).

7.2.7. **Informant consensus, use value and fidelity level:** Calculation of the value of informant consensus factor on the recorded ethnomedicinal plants showed that it ranges from 0.62-1.0 indicating that there is a well defined selection criterion of the plant used and also exchanged of information's among the different informants in the study area. Leeches expulsion from animal nostril, cancer or tumours and epistaxis have the highest ICF value 1.0 each as there is well defined selection criterion in the community since only one species has been reported to be used for each ailments. The value is also high for removal of block fish bone from throat (0.95), killing maggots in cattle's wound (0.92), blood pressure and cut or external injury and wound healing (0.91), gastritis (0.90), etc. as there is information exchanged among the different informants indicated by the high number of use reports or citations 298, 179 and 81 for each category of these ailments. An outline of ICF values for other categories of diseases or ailments are presented in the (Table-19). The lowest was observed for the ailment inflammation and burns in the category of dermatological infections with 0.62 ICF value and 9 citations from 4 different species. The three most cited disease or ailment categories are digestive disorders such as stomachache, gastritis, indigestion, constipation, flatulence or carminative, etc. with 31 plant species and 365 citations; intestinal illness including diarrhea and dysentery with 25 species and 297 citations and follow by cut or injury with 298 citations from 26 different species of medicinal plants used as remedy.

As calculated the use-value (UV), *Parkia roxburghii* G. Don., *Sapindus mukorossi* Gaernt., *Catharanthus roseus* (Linn.) G. Don., *Phlogacanthus curviflorus* Nees. and

Tithonia diversifolia (Hemsl.) A. Gray was recorded to have the highest use value. *Parkia roxburghii* G. Don is used in gastritis, diarrhea, dysentery and piles with a UV of 0.93, *Sapindus mukorossi* Gaertn and *Catharanthus roseus* (Linn.) G. Don used against tooth ache, epilepsy, constipation, stomachache, fevers and dry cough have UV 0.80 each while *Phlogacanthus curviflorus* Nees used in gastritis, fevers, headache, high BP, body ache, joint dislocation or sprain and *Tithonia diversifolia* (Hemsl.) A. Gray used against heamorrhoids, skin diseases and cut or injury was reported with a UV of 0.67 and 0.65. The use value (UV) of all other species recorded in this study is presented on the (Table-18). Also (Table-20) showed an outlines of some commonly use ethnomedicinal plants in the surveyed areas and their major uses with fidelity level. The medicinal plants with 100% fidelity level such as *Artemisia parviflora* Roxb., *Clerodendron colebrookianum* Walp. and *Physalis peruviane* Linn. are reported as remedy for one or two diseases. The calculated level for each of this medicinal plant also agrees with ICF value. Obviously, the remedies for frequently reported ailments have the highest FL value and those with low number of reports have the lowest FL values.

Table-18: Informant consensus factors according to ailment categories

Ailment categories	Type of biomedical ailments in the category	No. of Species	% all species	No. of use citations	% all use citations	ICF
Intestinal diseases	Diarrhea	23	19.17	121	6.28	0.82
	Dysentery	25	20.83	176	9.14	0.86
Digestive disorders	Gastritis	19	15.83	179	9.29	0.90
	Indigestion	2	1.67	10	0.52	0.88
	Constipation	3	2.50	11	0.57	0.80
	Stomachache	16	13.33	126	6.54	0.88
	Flatulence or carminative	7	5.83	39	2.02	0.84
Antidote	Snake and insect bites	5	4.17	39	2.02	0.89
Cut and injury	Controlled bleeding, contusion and wound healing	26	21.67	298	15.47	0.91
Skeleto-muscular system problems	Bodyache	12	10.00	92	4.77	0.88
	Bone fracture, joint dislocation and sprain	10	8.33	70	3.63	0.87
	Body swelling, arthritis and rheumatism	3	2.50	9	0.47	0.75
Veterinary diseases	Killing maggots and wound healing	7	5.83	81	4.20	0.92
	Expulsion of leeches from animal nostril	1	0.83	8	0.41	1.0
Abnormal blood sugar level	Diabetes	4	3.33	19	0.98	0.83
Oncogenes	Cancer or tumours	1	0.83	5	0.26	1.0
Fevers	Malaria and intermittent	19	15.83	126	6.54	0.85
Circulatory system disorders	Blood pressures	12	10.00	118	6.12	0.91
	Jaundice and hepatic complaints	6	5.00	33	1.71	0.84
ENT problems	Sinusitis	2	1.67	10	0.52	0.89
	Epistaxis or bleeding nose	2	1.66	21	1.09	0.95
	Ear-infections	3	2.50	9	0.46	0.75

Opthalmological uses	Conjunctivitis and other eye diseases	5	4.17	16	0.83	0.73
Dermatological infections	Boils, scabies and other skin diseases	9	7.50	43	2.23	0.81
	Inflammation and burns	4	3.33	9	0.47	0.62
Genito-urinary ailments	Kidney and urinary bladder stones	3	2.50	8	0.41	0.71
	Menstrual disorders and white discharge,	2	1.67	5	8	0.75
	Diuretic or painful urination	3	2.50	7	0.36	0.67
Respiratory diseases	Chest pain	3	2.50	12	0.62	0.82
	Cough and cold	8	6.67	22	1.14	0.67
Dental problems	Toothache and other gum complaints	12	10.00	44	2.28	0.74
Neuro-muscular problems	Epilepsy	2	1.67	5	0.26	0.75
Deworming	Anthelmentic or worm expulsion	5	4.17	17	0.88	0.75
Vomiting		5	4.17	29	1.50	0.86
Headache		4	3.33	20	1.03	0.84
Abortificient	Foetus expulsion	2	1.67	8	0.41	0.86
Piles or haemorrhoid		7	5.83	22	1.14	0.71
Fish bone removal		2	1.67	22	1.14	0.95
Hair care	Hair tonic, dandruff, lice problem	5	4.17	37	1.92	0.89

Table-19: Commonly use medicinal plants and their major uses with their Fidelity Level

Botanical name	Family	Major uses	Np	N	FL %
Artemisia parviflora Roxb.	Compositae or Asteraceae	Control bleeding in cut or injury and nose bleeding	57	57	100
Clerodendron colebrookianum Walp	Verbenaceae	High BP	37	37	100
Physalis peruviane Linn.	Solanaceae	Stomachache and dysentery	29	29	100
Curcuma caesia Roxb.	Zingiberaceae	Stomachache	23	24	95.83
Prunus persiaca (Linn.) Batsch.	Rosaceae	Killing maggots in animal wounds and skin diseases	32	34	94.12
Artemesia nilagirica (Clarke) Pamp.	Compositae or Asteraceae	Diarrhae, dysentery, cut or injury	43	48	89.58
Gymnopetalum cochinensis (Lour.) Kurz.	Cucurbitaceae	Jaundice and fever	17	19	89.47
Rhus semiliata Murry. DC.	Anacardiaceae	Dysentery and vomitting	51	63	87.30
Psidum gaujava Linn.	Myrtaceae	Diarrhae & dysentery	33	38	86.84
Thalictrum foliolosum DC.	Rananculaceae	Fever, high BP and stomachache	41	52	78.84
Eupatorium adenophorum Spreng.	Compositae or Asteraceae	Cut or external injury	44	56	78.57
Phlagocanthus curviflorus Nees	Acanthaceae	Fever, bodyache and high BP	64	84	76.19
Oroxylon Indicum (Linn.)Vent.	Bignoniaceae	Gastritis, killing maggots and wound healing	42	58	72.41

7.2.8. LIST OF ETHNOMEDICINAL PLANTS DOCUMENTED

Table-20: List of ethnomedicinal plants used by the tribal communities from Senapati district, Manipur

Species	Habit	Part use	Type of ailments treated	Use-value	Previously reported ethnomedicinal uses in literatures
Achyranthes aspera Linn.	H	Leaves	Body swelling and Toothache	0.14	pulmonary infections, cough, asthma, skin diseases (Newton *et al.*, 2002); cut, wounds, skin diseases, bone fracture (Kala, 2005)
Adhatoda zeylanica Medic.	S	Leaves	Body ache, chest pain and joint dislocation	0.24	Asthma, cold, cough, fever (Ignacimuthu *et al.*, 2006); fevers, headache, bodyache (Bantawa and Rai, 2009)
Phlogacanthus curviflorus Nees.	S	Leaves	Gastritis, high BP, fevers, headache, body ache, joint dislocation and sprain	0.67	Cough, fever (Sinha, 1996)
Scutellaria discolor Coleb.	H	Leaves	Intermittent fever	0.36	Gastric trouble (Manandhar, 1993); injuries, menstrual disorders (Khumbongmayum *et al.*, 2005); cuts and wounds (Kunwar *et al.*, 2006)
Thunbergia coccinea Wall.	Cl	Leaves	Cut or injury	0.12	Decoration (Srivastava, 2009)
Psidium guajuva Linn.	T	Leaves and fruits	Vomiting, diarrhea and dysentery	0.35	Cough (Maheshwari and Singh, 1984); astringent, diarrhea, ulcers, piles, cholera, vomiting (Chopra *et al.*, 1992); diarrhea (Tene *et al.*, 2007)
Rhus semialata Murry.	T	Fruits	Dry cough, vomiting, diarrhea and dysentery	0.47	Appetizer (Manadhar, 1987a); dysentery (Shrestha and Dhillion, 2003); cholera, dysentery (Hynniewta and Kumar, 2008); asthma, food poison, stomachache, dysentery (Rokaya *et al.*, 2010)
Catharanthus roseus (Linn.) G. Don.	H	Leaves	Fevers and dry cough	0.8	Cancer, diabetes, tonic (Jain, 1991); diabetes, high blood pressure (Sajem and Gosai, 2010)
Arisaema tortuosum (Wall.) Schott.	H	Leaves petiole	Bee sting and snake bite	0.09	Headache, toothache, stomache, menstruation problems (Rokaya *et al*, 2010)
Eleutherococcus aculeatum (Ait.) Seem.	S	Leaves	Ringworm and ear infections	0.14	
Panax psuodogiseng Wall.	H	Rhizome	Gastritis and other gastro-intestinal problems, high BP and aphrodiasic	0.62	Aphrodisiac, stimulat, dyspepsia, vomiting, antipyretic (Sinha, 1996); liver disorder, stomach colic, antipyretic, menstrual disorder (Saha *et al.*, 2011)
Ageratum conyzoides Linn.	H	Leaves	Cut or injury	0.18	Cut, wounds (Kala, 2005); hair lotion (Khumbongmayum *et al.*, 2005); stomach pain (Tene *et al.*, 2007)
Artemesia parviflora Roxb.	Us	Leaves	Cut or injury and nose bleeding	0.46	Hair care lotion (Sinha, 1996)

Artemesia nilagirica (Clarke) Pamp.	Us	Leaves	Colic, diarrhea and dysentery	0.4	Cough, headache, sores (Kala, 2005); stomach ulcer, hair lotion, insect repellent (Khumbongmayum *et al.*, 2005); mouth ulcer, dizziness, headache (Bantawa and Rai, 2009)
Bidens pilosa Linn. *var. minor* (Bl.) Scherff.	H	Leaves	Cut or injury and uncontrolled bleeding after delivery	0.3	Pulmonary diseases, leprosy (Puyvelde *et al.*, 1994); stomach pain, menstruation pain, scurvy, influenza, prostate disturbances, pneumonia (Tene *et al.*, 2007)
Blumeopsis flava (DC) Gagnepain	H	Leaves	Fevers, high BP, dry cough, chest pain and body ache, cut or injury, skin diseases and killing maggots	0.35	Bronchial congestion, catarrh, cold (Sinha, 1996)
Crassocephalum crepidioides (Benth.) Moore	H	Leaves and flowers	Gastritis, constipation, Diabetes, high BP and Cut or injury	0.28	Indigestion, headache, stomachache, (Kala, 2005); cut, wounds (Hynniewta and Kumar, 2008)
Eupatorium adenophorum Spreng.	H	Leaves	Cut or injury, diarrhea, dysentery and abortifacient	0.42	Boils, fever, insomnia (Manadhar, 1991, 1992); cuts, wounds (Uprety *et al.*, 2010)
Eupatorium riparium Regel. Gaertn.	H	Leaves	Skin diseases, cut or injury gastritis and diarrhea	0.47	High blood pressure, fever, flu, vomiting, nausea (Lavergne and Vera, 1989; Lavergne, 2001)
Gynura bicolor (Roxb. ex Willd.) DC.	H	Leaves	Gastritis and other stomach disorders	0.26	Intestinal worms (Kala, 2005)
Saussurea deltoidea (DC.) Sch. –Bip.	Us	Leaves	Gastritis and stomachache	0.12	
Sonchus asper (Linn.) Hill.	H	Leaves	Stomachache and gastritis	0.17	Wounds, boils, emollient (Sinha, 1996)
Spilanthes acmella Linn.	H	Flowers	Toothache and hookworm	0.5	Toothache, jaundice, sore throat, cut, injuries (Khumbongmayum *et al.*, 2005)
Spilanthes paniculata wallich ex DC.	H	Leaves	Diarrhea, dysentery and high BP	0.2	Constipation (Kala, 2005); toothache, cure cavity formation (Sajem and Gosai, 2006; Rethy *et al.*, 2010); toothache (Hynniewta and Kumar, 2008)
Tithonia diversifolia (Hemsl.) A. Gray	Us	Leaves	Heamorrhoids, skin diseases and cut or injury	0.65	Abdominal pains, indigestion, sore throat, and liver pain (Kokwaro, 1976)
Mahonia manipurensis Takeda	S	Bark	Fevers and jaundice	0.12	Dizziness (Sinha, 1996)
Alnus nepalensis D. Don.	T	Bark	Cut or injury	0.08	Cuts, burns (Joshi and Edington, 1990); gastric (Shrestha and Dhillion, 2003)

Betula alnoides Buch-Ham. ex D. Don	T	Bark	Diarrhea and dysentery	0.18	Antiseptic, used in snake bite (Sinha, 1996)
Oroxylon indicum (Linn.) Vent	T	Bark	Fever, gastritis, high BP, liver disorder, cancer and killing maggots	0.5	Purgative, headache (Kala, 2005); epilepsy, muscular sprain, general weakness (Khumbongmayum *et al.*, 2005); control hypertension (Mao *et al.*, 2009)
Bombax ceiba Linn.	T	Bark	Toothache	0.09	Skin diseases, female diseases, snake bite (Khumbongmayum *et al.*, 2005)
Cannabis sativa Linn.	Us	Leaves	Diarrheo, dysentery and swine fever	0.44	Leprosy, cough, bronchitis (Kirtikar and Basu, 1935); indigestion, rheumatic pain (Shrestha and Dhillion, 2003); Control bleeding (Kunwar *et al.*, 2006)
Sambucus javanica Bl.	S	Leaves	Bodyache, skin allergy and joint dislocation	0.21	Depuritive, diuretic and purgative (Sinha, 1996)
Viburnum foetidum Wall.	S	Leaves	Heamorrhoids	0.04	Mennohagia, uterine sedative (Sinha, 1996)
Carica papaya Linn.	T	Fruit	Gastritis and other stomach disorders, diabetes, expulsion of intestinal worm and abortificent	0.32	Expectorant (Kirtikar and Basu, 1935); Malaria (Teklehaymanot and Giday, 2007)
Drymaria cordata (Linn.) Roem & Schult.	Cr	Leaves	Headache, cut or injury, snake bite, sinusitis, conjunctivitis	0.23	Cough, dysentery, muscular sprain (Khumbongmayum *et al.*, 2005); sinuses, tonsillitis (Bantawa and Rai, 2009)
Chenopodium ambrosiodes Linn.	Us	Leaves	Killing maggots and wound healing	0.19	Cough, pulmonary complaints (Kirtikar and Basu, 1935); toothache (Kala, 2005)
Bryophyllum pinnatum (Lam.) Krutz.	H	Leaves	Burns and inflammation, gastritis	0.14	Blood purification, cancer and menstruation pain (Tene *et al.*, 2007)
Gynnopetalum cochinensis (Lour.) Kurz.	Cl	Whole plant	Jaundice, fevers and painful urination	0.27	Antidote in food poisoning, tetanus (Sinha, 1996)
Melothria maderaspatana (Linn.) Cogn.	Cl	Leaves and fruits	Fevers, jaundice and bodyache	0.22	Toothache, jaundice, vertigo, biliousness (Khumbongmayum *et al.*, 2005)
Cuscuta reflexa Roxb.	Tw	Whole plant	Bodyache, sprain and joint dislocation	0.25	Bone fracture, body swelling (Joshi and Edington, 1990; Shrestha and Dhillion, 2003); purgative (Kala, 2005); jaundice (Rokaya *et al.*, 2010)
Elaeocarpus floribundus Bl.	T	Fruits	Dry cough and indigestion	0.15	Antiseptic, mouthwash in inflamed gum (Sinha, 1996)
Rhododendron arboretum Sm.	T	Flowers	Removal of block fish bone	0.22	Diarrhea, dysentery (Shrestha and Dhillion, 2003); nasal bleeding (Uniyal *et al.*, 2006); fish bone problem (Bantawa and Rai, 2009)

Rhododendron arboretum Sm.	T	Flowers	Removal of block fish bone	0.22	Diarrhea, dysentery (Shrestha and Dhillion, 2003); nasal bleeding (Uniyal *et al*., 2006); fish bone problem (Bantawa and Rai, 2009)
Emblica officinalis Gaertn.	T	Bark and fruits	Gastritis, vomiting, diarrhea, dysentery, dry cough and body ache	0.48	Acrid, cooling, refrigerant, diuretic, diarrhea, dysentery, anaemia, jaundice, cough (Chopra *et al*., 1992); dyspepsia, jaundice (Khumbongmayum *et al*., 2005)
Glochidion oblatum Hook. f.	S	Leaves	Diarrhea and dysentery	0.4	Dysentery (Sinha, 1996)
Jatropha curcas Linn.	T	Branches	Burns and relieved inflammation	0.31	Boils, pimples (Manandhar, 1993); toothache (Jadhav, 2006); herpes, antiparasite (Tene *et al*., 2007)
Phyllanthus fraternus Web.	H	Whole plant	Diarrhea and kidneystone	1	Leucoderma (Khumbongmayum *et al*., 2005)
Ricinus communis Linn.	S	Leaves	Body ache, joint and chest pains, joint dislocation and sprain	0.3	Leprosy, asthma, bronchitis, sprains, wounds, injuries (Kirtikar and Basu, 1935); toothache (Teklehaymanot and Giday, 2007)
Quercus serrata Thunb.	T	Bark and extract from cut branches	Cut or injury, diarrhea, dysentery, vomiting, dry cough and analgesic against bee stink	0.33	
Dicentra scandens (D.Don.) Walp.	Cl	Root tubers	Fevers, stomachache and high BP	0.5	Anthelmintic, fever, wound healing (Manandahar, 1993); fevers, blood pressure, gastro-intestinal disorders, toothache (Pfoze and Chiezou, 2006)
Swertia chiraita Linn.	H	Leaves	Intermittent fever and relieved body ache	0.11	Fevers, headache and indigestion (Joshi and Edington, 1990; Shrestha and Dhillion, 2003; Uprety *et al*., 2010); cough, cold, fevers, headache (Manandhar, 2002; Rokaya *et al*., 2010); malaria (Hynniewta and Kumar, 2008)
Swertia pulchella (D. Don) Clarke.	H	Whole plant	Fevers and abdominal flatulence	0.29	Cough, cold, fevers, headache (Rokaya *et al*., 2010; Manandhar, 2002)
Geranium nepalense Sw.	H	Leaves	Crushed leaves paste is applied for cut or injury and wound healing	0.18	Toothache and gum bleeding (Hynniewta and Kumar, 2008); cuts and wounds (Uprety *et al*., 2010)
Curculigo orchioides Gaertn.	H	Rhizomes	Cut or injury	0.16	Dysentery, peptic ulcer (Manandhar, 1991)
Juglans regia Linn.	T	Leaves and bark	Skin diseases and toothache	0.29	Astringent, tonic, anthelminthic (Ugulu *et al*., 2009); toothache and gum problems (Rokaya *et al*., 2010)

Calamintha umbrosa (Bieb.) Benth.	H	Leaves	Cut or injury and wound healing	0.12	Whole plant eaten to ensure good health (Saha *et al.*, 2011)
Elsholtzia blanda Benth.	H	Leaves	Diarrhea, dysentery, stomachache, carminative and flatulence	0.37	Cough and cold (Taylor et al., 1995); choleric diarrhea (Sinha, 1996)
Mentha arvensis Linn.	H	Leaves	Flatulence and removed gas	0.25	Carminative, stomachic (Singh *et al.*, 1979); tongue infection (Shrestha and Dhillion, 2003)
Leucus indica Linn.	H	Leaves	Cut and injury, killing maggots and bleeding piles	0.18	
Ocimum basilicum Linn.	H	Leaves	Carminative or flatulence and fever	0.28	Dyspepsia, carminative, diuretic (Ugulu *et al.*, 2009); Stomach pain, fever, gastritis, influenza, high blood pressure, internal infections, relaxant (Tene *et al.*, 2007)
Ocimum sanctum Linn.	H	Leaves and flowers	Fevers and dry cough		Asthma, bronchitis, expectorant, cough (Kirtikar and Basu, 1935); gastric disorders, bronchitis, earache antiseptic, diaphoretic, hepatic affection (Chopra *et al.*, 1992)
Litsea cubeba (Lour.) Pers.	T	Bark	Emeting, diarrhea and dysentery	0.14	Cough, cold, hair tonic, indigestion, good sleep (Kala, 2005); foot and mouth diseases of cattle's (Mao *et al.*, 2009)
Bauhinia purpurea Linn.	T	Flowers and leaves	Diabetes, piles, gastritis, constipation, diarrhea, dysentery, menstrual problem and remove block fish bone from throat	0.38	Poisonous bite, leucorrhoea, menstrual disorder and leprosy (Khumbongmayum *et al.*, 2005)
Desmodium triquetrum DC.	H	Leaves	Urinary bladder stone	0.28	Piles (Sinha, 1996); vermicide (Sajem and Gosai, 2010)
Entada phaseoloides (Linn.) Merr.	Cl	Seed cotyledon s	Toothache	0.5	Stomach ulcer, fevers and headache (Khumbongmayum *et al.*, 2005)
Erythrina arborescens Roxb.	T	Stem bark	Stomachache	0.48	Toothache and preveny dental caries (Hynniewta and Kumar, 2008)
Mimosa pudica Linn. with *Eupatorium adenophorum* Spreng.	H	Leaves and root	Gastritis, haemorrhoid, painful urination	0.24	Piles (Sajem and Gosai, 2010)
Parkia roxburghii G. Don.		Pods cover	Gastritis, diarrhea , dysentery and piles	0.93	Intestinal disorders, bleeding piles, dirrhea, dysentery (Khumbongmayum *et al.*, 2005)

Acorus calamus Linn.	H	Rhizome	Stomachache, epilepsy, toothache, killing head lice's and insects repellant	0.33	Rheumatic pain, headache, snake bite (Joshi and Edington, 1990); cough/cold (Shrestha and Dhillion, 2003); Cough and cold (Uprety *et al.*, 2010)
Asparagus filicinus Buch.-Ham. Ex D. Don.	Cl	Root tuber	Womb and menstrual disorders	0.09	Antihelmintic, diuretic, diarrhea, skin diseases (Kunwar *et al.*, 2006; Rokaya *et al*, 2010)
Smilax ovalifolia Roxb.	Cl	Tender shoot and root	Cut or injury, arthritis and rheumatism	0.19	Rheumatic swellings, urinary complaints, dysentery (Sinha, 1996)
Lygodium japonicum (Thunb.) Sw.	Cl	Leaves	Jaundice	0.2	Expectorant (Anon., 1986); heart complaints (Khumbongmayum *et al.*, 2005); diabetes, wounds and ulcers (Yumkham and Singh, 2011)
Osbeckia stellata Wall.	S	Leaves and roots	Diarrhea and dysentery	0.26	Antidiabetes (Khan and Yadava, 2010)
Cedrela serrata Royle	T	Leaves and root bark	Joint dislocation, sprain and high BP	0.21	Fever, dysentery, diabetes, blood diseases, skin diseases (Awan *et al.*, 2011)
Melia composita Willd.	T	Leaves and fruits	Intermittent fever, anthelmintic and stomachache	0.19	Stomach, liver troubles (Das *et al.*, 2008)
Ficus auriculata Lour.	T	Fruits	Diarrhea and dysentery	0.24	Diarrhea and dysentery (Manandhar, 1991; wound healing (Shrestha and Dhillion, 2003; Kunwar *et al.*, 2010)
Myrica nagi (Thunb.) Hook.	T	Bark	Diarrhea and dysentery	0.23	Dysentery (Hynniewta and Kumar, 2008)
Mirabilis jalapa Linn.	H	Roots	Cut or injury	0.24	Fevers, discharge of semen through the urine (Manandhar, 1993)
Oxalis corniculata Linn.	Cr	Whole plant	Tooth ache, cut or injury, dysentery and as washing soap for glossy hair	0.19	Stomach complaints, piles, colic, dysentery, hair lotion (Khumbongmayum *et al.*, 2005); diarrhea (Tene *et al.*, 2007); boils , skin problems, diarrhea (Rokaya *et al.*, 2010)
Passiflora edulis Sims	Cl	Leaves	Stomachache, gastritis and dysentery	0.24	Tender ground leaves with Psidium guajava leaves is taken in blood dysentery (Hynniewta and Kumar, 2008)
Plantago erosa Wall.	H	Whole plant	Dry cough	0.13	Constipation (Kala, 2005); Leprosy (Sharma *et al.*, 2001); diarrhea, dysentery (Rokaya *et al.*, 2010); muscular sprain, fever, boils (Khumbongmayum *et al.*, 2005); earache, toothache, gum bleeding (Sajem and Gosai, 2010)

Arundo donax Linn.	Us	Tender shoot and leaves	Killing maggots and wound healing	0.1	Worm-affections, typhoid, pneumonia, asthma (Sinha, 1996)
Cynodon dactylon Pers.	H	Whole aerial parts	Conjunctivitis	0.21	Nose bleeds. Burns (Shrestha and Dhillion, 2003); diuretic, blood depuratic (Ugulu et al., 2009); liver cirrhosis (Bantawa and Rai, 2009)
Imperita cylindrical (Linn.) P. Beauv.	H	Roots	Worm expulsion	0.14	Gastri trouble (Manandhar, 1993); diarrhea, dysentery, gonorrhoea, control bleeding (Khumbongmayum *et al.*, 2005)
Thysanolaena maxima (Roxb.) Kuntz.	Us	Roots	Gastro-intestinal worms	0.33	Mouth-wash in fever (Sinha, 1996); boils, cancer (Hynniewta and Kumar, 2008); rituals (Namsa *et al.*, 2011)
Punica granatum Linn.	S	Roots	Blood dysentery	0.35	Bronchitis, sore throat, chest, troubles (Kirtikar and Basu, 1935); bronchitis, cough (Shah and Joshi, 1971; Anon., 1986); indigestion, diarrhea, dysentery, cough and cold, (Rokaya *et al.*, 2010)
Ranunculus sceleratus Linn.	H	Roots	Boils	0.11	Urinary disorder, blisters, skin diseases (Khumbongmayum *et al.*, 2005)
Thalictrum foliolosum DC.	H	Roots and leaves	Fevers, stomachache, high BP, toothache and skin diseases	0.62	Diuretic, antiperiodic, purgative (Sinha, 1996); stomach pain, gastric trouble (Uniyal *et al.*, 2006)
Fragaria nilgerrensis Schldl.	Cr	Whole plant	Painful urination, diarrhea, dysentery, blood vomiting, bleeding nose and flatulence	0.32	
Potentilla fulgens Wall. ex Hook.	H	Roots	Burns and toothache	0.12	Stomach disorders, certain forms of cancer, diabetes mellitus (Syiem *et al.*, 2002, 2003; Rosangkima and Prasad, 2004); gastro-intestinal disorders (Uprety *et al.*, 2010); dentrifrice (Kunwar *et al.*, 2010); high blood pressure (Hynniewta and Kumar, 2008)
Prunus persica (Linn.) Batsch.	T	Leaves	Killing maggots, skin diseases and ear infections,	0.27	Cough, bronchitis, expectorant (Kirtikar and Basu, 1935); remove worms in animal wounds (Manandhar, 1993)
Rubus ellipticus Smith.	S	Root bark	Dysentery and diarrhea	0.18	Stomach pain, typhoid (Shrestha and Dhillion, 2003) indigestion (Kala, 2005); sore throat, excessive thirst and weakness (Manandhar, 1992; Rokaya *et al.*, 2010)
Rubus niveus Thunb.	S	Root	Dysentery and diarrhea	0.6	Excessive bleeding during menstrual cycle (Uniyal *et al.*, 2006); cough, cold, diarrhea (Rokaya *et al.*, 2010)

Paederia foetida Linn.	Cl	Leaves and roots	Stomachache, diarrhea, dysentery, gastritis, bodyache, joint dislocation and bone fracture	0.31	Gastritis, diarrhea, stomach disorder (Kala, 2005); piles, bone fracture (Khumbongmayum *et al*., 2005)
Zanthoxylum armatum DC.	S	Fruits	Carminative, flatulence and burns	0.46	Cold, cough, fever, appetizer (Kala, 2005); gastro-intestinal disorders (Shrestha and Dhillion, 2003; Uprety *et al*., 2010)
Zanthoxylum rhetsa (Roxb.) DC.	T	Fruits and leaves	Carminative, flatulence, indigestion and gas formation	0.54	Cholera (Wealth of India, 1976; Ambasta, 1986)
Sapindus mukorossi Gaertn.	T	Fruit pulps and seed cotyledons	Tooth ache, epilepsy constipation, fevers and stomachache	0.8	Expectorant, emetic, alexipharmic, abortificent (Kirtikar and Basu, 1991); spermicidal and used in contraceptive cream (Dwivedi *et al*., 1990; Rastogi and Mehrotra, 1999)
Pratia begonifolia (Wall.) Lindl.	Cr	Leaves	Sinusitis	0.4	Dysentery, tonsillitis, snake bite (Saha *et al*., 2011)
Datura arboreatum Mettel	S	Stem and leaves	Snake bite, joint dislocation, sprain and bodyache	0.23	Antiamoebic (Tona *et al*., 1998); constipation, gastritis, blood purification (Kala, 2005)
Nicotiana tabacum Linn.	H	Leaves	Toothache, skin diseases and killing maggots and piles	0.21	Allergy, strokes, rheumatism (Tene *et al*., 2007); skin infections (Sajem and Gosai, 2006; 2010)
Physalis peruviane Linn.	H	Leaves	Stomachache and dysentery	0.33	Pain in pregnancy (Kala, 2005); Disinfectant, healing of wounds (Tene *et al*., 2007)
Solanum khasianum Clarke	Us	Fruits	Washing soap and removal of leech	0.18	Toothache (Kala, 2005); leech killer, toothache (Rethy *et al*., 2010)
Solanum kurzii Br.	S	Fruits	High BP and headache	0.22	Cough, worms infestation (Kala, 2005); anti-allergy (Mao *et al*., 2009)
Solanum nigrum Linn.	H	Fruits	Mouth and nose diseases of chicken	0.17	Liver tonic, indigestion (Kala, 2005); Antispasmodic, antiallerjic, Sedative (Ugulu *et al*., 2009); laxative, diuretic, tonic (Rokaya *et al*., 2010)
Solanum spirale Roxb.	Us	Leaves	Headache	0.14	Narcotic, diuretic (Sinha, 1996)
Paris polyphylla Sm.	H	Rhizomes	Cut or injury, gastritis, fevers and toothache	0.22	Fevers, headache and maternity problems (Joshi and Edington, 1990; Shrestha and Dhillion, 2003; Uprety *et al*., 2010); cuts, wounds (Rokaya *et al*., 2010; Kunwar *et al*., 2006)

Schima wallichii (DC.) Korth.	T	Stem bark	Cut or injury	0.20	Anthelmintic (Manandhar, 1993); expulsion of intestinal worms, gonorrhea (Khumbongmayum *et al.*, 2005)
Centella asiatica (Linn.) Urban	Cr	Whole plant	Conjunctivitis and gastritis	0.33	Bronchitis, asthma, leprosy (Kirtikar and Basu, 1935); tuberculosis, cough, leprosy (Kharkhongor and joseph, 1981); blood purification (Shrestha and Dhillion, 2003)
Hydrocotyle sibthorpioides Lam.	Cr	Whole plant	Removing thorns	1.0	Relieve fevers (Manandhar, 1993); liver complaints, applied to boils to promote suppuration (Sinha, 1996)
Oenanthe javanica (Bl.) DC ssp. *stolonifera* Wall.	H	Whole plant	Gastritis and low BP	0.37	Making Singju, a kind of local preparation (Jain *et al.*, 2011)
Debregeasia longifolia (Burm. f.) Wedd.	T	Leaves	Diabetes	0.10	Antidiabetic (Khan and Yadava, 2010)
Pouzolzia bennettiana Wight	H	Roots	Cut or injury	0.16	Stomach disorder (Namsa *et al.*, 2011)
Clerodendrum colebrookianum Walp. ex Walp.	S	Leaves	High BP	0.41	Rheumatism (Kharkhongor and Joseph, 1981); malaria, liver troubles (Hynniewta and Kumar, 2008); high blood pressure (Rethy *et al.*, 2010; Namsa *et al.*, 2011)
Lantana camara Linn.	S	Leaves and flowers	Fevers, dry cough, jaundice, Joint dislocation and eye infections	0.20	Malaria, atoxy, rheumatism (Chopra *et al.*, 1992); digestive, cold, flu, expectorant (Ugulu *et al.*, 2009)
Verbena officinalis Linn.	H	Leaves	Stomachache	0.33	Snake bite and stomachache (Teklehaymanot and Giday, 2007)
Viscum articulatum Burm. f.	S	Whole plant	Bone fractured, body ache and joint dislocation	0.21	Febrifuge, aphrodisiac, cuts (Sinha, 1996); stomach troubles in new born baby (Hynniewta and Kumar, 2008)
Costus speciosus (Koening) Sm.	H	Stem	Ear infection	0.17	Sexual hormones and contraceptives (Warrier *et al.*, 1993); urinary problems and ear-ache (Khumbongmayum *et al.*, 2005); juvenile diabetes (Bantawa and Rai, 2009); jaundice (Rethy *et al.*, 2010)
Curcuma longa Linn.	H	Rhizomes	Cut or injury	0.50	Antispasmodic activity (Ammon and Wahl, 1991); anti-HIV, antioxidant, anti-tumour, antivenom (Araujo and Leon, 2001)
Curcuma caesia Roxb.	H	Rhizomes	Stomachache and fevers	0.20	Cough, asthma (Kala, 2005); anti-inflammatory and anti-asthmatic, dysentery, wound healing (Tushar *et al.*, 2010)
Zingiber purpureum Rosc.	H	Rhizomes	Killing head lice's	0.26	Antifungal (Ficker *et al.*, 2003)

DECLARATION OF AGREEMENT

This is to certify that Mr. Neli Lokho Pfoze working on the ethnobotanical studies of Senapati district, Manipur have been fully supported by the undersigned for his research activities and documentation on the traditional knowledge of medicinal plants and its uses in different villages in the district. The information and knowledge we shared with him during the course of interaction, interview and discussion is to the best of our knowledge gathered are based on traditional practices which we were given treatment to different patients for many years.

We the undersigned will not have any objection in case of positive outcome from the knowledge we divulged to him that could benefit mankind and will be very grateful and highly valued if Mr. Lokho Pfoze sincerely acknowledge our sharing and contributions that we have rendered to him.

This agreement between the two parties (researcher & informant) was reached in the presence of the respective village Chairman/Secretary as the witness.

Name of the Informant	Village	Tribe or Community	Sex (M/F)	Informant Signature	Village Chairman/ Secretary Signature
R. Yongio	upper khabung.	Poumai	Male	R. Yongio	D. Elsho
R. T. Khale	upper khabung	Paumai	male	R. T. Khale	D. Elsho
Lamsim	Motbung	Thadou	Male	[illegible]	[illegible]
Lamsek	Motbung	Thadou	Male	[illegible]	[illegible]
Haotin Thang	S. changpou [illegible]	Vaiphei	male	[illegible]	[illegible]

Name of the Informant	Village	Tribe or Community	Sex (M/F)	Informant Signature	Village Chairman/ Secretary Signature
Paliet	S. Changoubung	Thadou	Male	Paliet-	Thu.
N. Kholi	Emefiilu	Mao	Male	Kholi	Sey.
K. Ashikra	Madungdong	Mao	Female	Ashikra	Chairman
M. Sani	Poumata Centre	Pouzmai	Male		Sey
SEIKHOSAT	S. Bungnom	Khongsai	Male		
Kaikholam	Motbung	Thadou Lhouvum	Male		
S. ASOR	Karong	poumai	Male		9/11/011

Table-21: Showing total number of ethnobotanical plant species documented

Plant group		Number of families	Number of genera	Number of species	Total number		
					Families	Genera	Species
Ethnomedicinal plant							
Angiosperm	Dicot	47	94	104	56	109	120
	Monocot	8	14	15			
Pteridophyte		1	1	1			
Wild Edible Plant							
Angiosperm	Dicot	33	44	50	42	56	63
	Monocot	5	8	8			
Wild Edible Mushrooms		1	3	3			
Pteridophyte		1	1	2			
Wild Edible Fruit							
Angiosperm	Dicot	16	23	33	19	27	37
	Monocot	3	4	4			
Grand total number					91	161	188

7.3. Phytochemical data

Preliminary phytochemical screening for the present of alkaloids, flavonoids, saponins and tannins was conducted for 23 different species of locally used ethnomedicinal plants belonging to 21 families. Different plant parts such as leaf, roots, rhizome, bark, fruits and flowers were screened and observed that alkaloids were detected in 6 different species, flavonoids and tannins in 18 species each and saponins in 11 different species. Also quantitative assessment of the different classes of compounds present was graded as + ve to +++ ve. From the table it is observed that alkaloids are present in high amount in *Dicentra scandens* (D. Don.) Walp., *Mahonia manipurensis* Takeda and *Thalictrum foliolosum* DC., etc. Flavonoids in *Begonia picta* Smith, *Myrica nagii* (non Thunb.) Hook., *Paris polyphylla* Sm. and *Potentilla fulgens* Wall., *Scutellaria discolor* Coleb. Saponin in *Asparagus affinis* Buch.-Ham. ex D. Don., *Costus speciosus* Koening Sm., *Paris polyphylla* Sm., *Panax pseudoginseng* Wall., *Rubus ellipticus* Smith and in *Sapindus mukorossii* Gaertn. Similiarly, tannins are also detected in high amount in *Begonia picta* Smith, *Juglan regia* Linn., *Musseandra glabra* Vahl, *Myrica nagii* (non Thunb.) Hook., *Potentilla fulgens* Wall., *Rubus ellipticus* Smith, *Saussurea deltioidea* Linn. and *Scutellaria discolor* Coleb. The details of the screening results are presented in the (Table-22) below:

Table-22: Phytochemical screening of locally used selected ethnomedicinal plants

Name of the species	Part tested	Alkaloids	Flavonoids	Saponins	Tannins
Asparagus affinis Buch.-Ham. ex D. Don	Root	– ve	– ve	+++ ve	– ve
Begonia picta Smith	Root	– ve	+++ ve	+ ve	+++ ve
Costus speciosus Koening Sm.	Rhizome	– ve	+ ve	+++ ve	+ ve
Curcuma caesia Roxb.	Rhizome	– ve	+ ve	– ve	– ve
Dicentra scandens (D. Don.) Walp.	Root tuber	+++ ve	– ve	– ve	+ ve
	Leaf	+++ ve	+ ve	– ve	– ve
Juglan regia Linn.	Stem bark	– ve	+ ve	– ve	+++ ve
Mahonia manipurensis Takeda	Stem bark	+++ ve	– ve	– ve	+ ve
	Leaf	++ ve	+ ve	– ve	++ ve
Melia composita Willd.	Fruit	+ ve	– ve	– ve	– ve
Melothria purpusilla (Blume) Cogn.	Leaf	– ve	– ve	– ve	+ ve
Musseandra glabra Vahl	Flower	– ve	++ ve	– ve	+++ ve
Myrica nagii (non Thunb.) Hook.	Stem bark	– ve	+++ ve	+ ve	+++ ve
Oroxylon indicum (Linn.) Vent.	Stem bark	– ve	+ ve	– ve	++ ve
Paris polyphylla Sm.	Rhizome	– ve	+++ ve	+++ ve	– ve
Panax pseudoginseng Wall.	Rhizome	+ ve	– ve	+ ++ve	– ve
Phlagocanthus curviflorus Nees	Leaf	+ ve	– ve	– ve	+ ve
	Flower	+ ve	++ ve	– ve	+ ve
Potentilla fulgens Wall.	Root	– ve	+++ ve	– ve	+++ ve
Physalis peruviane Linn.	Leaf	+ ve	+ ve	– ve	+ ve
Rubus ellipticus Smith.	Root bark	– ve	++ ve	+++ ve	+++ ve
Sapindus mukorossii Gaertn.	Fruit	– ve	+ ve	+++ ve	– ve
Saussurea deltioidea Linn.	Leaf	– ve	++ ve	– ve	+++ ve
Scutellaria discolor Coleb.	Leaf	– ve	+++ ve	+ ve	+++ ve
Swertia Pullchella (D.Don.) Clarke	Leaf	++ ve	+ ve	++ ve	+ ve
Thalictrum foliolosum DC.	Root	+++ ve	– ve	+ ve	+ ve

Table-23: Rf values of the different alkaloids fractions

Plant parts	Spot No.	Distance of solvent front in cm	Spot distance of standard alkaloids		Distance of spot from origin in cm	Rf value
			Berberine	Palmatine		
Stem bark	1	8.5			0.55	0.065
	2				1.45	0.171
	3			1.85	1.85	0.218
	4		2.45		2.45	0.289
	5				6.4	0.752

UV-VIS Spectroscopy

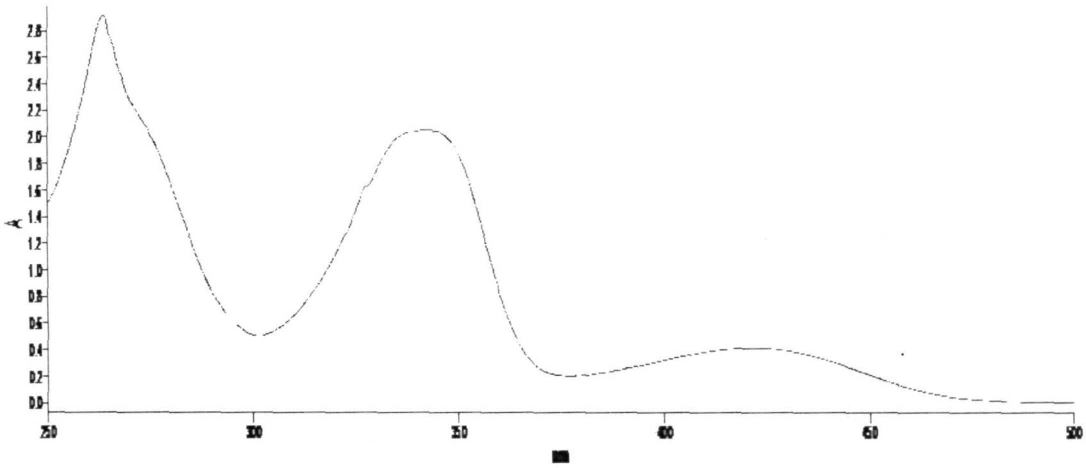


Fig.19. UV spectrum of Berberine chloride (Standard), λ_{max} - 341.06.

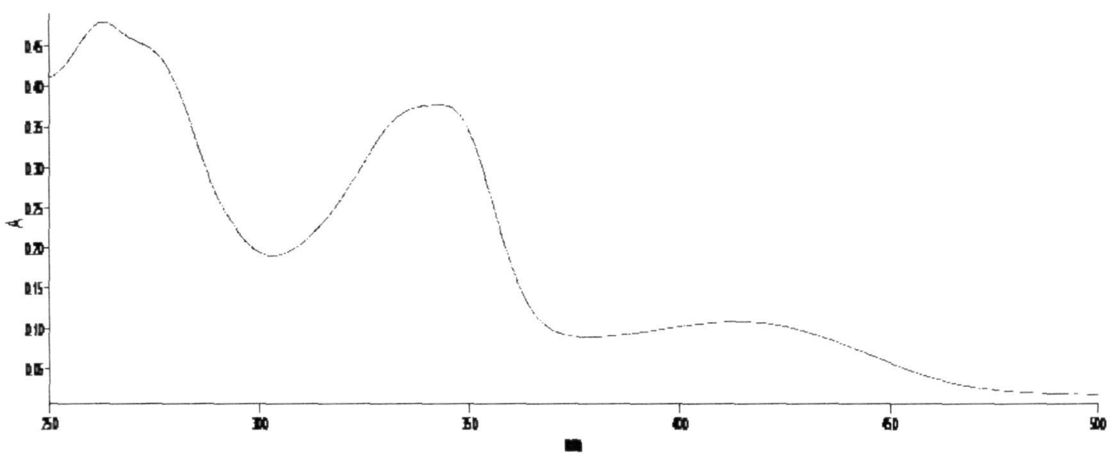


Fig.20. UV spectrum of fraction-II, λ_{max}-342.86.

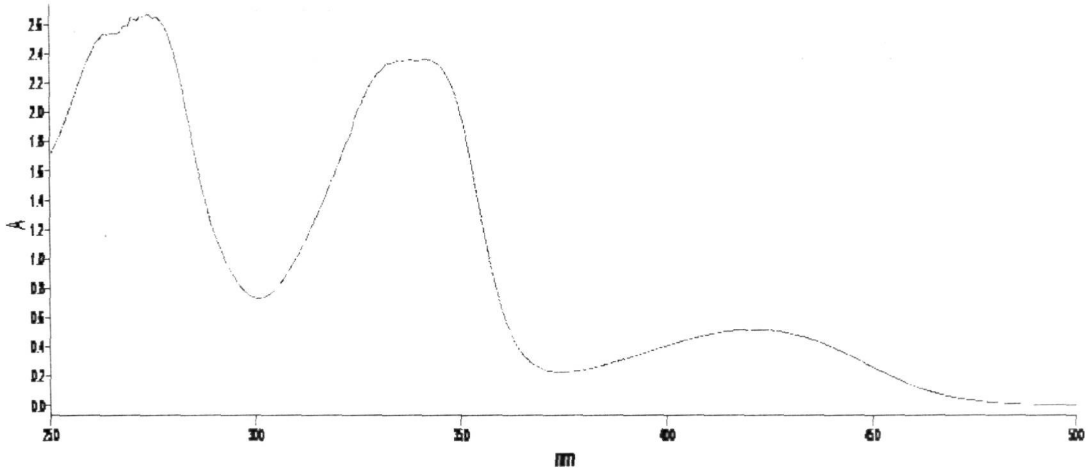


Fig.21. UV spectrum of Palmatine chloride hydrate (Standard), λ_{max} -342.24.

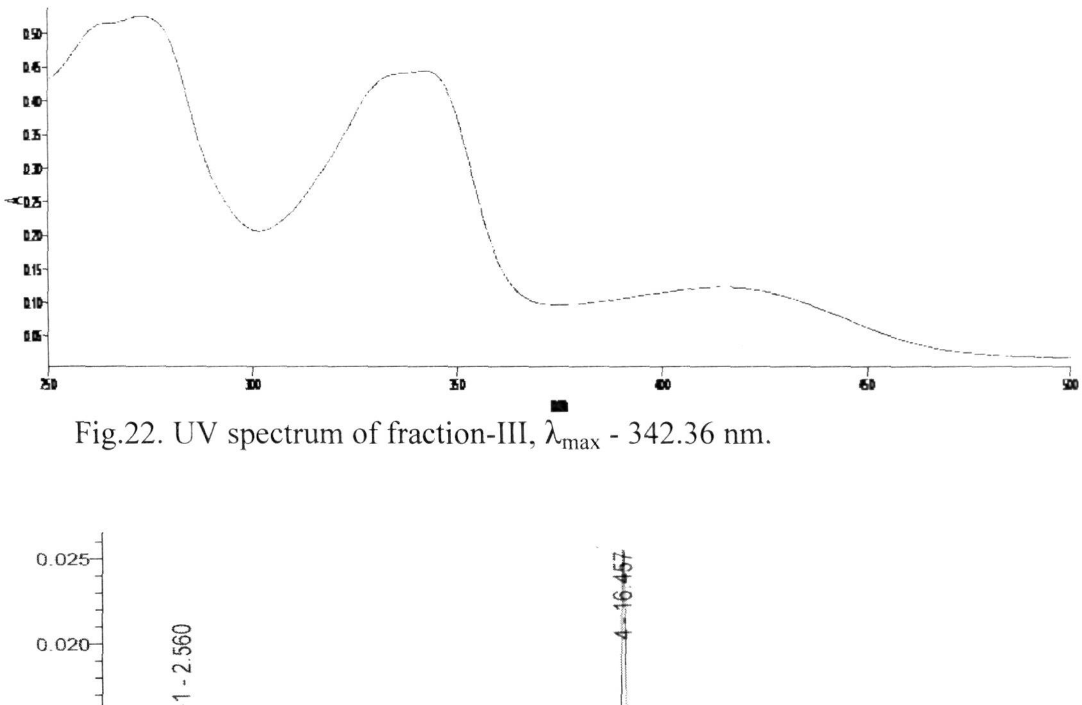


Fig.22. UV spectrum of fraction-III, λ_{max} - 342.36 nm.

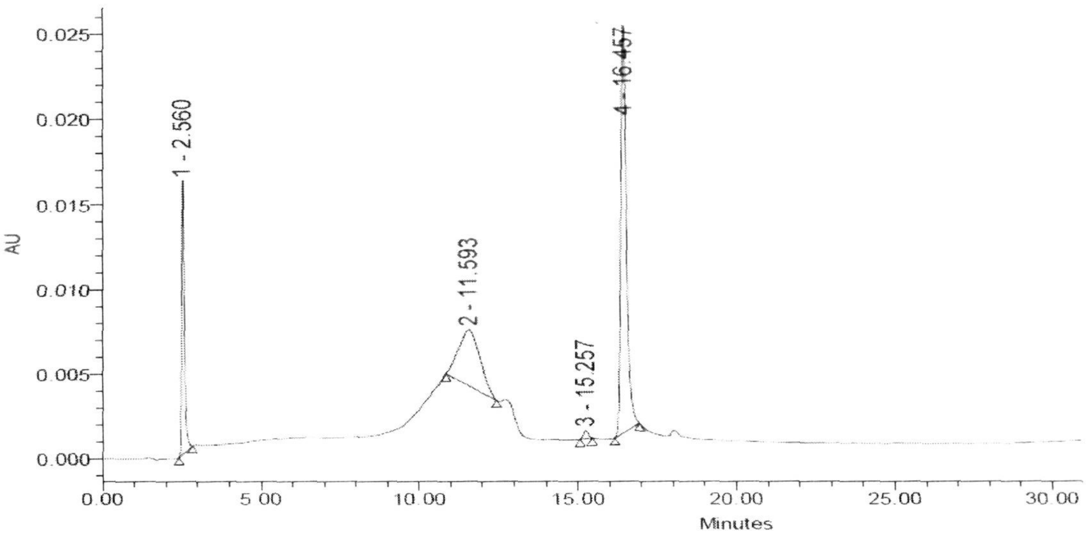


Fig.23. HPLC chromatogram of Berberine chloride standard.

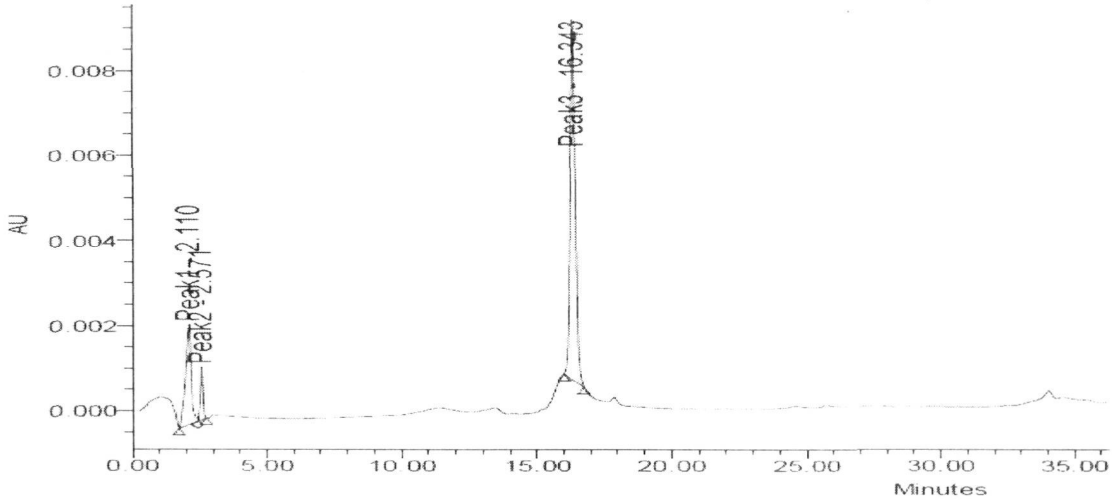


Fig.24. HPLC chromatogram of FR-II from *M. manipurensis*.

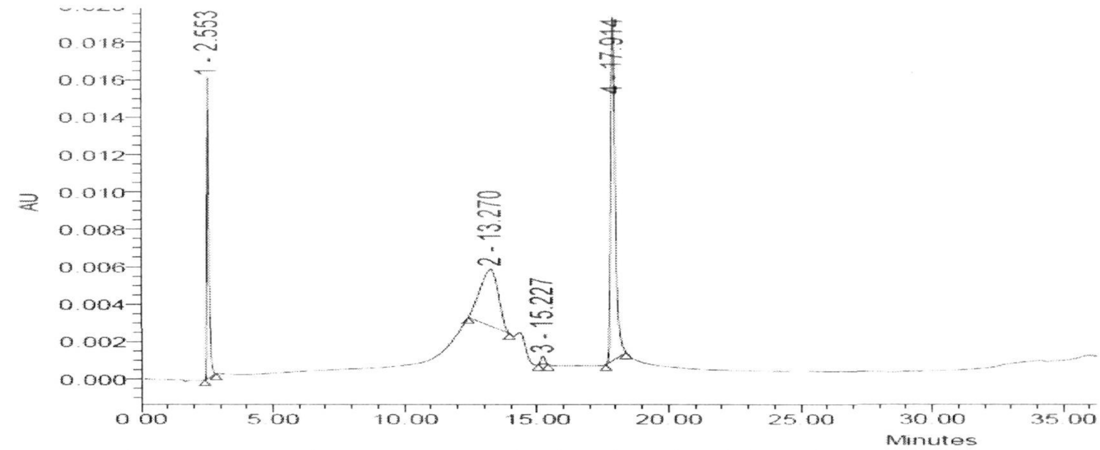


Fig.25. HPLC chromatogram of Palmatine chloride hydrate standard.

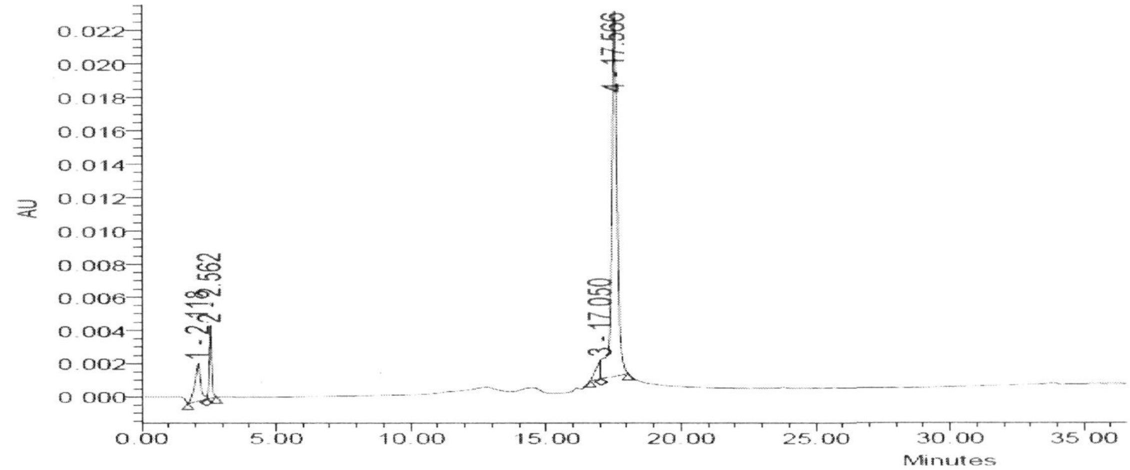


Fig.26. HPLC chromatograph of FR-III from *M. manipurensis*.

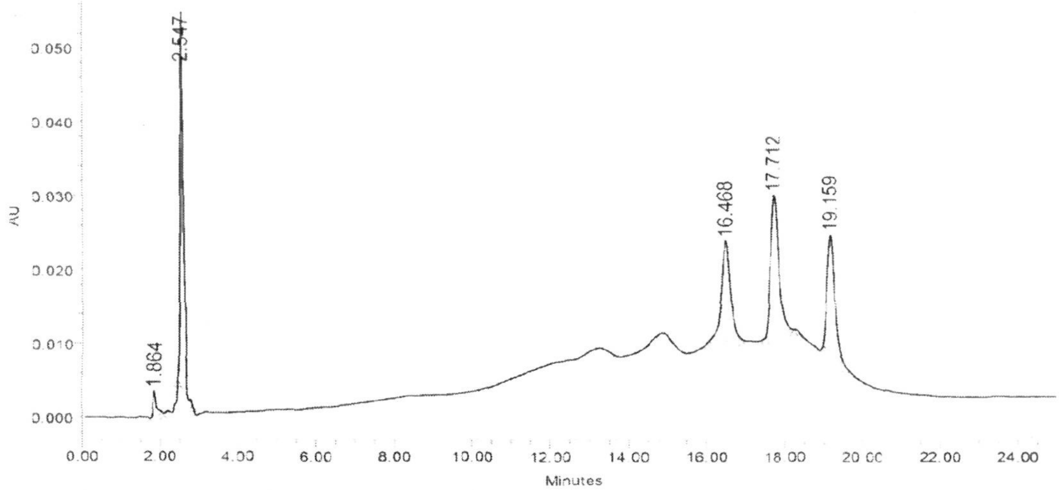


Fig.27. HPLC chromatogram of purified alkaloid fraction from *M.manipurensis*.

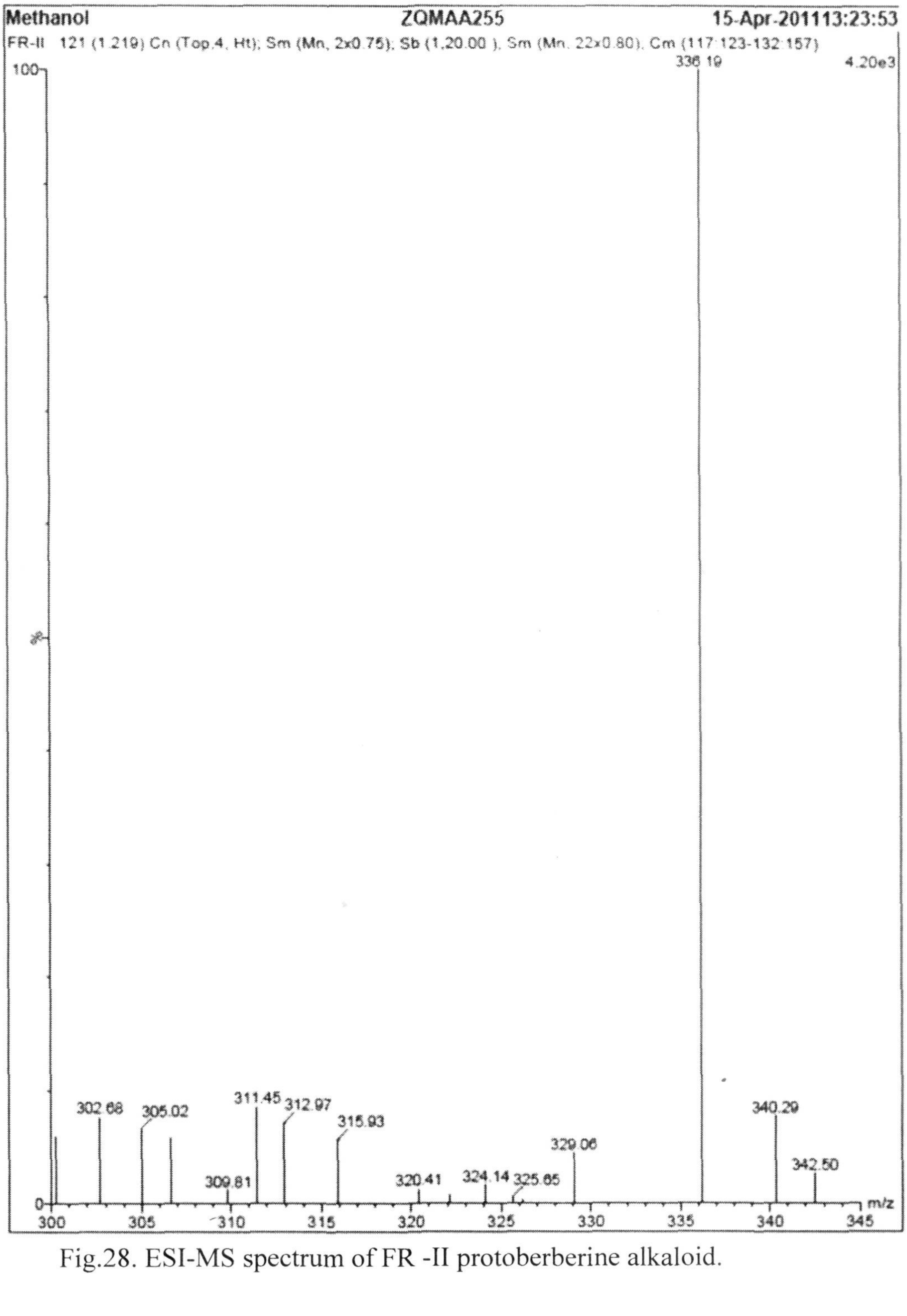


Fig.28. ESI-MS spectrum of FR -II protoberberine alkaloid.

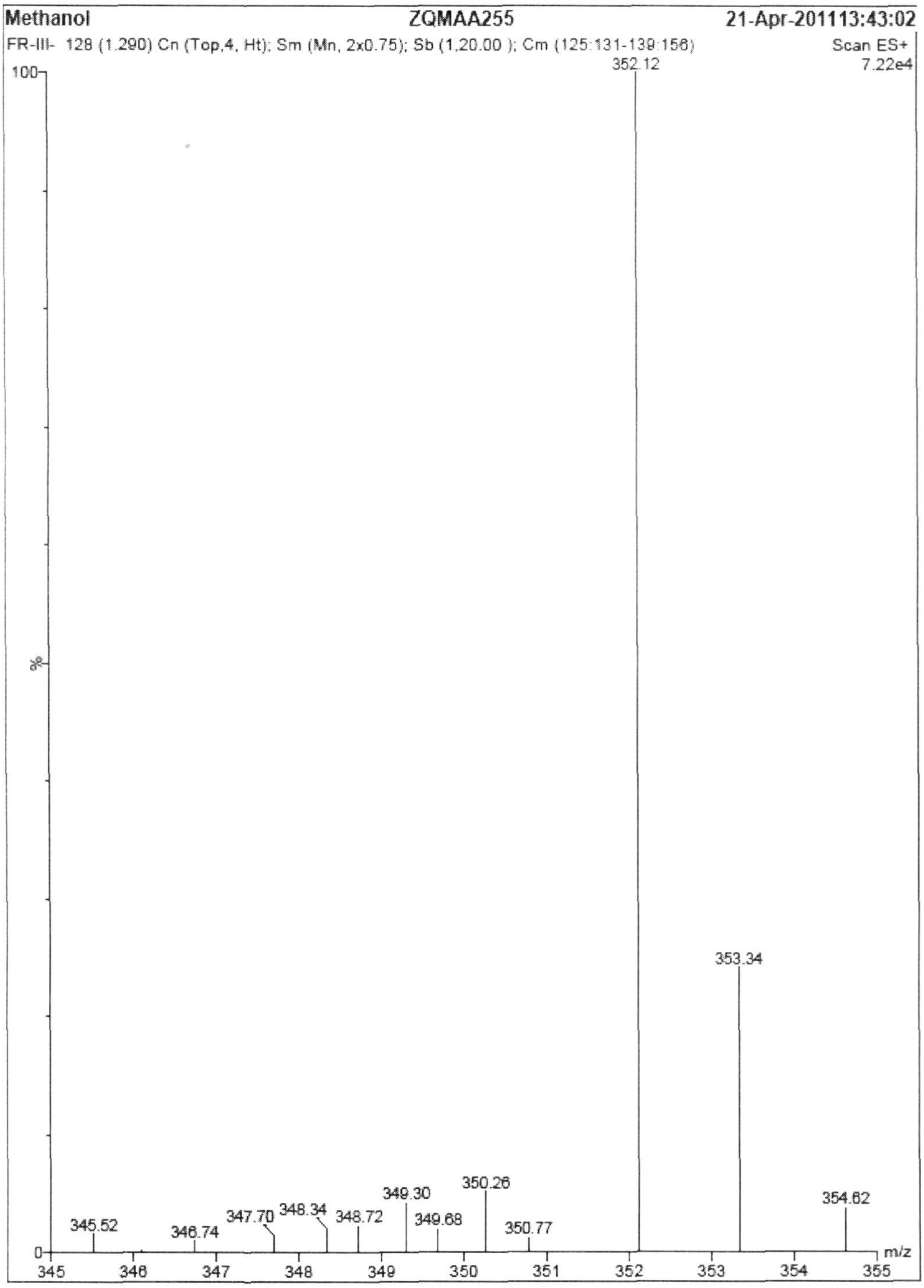


Fig.29. ESI-MS spectrum of FR-III protoberberine alkaloid.

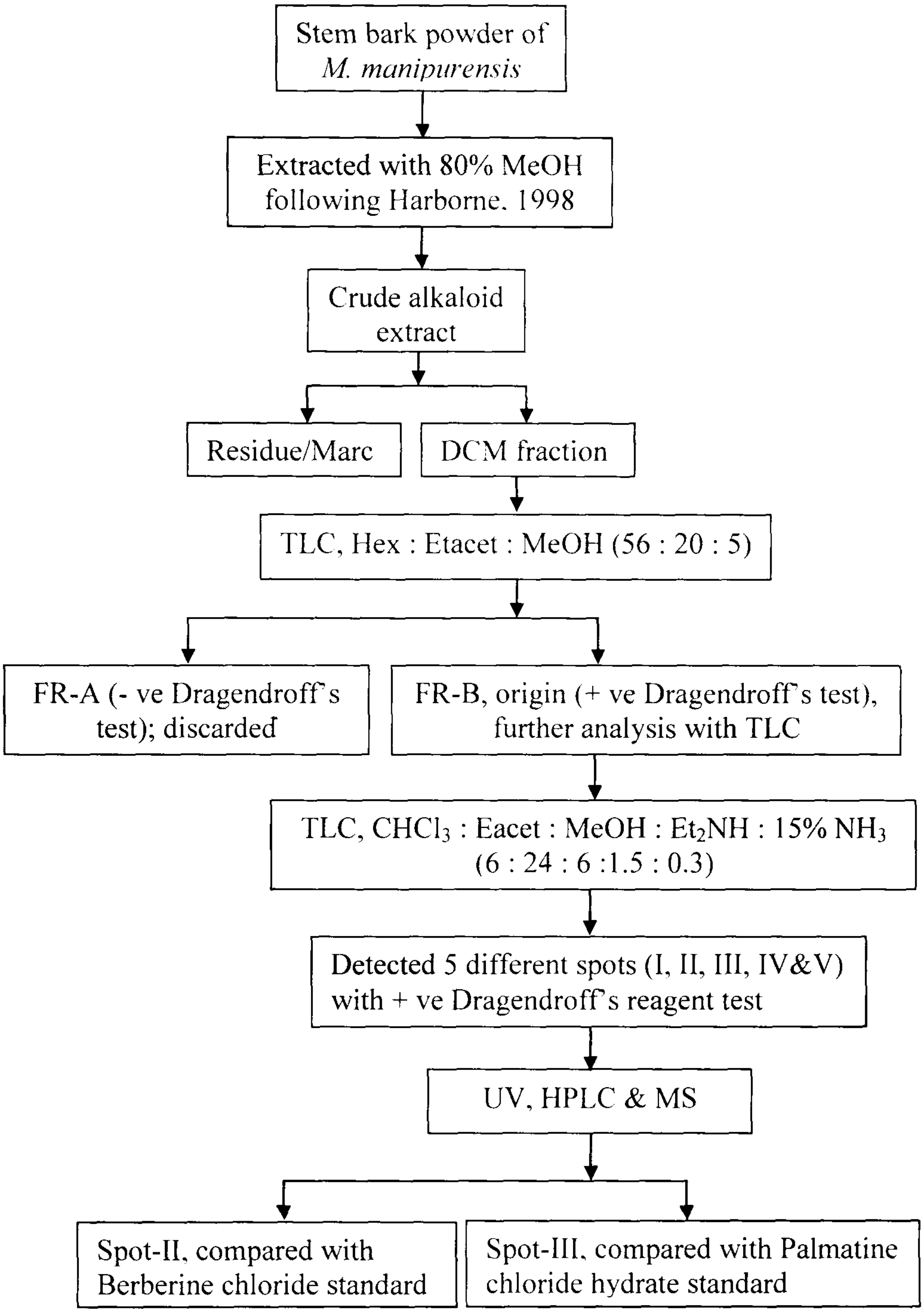


Fig.30. Isolation of protoberebreine alkaloids from stem bark of *M.manipurensis*

CHAPTER-VIII

8.1. DISCUSSIONS

8.1.1. **Wild edible plants and fruits:** Consumption of wild food plants formed not only an integral part of the culture and tradition of the tribal and other indigenous communities but also contributes a significant amount to the diet and economy of these peoples. A wide range of wild plant species are consumed by these peoples as green leafy vegetables, roots, shoots, flowers, fruits as well as edible mushrooms. Analyses of the nutritional content has been done in a number of studies (Maundu *et al.*, 1999; Nordeide *et al.*, 1996; Orech *et al.*, 2007; Shackleton *et al.*, 1998; Sundriyal and Sundriyal, 2001) and reported that the nutritional value of many traditional leafy vegetables is higher than several known common cultivated vegetables. Many of these edible plants are rich in nutrient content and formed as good sources of carbohydrate, vitamins and minerals. It plays an important role in meeting the nutritional requirement of the tribal population and other indigenous communities mainly in developing countries of the world. Therefore, analysis of the nutritional value of some of the most commonly preferred and consumed wild plants will help to identify and prioritized species that can be included in traditional agriculture or agro-forestry system based on their nutritional values. These species can also provide ecological security as they are more disease resistance, grow in diverse climatic and habitat conditions and ensure sufficient production despite adverse conditions.

World over, the tribal population still stores a vast knowledge on utilization of local plants as food material and other specific uses (Sundriyal *et al.*, 1998). The Nagas and the Kukis are also not an exception in storing this rich traditional knowledge on plant use. These two tribal communities formed the dominant groups that inhabit in the hill districts of Manipur. Ethnically, these two tribal groups belonged to the Tibeto-Burman Mongoloid racial stock. They possess rich valuable reservoirs of traditional knowledge on plants used largely due to the prevalence of rich diversity of vegetations as the study area falls in the Indo-Burma global biodiversity hotspot. Also many of these wild edible plant species are found to be sold in the local markets particularly by poor and economically marginalized families, thereby generating a supplementary income to their household economy. This marketing plays an important role in the socio-economic development of any area as it helps serve the people and the region. Although market survey and listing on the use of wild edible plants and fruits have been reported by some workers from Manipur (Singh and Singh, 1985; Singh *et al.*, 1988; Devi *et al.*, 2010; Salam *et al.*, 2010; Jain *et al.*, 2011) and elsewhere in the North eastern region including the Sikkim Himalaya (Samant and Dhar, 1997; Sundriyal and Sundriyal, 2004; Kayang, 2007; Sarma *et al.*, 2010) however more detailed study on the assessment and evaluation of local dependency on leafy wild edible plants and fruits have not been reported earlier and it has been observed that the present study is one of such work involving more detailed investigations on the use of wild edible plants at the local level. Also so far, no such attempt has been made to explore the wild edible plants from the district. Moreover, a fairly good number of these edible plants are also reported to have both therapeutic and dietary functions and hence are used as medicinal food remedy. But the nutritional values and toxic side effects of wild edible plant resources of the region have not been properly investigated and are still remains underutilized. Therefore, the recorded wild edible plants may serve as a baseline data for future studies on nutritional evaluation and possible side effects. It will also be helpful to identify and then prioritize plants that may improve nutritional values and increase the dietary diversity. Some of these wild edible plants may serve as a potential valuable food sources if brought into cultivation and could be part of a strategy to be used as sources of supplementary food. Further. during interview and discussion with the local elders and young individuals revealed that the traditional knowledge of the use of these wild edible plant resources is eroding among the younger generations. The main reasons for the lost of this valuable knowledge according to the local informants are increasing socio-economic conditions, not organized documented records, changing occupations among the younger generations as they are mostly engage their work in organized sectors rather than in their traditional agricultural activities and introduction of new varieties of agricultural crops. Similar observation was also reported by other workers (Lindeberg *et al.*, 2003; Maikhuri *et al.*, 2004). With exception of some common and well known used species, a number of lesser known edible plants such as *Rhynchotechum ellipticum* (Wall. ex Dietr.) DC., *Chenopodium album* Linn., *Diplazium esculentum* (Retz.) Sw., *Eurya japonica* Thunb., *Wendlandia glabrata* DC., etc. which have been used as leafy vegetables have no knowledge about its use among many of the young people. This is a serious concern on the preservation and transmission or dissemination of traditional knowledge on the one hand and conservation and management of the region's biodiversity resources on the other. The concept of biodiversity conservation will be more meaningful only when both traditional knowledge about the use of its local flora is properly recorded and documented along with the preservation and management of the resources particularly the threatened and endangered species in a more sustainable way. A number of publications (Grivetti and Ogle, 2000; Kala. 2007; Maikhuri *et al.*, 2000; Ogoye-Ndegwa and Aagaard-Hansen, 2003) also emphasized the importance of the diversity of wild edible plants and traditional knowledge on the use of these wild food plants in the search for new sources of food from the wild. Therefore, proper and organized documentation of local plants used is requiring for identification of potential species for prioritization of conservation through sustainable management so that the resources and knowledge can be preserved, managed and utilized. In other words, conservation and sustainable management of wild edible plants and fruits will help to enhance and maintain the regional floral diversity with minimal adverse impact on the biodiversity. North eastern region in general and Manipur state in particular, not much effort or study has been made till date to determine the food potentials or local availabilities of these edible wild plant resources and also the quantum of collection marketed. Hence, no strategy for conservation of this important group of plants has been developed.

8.1.2. **Ethnomedicinal plants:** Traditional medicine or ethnomedicine is a set of empirical practices embedded is the knowledge of a social group often transmitted orally from generation to generation with the intent to solve health problems. It is alternative to western medicine and is strongly linked to religious beliefs and practices of indigenous cultures (Upadhyay *et al.*, 2010). Virtually it forms the basis of primary healthcare in almost all the developing countries of the world. The main reasons for the use of traditional medicine by the indigenous and rural communities are (a) there are cases where local herbal treatment are found more potent and effective than modern drugs and hence local people have faith on plants used as a medicine (b) easy accessibility and availability of local medicinal plants (c) less accessibility or no access to modern drugs due to remoteness of their place of settlement and (d) low financial status of the rural people to afford relatively high cost modern medicine. Usually the knowledge of the used of this herbal medicine is kept with utmost secrecy by the practitioners because they believe that the medicinal preparations would lose its efficacy when the knowledge is divulged to others. Therefore in most cases the medicine men revealed the knowledge about specific use of a plant to one of the most reliable members in the family or a close relative and this oral tradition of passing the knowledge often continue through down the generations. Similar transferred of indigenous knowledge through oral tradition was also reported by other workers (Jain and Saklani, 1991; Rokaya *et al.*, 2010; Rajkumar and Shivanna, 2009; Uprety *et al.*, 2010) from other parts of India. In other words, since the knowledge has been transmitted orally without any systematic written records, as such there is a high chance that the knowledge is exposed to great risk of disappearance in the future. The main reason could be like dead of the medicine man before passing the knowledge to other members in the family or close relative and also may be in the process correct knowledge is not properly transmitted. For instant, such cases have been reported in Ecuador, where original knowledge on the use of plants had declined due to the lack of systematic knowledge transmission (Bussmann and Sharon, 2006). Further, during interviewed and discussion with the local informants revealed similar cases of losing traditional knowledge partly due to heavy dependent of the local population on modern healthcare system and also because may be the knowledge is not properly pass on to others by the herbal practitioners. In addition, the plant populations are also destroyed from their natural habitats by other anthropogenic activities like deforestation, habitat encroachment through traditional shifting cultivation, forest fires, etc. Thus, in order to protect plants and indigenous knowledge for conservation and sustainable management, there is an urgent need for more documentation, identification and prioritization of important medicinal plants, development of database and proper harvesting techniques, formulation of cultivation techniques for potential species, community participatory management and awareness programs in the district.

Manipur, which is well known for its rich floral biodiversity with many endemic species and ethnic cultures, requires urgent needs for more ethnobotanical field exploration and study. A large majority of the plants used in local traditional medicine in the state or elsewhere in the region lacks phyto-therapeutic evidences. Therefore it is requires that steps must be taken up to perform phytochemical or pharmacological studies to explore and validate the potential of local plants used in medicine. The present study revealed a rich heritage of medicinal knowledge and high diversity of ethnomedicinal plant from the study area. During the survey, about 120 medicinal plants including 8 species of plant having ethno veterinary importance were recorded. The uses of plants documented in this study were also compared with previously published literatures from other workers in the state and elsewhere were observed and recorded (Table-20). Few plant species such as *Clerodendron colebrookianum* Walp. ex. Walp., *Dicentra scandens* (D. Don.) Walp., *Gymnopetalum cochinensis* (Lour.) Kurz., *Panax pseudoginseng* Wall., *Phlagocanthus curviflorus* Nees, *Oroxylon indicum* (Linn.) Vent., *Thalictrum foliolosum* DC., etc. used by the tribal people of the district against high BP, fevers, jaundice, gastritis, killing maggots and wound healing in cattle's have good evidence of effectiveness. The information documented on the medicinal uses of some selected plants does may be used for future studies on phytochemical and pharmacological investigations. Many of the species documented in this study were previously reported to have phytochemical or pharmacological properties. For example the used of *Acorus calamus* for stomachache and throat problem is supported by other studies (Devkota *et al.*, 1999; Shinwari and Khan, 2000) mentioning that the stem and rhizomes have antimicrobial properties. *Asparagus filicinus* used for diarrhea has been proven to have significant anti-diarrhea activity (Bopana and Saxena, 2007). The plant *Oroxylum indicum* is used in Asian folk medicine for the treatment of abdominal tumors (Soe and Myongure, 2004). The plant is also reported to have anti-cancer properties (Lambertini *et al.*, 2004; Costa-Lotufo *et al.*, 2005). The rhizome of *Paris polyphylla* is used in traditional Chinese medicine as a haemostatic and antimicrobial (Song *et al.*, 2001; Shanshan *et al.*, 2004). Studies of the aqueous, ethanolic and methanolic extracts showed anticancer activity on several types of cancer cell lines. More extensive phytochemical and pharmacological studies further identified steroid saponins as the main antitumor active components (Song *et al.*, 2001; Ravikumar *et al.*, 1979; Shi *et al.*, 1992). Similiarly *Swertia chiraita* used to cure cough, cold, fever, malaria and headache is mentioned as antipyretic or anti-inflammatory and antibacterial or anti-fungal in other studies (Chowdhury *et al.*, 1995; Devkota *et al.*, 1999; Bharyava *et al.*, 2009).

Modern scientific evaluation of medicinal plants and herbs is mainly concerned with validating the traditional used of plants and identifying the active components of extract and preparation (Palombo, 2006). The information of such traditional uses of plant in medicine can be gathered either from plants used in organized traditional medical system such as Ayurveda, Unani and traditional Chinese medicine (Bannerman *et al.*, 1975; Bannerman, 1979) or from herbalism, folklore and shamanism which concentrate on an apprenticeship system of information passed to the next generation through a traditional healer or herbalist (Rastogi and Dhawan, 1982). Phytochemical analysis and evaluation of pharmacological activity on ethnomedicinal plant extracts has resulted in identification of a large number of plant secondary metabolites such as phenolics and polyphenols, alkaloids, terpenoids, essential oils, etc. exhibiting such activity. For example, in one of the studies conducted by Fabricant and Farnsworth (2001), out of the 122 identified compounds obtained from 94 species of plants that are used globally as drugs, about 80% have been demonstrated to have an identical ethnomedical use or related to the current use of the active elements of the plant. Also it is worth mentioned that not all the plant parts contain similar content or concentration of the active constituents. In many plants, different parts contain totally different phytochemical substances (Aburjai *et al.*, 2005; Bruneton, 1999). From phytochemical screening result (Table 22), it is observed that all the plants contain one or the other group of different pharmacologically active phytochemicals such as alkaloid, flavonoids, saponins and tannins. Alkaloids are tested with high amount in the methanolic extracts of *Dicentra scandens* (D. Don.) Walp. root tuber, *Mahonia manipurensis* Takeda stem bark and *Thalictrum foliolosum* DC. root as graded with +++ ve. The local people used these plants for treating fevers, high BP, stomachache, toothache and skin diseases. The antimicrobial properties of alkaloids have been well established. Berberine, a quaternary alkaloid for instant which occur widely in different species of the genera *Mahonia* and *Thalictrum* inhibits the growth of many microorganisms including fungi, protozoa and bacteria (Amin *et al.*, 1969; Hahn and Ciak, 1976). This alkaloid is also potentially effective against plasmodia (Omulokoli *et al.*, 1997). The studies further suggest that this substance have shown fever reducing and hypotensive properties causing a reduction in blood pressure (Verpoorte, 1998; Arayne *et al.*, 2007). This perhaps could probably support the information about the traditional uses of these plants in the treatment and management of these diseases by the tribal communities of the district. Similarly, phenolic and polyphenolic compounds such as saponins and tannins are also detected in high amount in the methanolic extracts particularly in species such as *Begonia picta* Smith, *Juglan regia* Linn., *Musseandra glabra* Vahl, *Myrica nagii* (non Thunb.) Hook., *Potentilla fulgens* Wall., *Rubus ellipticus* Smith, *Saussurea deltioidea* Linn., *Scutellaria discolor* Coleb., *Costus speciosus* Koening Sm., *Paris polyphylla* Sm., *Panax pseudoginseng* Wall., *Sapindus mukorossii* Gaertn., etc. The local people used these plants to treat against gastrointestinal disorders such as diarrhea and dysentery, constipation, stomachache, gastritis, burns and inflammation, fever, tooth ache, ear infection, aphrodiasic and wound healing. Both these classes of compounds are widely distributed in higher plants and many have been traditionally used for a wide range of anti-infective and other pharmacological activities. Tannins are known to exhibits the properties of antidiarrhea, antihaemorrhagic and wound healing activities (Asquith and Butler, 1986; Ogunleye and Ibitoye, 2003). Similarly, biological and pharmacological properties of saponins have been reported in several reviews by different workers with the most recent being Lacaille-Dubois and Wagner (1996); Sparg *et al.*, (2004), etc. Some important biological activities exhibited by saponidal compounds include anti-inflammatory (Just *et al.*, 1998; Li *et al.*, 2002), antimicrobial (Escalante *et al.*, 2002; Konishi *et al.*, 1998; Quiroga *et al.*, 2001), antiparasitic (Traore *et al.*, 2000), cytotoxic and antitumor (Lee *et al.*, 1999; Xiao *et al.*, 1999), etc. Therefore the traditional used of these plants against gastrointestinal disorders such as diarrhea and dysentery, fever, tooth ache and wound healing may be attributed mainly due to the presence of these groups of plant secondary metabolites. Likewise flavonoids, another chemically diverse group of plant phenolic compounds widely occur in different parts of higher plant such as fruits, nuts, seeds, stems, flowers, etc. They possesses marked biological activities and many of them are formed as active principles of medicinal plants exhibiting wide range of pharmacological effects (Debruyne *et al.*, 1999; Kong *et al.*, 2003; Marles *et al.*, 2003; Yilmaz and Toledo, 2004). For centuries, preparations containing these compounds as the principal physiologically active constituents have been used to treat human diseases. Increasingly, this class of natural products is becoming the subject of anti-infective research and many groups have isolated and identified the structures of flavonoids possessing antifungal, antiviral and antibacterial activity (Cushnie and Lamb, 2005). The present preliminary phytochemical investigation detected that this particular class of compounds are also occur with high amount in plants such as *Begonia picta* Smith, *Myrica nagii* (non Thunb.) Hook., *Paris polyphylla* Sm., *Potentilla fulgens* Wall. ex Hook., *Scutellaria discolor* Coleb., etc. Locally, these plants are used for treating such ailments or diseases like cut or external injury, diarrhea, dysentery, fevers and toothache thereby supporting the information of its uses. In other words, activity directed fractionation bioassay is require in isolating and identified the bioactive compounds presents in the plant extract. Also there is possibility that different phytochemical components could act synergistically to produce the observed therapeutic effects. Hence fractionation and separating the individual components may lead to a loss or less effective against the desired activity. Therefore it is worth mentioned that continue examination of those plants used in traditional medicine systems is required not only to verify and validate the scientific basis for bioactivity but also such investigations will enable us to assessed and understand the quality, efficacy and safety of such preparations or extracts. In other words, appropriately designed clinical trials will provide the necessary evidence to support the efficacy of plant that is used in traditional medicine systems.

8.2. CONCLUSION

The study revealed a rich diversity of wild edible and ethnomedicinal plants used by both the Naga and the Kuki tribal communities from the district. The ethnobotanical plants particularly edible wild plants are collected by the local people not only for household used but a good amount of the collections are available for selling in the local markets for household income generation. A total of 100 edible wild plants (63 edible plants and 37 edible fruits) belonging to 60 taxonomic families and 83 genera are documented. 29 species (46.03%) of edible plants and 14 species (37.83%) of edible fruits recorded in the present study are hitherto unreported from the state and are new records from the area. A case study on the assessment and evaluation of local dependency on selected wild edible plants and fruits revealed that there is a high dependency of local community on the wild resources. Analysis of the number of household percent involved in collection on few selected edible plants and fruits revealed that the dependencies varies significantly from species to species in the three localities under study and are ranges from 29.36% (*Lentinula lateritia* (Berk.) Pegler) to 100% household (*Musa* sps. and *Oenanthe stolonifera* Wall.) in case of wild edible plants. Similarly, in the case of wild edible fruits the value ranges from 9.52% to 57.14% for *Juglan regia* Linn. and *Prunus persiaca* (Linn.) Batsch respectively. Also, comparing the percent of total monetary value for each selected species revealed that *Lentinula lateritia* (Berk.) Pegler generated maximum amount (52.96%) for edible plants while *Docynia indica* Dcne. (28.75%) contributed the highest total monetary value for edible fruits selected in this study. Further comparison of the quantum of collection and number of households involved in collection of both the selected edible plants and fruits in the three localities showed that Emeifiithumei is highest. This is mainly because of the more accessibility and availability of the resources in the village vicinity and forest area, low economic status of the villagers as most of them are engage on traditional agriculture farming and hence exerts more dependence pressure on the wild or forest resources, less accessibility to local markets as the village is located about 13 Km away from the NH-39 and hence dependence on outside vegetable products selling in the local markets is low. Also it has been observed and reported during interviewed and discussion with local informants that some wild edible plants such as *Oenanthe stolonifera*, *Elatostema sessile*, *Chimonobambusa callosa*, *Musa* species, etc. are collected more than others from the wild by the local people. They collect these edible plants both for household used as well as selling in the local markets for supplementary income generation. This led to rapid depletion of its population from their natural habitats which are a serious concern and a threat for their sustainability and conservation.

Moreover, a total of 120 different species of medicinal plants belonging to 56 families and 109 genera are recorded to have been used for treating 53 different diseases or ailments. Analysis of the value of informant consensus factor showed that it ranges from 0.62-1.0 indicating that there is a well defined selection criterion of the plants used and also exchange of informations among the different informants in the study area. There has been not report of cultivation of medicinal plants by the local people from the surveyed sites and the preparations are made by collecting the plants from the wild. This is a serious concern from the point of conservation and sustainability of the resources because such collection from the wild may lead to depletion of the population or even extinction of the resources particularly the rare and endangered species if it goes unabated. A good example of such cases recorded from the district is *Panax pseudoginseng* Wall. and *Paris polyphylla* Sm. Excessive collection of these high value medicinal plants for trade outside the state and region in recent years leads to wipe out of the whole population from their natural habitats. In other words, overharvesting of medicinal plants may have a profound and deleterious effect on critically needed resources (Cordell and Colvard, 2012). Moreover, preliminary phytochemical screening of some lesser known locally used ethnomedicinal plants detected a variety of bioactive compounds such as alkaloids, flavonoids, saponins, tannins, etc. A large number of *in vivo*, *in vitro* as well as clinical studies carried out by various workers are available in literatures and reported that these types of phytochemicals exhibits a wide range of pharmacological activities thereby validating its uses in traditional or folklore medicine. From a total of 23 different species of locally used ethnomedicinal plants selected in this study, alkaloids have been detected in 6 different species, flavonoid and tannin in 18 species each and saponin in 11 different species. Further, phytochemical analysis of protoberberine alkaloids from *M. manipurensis* Takeda stem bark extract resulted in the separation and isolation of two compounds marked as FR-II and FR-III. A comparison of both chromatographic fingerprints of TLC and HPLC as well as with the spectroscopic data of UV and MS spectra of the two fractions with the standards Berberine chloride and Palmatine chloride hydrate showed that the values of these two fractions are very closely match with the two standards indicating that the two fractions isolated in this study are probably to be of these two compounds.

PLATE - I

A

B

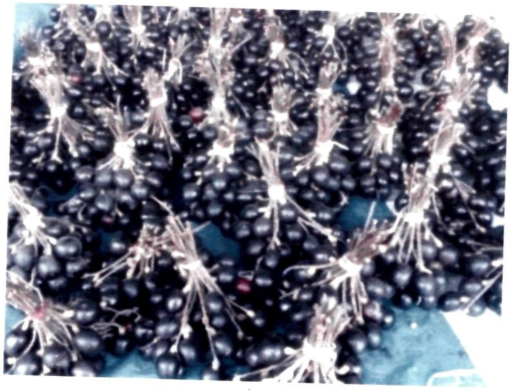
C

D

E

PLATE-I: Showing study area. (A) General view of part of the district (B) View of Kodzi-ri forest in the foot hill of Mt. Tenipu (Esii) (C) Liyai Khullen (D) Maopondung (E) Emeifiithumei

PLATE -II


A


B


C


D


E


F


G


H

I

J

K

L

PLATE-II: Showing marketable wild edible fruits (A) *Prunus nepalensis* (B) *Docynia indica* (C) *Juglan regia* (D) *Rhus semialata* (E) *Spondias acuminata* (F) *Emblica officinalis* (G) *Myrica farquhariana* (H) *Elaeocarpus floribundus* (I) *Calamus floribundus* (J) *Baccaurea sapida* (K) & (L) Shops selling varieties of wild edible fruits at Mao Gate

PLATE-III

A B

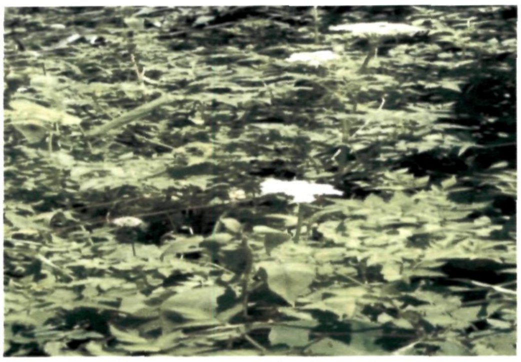
C D

E F

G H

PLATE-III: Showing wild edible fruit plants from their natural habitats (A) *Viburnum foetidum* B) *Castanopsis tribuloides* (C) *Spondias acuminata* (D) *Diospyros kaki* (E) *Rubus rugosus* (F) *Emblica officinalis* (G) *Juglan regia* (H) *Rubus ellipticus*

PLATE-IV

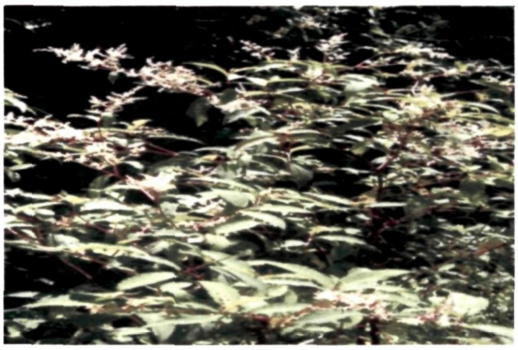

A


B


C


D


E


F


G


H

PLATE-IV: Showing some wild edible plants growing from their natural habitats (A) *Oenanthe stolonifera* (B) *Acacia oxyphylla* (C) *Momordica dioica* (D) *Rhynchotechum ellipticum* (E) *Diplazium esculentum* (F) *Polygonum molle* (G) *Elatostema sessile* (H) *Solanum spirale*

PLATE-V

A

B

C

D

E

F

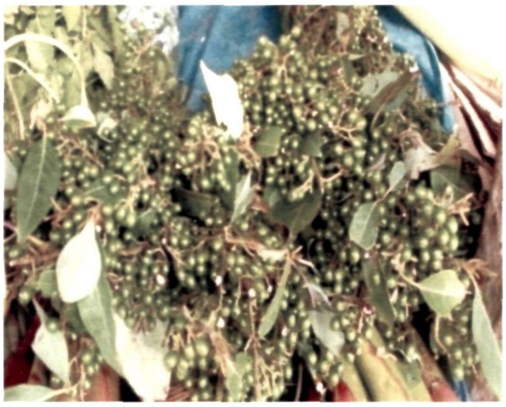
G

H


I


J


K


L


M


N

PLATE-V: View of the Sellers selling different vegetables in the markets. A, B & C Senapati market; D & E (*Arundinaria callosa*), F & G (*Rhus semialata* and *Schizophyllum commune*) Motbung bazaar; H (*Lentinula lateritia*), I (*Auricularia delicata*), J (*Zanthoxylum armatum*) & K Mao Gate; L (*Litsea cubeba*), M (*Eurya acuminata*) & N (*Trichodesma khasianum*) Kangpokpi bazaar.

PLATE-VI

A

B

C

D

E

F

G

H


I


J


K


L


M


N


O


P

Q R

S T

U V

PLATE-VI: Some locally used ethnomedicinal plants from their natural habitat (A) *Mahonia manipurensis* (B) *Paris polyphylla* (C) *Dicentra scandens* (D) *Costus speciosus* (E) *Clerodendron colebrookianum* (F) *Acorus calamus* (G) *Oroxylon indicum* (H) *Mimosa pudica* (I) *Gymnopetalum cochinensis* (J) *Panax psuodo-ginseng* (K) *Scutellaria discolour* (L) *Thalictrum foliolosum* (M) *Melia composita* (N) *Spilanthes acmella* var. *oleracea* (O) *Melothria maderaspatana* (P) *Drymaria cordata* (Q) *Paederia foetida* (R) *Viscum articulatum* (S) *Potentilla fulgens* (T) *Lygodium japonicum* (U) *Pratia begonifolia* (V) *Ricinus communis*

PLATE - VII

PLATE-VII: Interview conducted with the local informants and some local herbalists (A) Maopondung (B) Upper Khabung (C) Liyai Khullen (D) Herbalists Kaikholam Lhungjang (left) and Seikhosat Paojalam (centre) in Motbung (E) Changloubung (F) herbalist Sani Maikho (left) along with one local informant in Paomata Centre (G) Herbalist Sheli Asor diagnosing a patient in Karong (H) Collection of *Mahonia manipurensis* plant for chemical analysis

PLATE-VIII

A

B

C

D

E

F

G

H

PLATE-VIII: Some selected locally used ethnomedicinal plant parts for phytochemical screening (A) *Costus speciosus* rhizome (B) *Dicentra scandens* root tubers (C) *Mahonia manipurensis* stem bark (D) *Panax psuodo-ginseng* rhizome (E) *Paris polyphylla* rhizome (F) *Oroxylon indicum* stem bark (G) *Begonia picta* root tubers (H) *Curcuma aeruginosa* rhizome

PLATE-IX

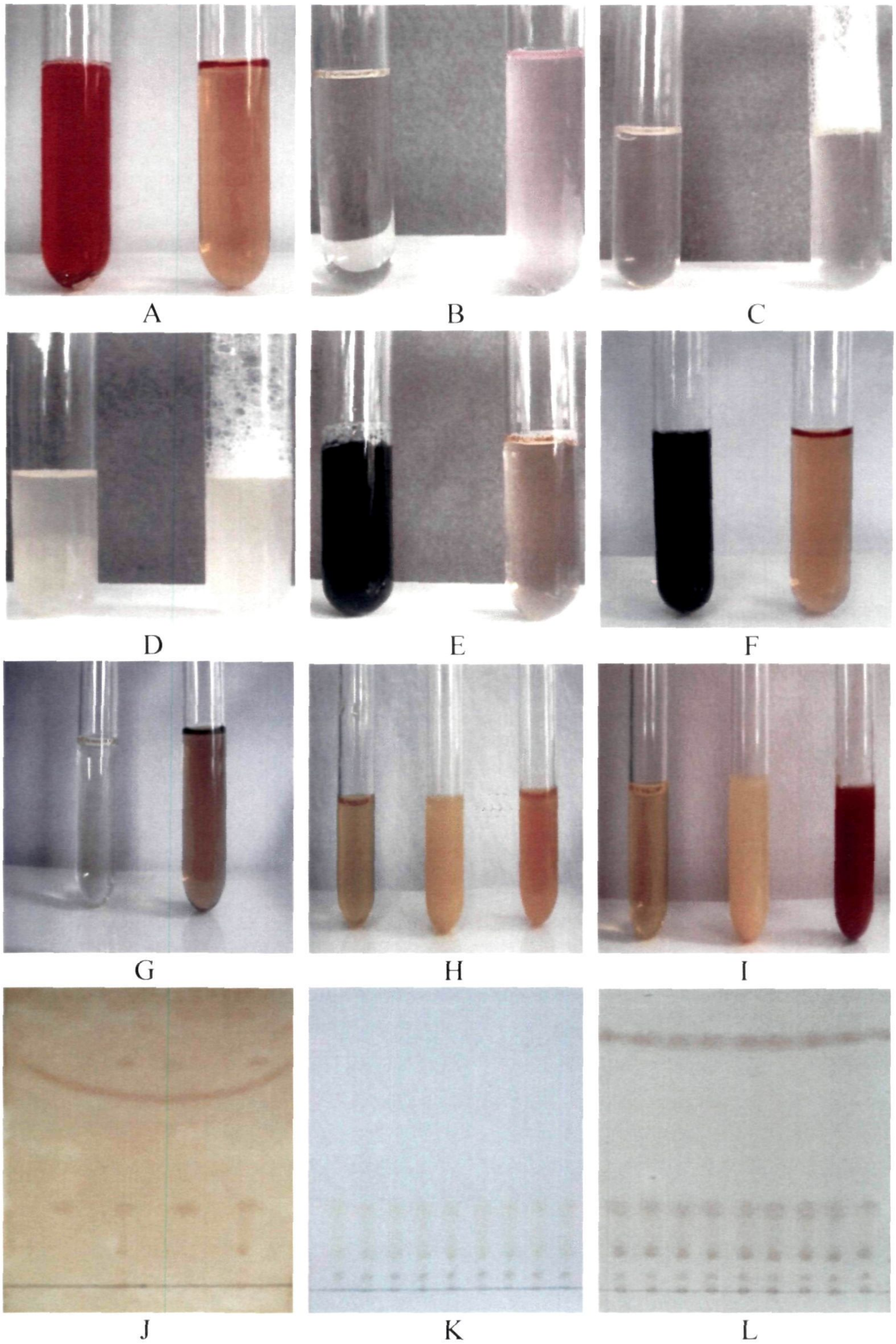


PLATE-IX: Phytochemical screening results of selected ethnomedicinal plants (A) & (B) flavonoids in *Potentilla fulgens* and *Paris polyphylla*; (C) & (D) saponins in *Costus speciosus* and *Paris polyphylla*; (E), (F) & (G) tannins in *Rubus ellipticus*, *Juglan regia* amd *Oroxylon indicum*; (H) & (I) alkaloids in *Mahonia manipurensis* and *Dicentra scandens*; (J), (K) and (L) TLC of alkaloid fractions

BIBLIOGRAPHY

Aburjai, T., Hudaib, M., Carvini, V., 2005. Chemical composition of the essential oil from different aerial parts of lavender (*Lavandula coronopafolia* Poiert) (Lamiaceae) grown in Jordan. *Journal of Essential Oil Research*, **17**: 49-51.

Acharyya, B. K., Sharma, H. K., 2004. Folklore medicinal plants of Mahmora area, Sivasagar district, Assam. *Indian Journal of Traditional Knowledge*, **3**: 365-372.

Ahmed, A. A., Borthakur, S. K., 2005. Ethnobotanical wisdom of Khasi (Hynniewtreps) of Meghalaya. Bishen Singh Mahendra Pal Singh, Dehradun, India.

Ahrendt, L. W. A., 1961. Berberis and Mahonia-a taxonomic revision. *Journal of Linnean Society Botany*. London **57**: 296-398.

Airong Li, Zhu, Y., He, X., Tian X., Xu, L., Ni, W., Jiang, P., 2008. Evaluation of antimicrobial activity of certain Chinese plants used in folkloreic medicine. *World Journal of Microbiological Biotechnology*, **24**: 569-572.

Alexiades, M. N., 1996. Selected guidelines for ethnobotanical research: a field manual. New York Botanical Garden, Bronx, New Yor, USA.

Al-Saleh, F. S., Gamal El-Din, A. Y., Abbas, J. A., Saeed, N. A., 1997. Phytochemical and biological studies of medicinal plants in Bahrain: the family of Chenopodiaceae-part 2. *International Journal of Pharmacognosy*, **35**(1): 38-42.

Ambasta, S. P., 1986. The useful plants of India. Publication and Information Directorate, CSIR, New Delhi, 698-699.

Ameenah Gurib-Fakim, 2006. Medicinal plants: traditions of yesterday and drugs of tomorrow. *Molecular Aspects of Medicine*, **27**: 1–93.

Amin, A. H., Subbaiah, T. V., Abbasi, K. M., 1969. Berberine sulfate: antimicrobial activity, bioassay and mode of action. *Canadian Journal of Microbiology*, **15**: 1067-1076.

Ammal, J. E. K., 1955. An introduction to the subsistence economy of India: paper No. 10, Wenner-Gref Foundation. International symposium on "Man's role in changing the face of the earth". Princeton Inn, Princeton, N. J., 16-22.

Ammon, H. P. T., Wahl, M. A., 1991. Pharmacology of *Curcuma longa*. *Planta Medica*, **57**: 1–7.

Angami, A., Gajurel, P. R., Rethy, P., Singh, B., Kalita, S. K., 2006. Status and potential of wild edible plants of Arunachal Pradesh. *Indian Journal of Traditional*

Knowledge, **5**(4): 541-450.

Anis, K. V., Kuttan, G., Kuttan, R., 1999. Role of berberine as an adjuvant response modifier during tumor therapy in mice. *Pharmacy and Pharmacology Commununications*, **5**: 697-700.

Arayne, M. S., Sultana, N., Bahadur, S. S., 2007.The Berberis story: *Berberis vulgaris* in therapeutics. *Pakistan Journal of Pharmaceutical Science*, **20**(1): 83-92.

Arora, R. K., 1991. Conservation and management concept approach. In R. S. Paroda and R. K. Arora (Eds) Plant Genetic Resources, IBPGR, New Delhi.

Ashalata, D. K., Khan, M. L., Tripathi, R. S., 2005. Ethnomedicinal plants in the sacred groves of Manipur. *Indian Journal of Traditional Knowledge*, **4**: 21-32.

Asquith, T. N., Butler, L. G., 1986. Interaction of condensed tannins with selected proteins. *Phytochemistry*, **25**(7): 1591-1593.

Atindehou, K. K., Kone, M., Tenneaux, C., Traore, D., Hostettman, K., Dosso, M., 2002. Evaluation of the antimicrobial potential of medicinal plants from the Ivory Coast. *Phytotherapy Research*, **16**: 497-502.

Awan, M. R., Iqbal, Z., Shah, S. M., Jamal, Z., Jan, G., Afzal, M., Majid, A., Gul, A., 2011. Studies on traditional knowledge on economically important plants of Kaghan Valley, Mansehra district, Pakistan. *Journal of Medicinal Plant Research*, **5**(16): 3958-3967.

Baker, J. T., Borris, R. P., Carte, B., Cordell, G. A., Soejarto, D. D., Cragg, G. M., Gupta, M. P., Iwu, M. W., Maduud, D. R., Tyler, V. E., 1995. Natural product drug discovery and development new perspectives on international collaboration. *Journal of Natural Products*, **58**: 1325-1357.

Balakrishnan, N. P., 1981 & 1983. Flora of Jowai and vicinity, Meghalaya, Vols 1-2, Botanical Survey of India, Howrah, India.

Balemie, K., Kehebew, F., 2006. Ethnobotanical study of wild edible plants in Derashe and Kucha districts, South Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, **2**: 53.

Ballick, M. J., 1996. Annals of the Missouri Botanical Garden, volume 4, Missouri Botanical Garden, 57-65.

Bandoni, A. L., Mendiondo, M. E., Rondina, R. V. D., Coussio, J. D., 1971. Survey of Argentine medicinal plants I. Folklore and phytochemical screening. *Lloydia*, **35**(1): 69-80.

Bannerman, R. H. O., 1979. Acupuncture: the WHO view, World Health Magazine, 24-29.

Bannerman, R. H. O., Cummins, A., Djukanovic, V., Koko, U., 1975. Indigenous system of medicine in India. In: Djukanovic, V., Mach, E. P (Eds.), alternative approaches to meeting basic health needs in developing countries. WHO, Geneva, 84-91.

Bantawa, P., Rai, R., 2009. Studies on ethnomedicinal plants used by traditional practitioners, *Jhankri*, *Bijuwa* and *Phedangma* in Darjeeling Himalaya. *Natural Product Radiance*, **8**: 537-541.

Barua, K.N., Bora, I.P., Singh, J., 2008. Traditional inventory of some potential economic plants related to Angami tribe in Nagaland. *Journal of Economic and Taxonomic Botany*, **32**: 417-424.

Barua, U., Hore, D. K., Sarma, R., 2007. Wild edible plants of Majuli island and Darrang districts of Assam. *Indian Journal of Traditional Knowledge*, **6**(1): 191-194.

Baruah, P., Sharma, G. C., 1984. Studies on the medicinal uses of the plants by the Boro tribals of Assam-II. *Journal of Economic and Taxonomic Botany*, **5**: 599-604.

Bezakova, L., Misik, V., Malekova, L., Syajdlenka, E., Kostalova, D., 1996. Lioxygenase inhibition and antioxidant properties of bisbenzylisoquinoline alkaloids isolated from *Mahonia aquifolium*. *Pharmazie*, **51**: 758-761.

Bharyava, S., Rao, P. S., Bhargava, P., Shukla, S., 2009. Antipyretic potential of *Swertia chirata* Buch. Ham. root extract. *Scientia Pharmaceutica*, **77**: 617-623.

Bhuyan, L. R., 2003. Some plants used as medicine by the Nishi tribe of Arunachal Pradesh: a preliminary study. *Journal of Economic and Taxonomic Botany*, **27**: 447-450.

Biossya, C. L., Majumdar, R., 1980. Some folklore claims from the Brahmaputra valley of Assam. *Journal of Ethnomedicine*, **6**: 139-145.

Bisht, N. S., Mohit, G., Zafar, S., Gusain, M. S., 2005. Status of collection, cultivation and marketing of medicinal and aromatic plants in Pithoragarh, Uttaranchal. *Indian Forester*, **131**(3): 346-357.

Bopana, N., Saxena, S., 2007. *Asparagus racemosus*-ethnopharmacological evaluation and conservation. *Journal of Ethnopharmacology*, **110**: 1-15.

Borthakur, S. K., 1976. Less known medicinal uses of plants among the tribals of Mikir Hills. *Bulletin Botanical Survey of India*, **18**: 166-171.

Browder, J. O., 1990. Extractive reserves will not serve the tropics. *Bioscience*, **40**: 640.

Bruneton, J., 1999. Pharmacognosy, Phytochemistry, Medicinal Plants, 2nd ed., Intercept Ltd., Andover, UK.

Bussmann, R. W., Sharon, D., 2006. Traditional medicinal plant use in northern Peru: tracking 2000 years of healing culture. *Journal of Ethnobiology and Ethnomedicine*, **2**: 47.

Caron, C., Hoizey, M. J., Le Men-Olivier, L., Massiot, G., Zeches, M., Choisy, C., Le Magrex, E., Verporte, R., 1988. Antimicrobial and antifungal activities of quasi-dimeric and related alkaloids. *Planta Medica*, **54**(5): 409-412.

Carter, H. G., Carter, D. N., 1921. Useful plants of the district Lakhimpur in Assam. *Records Botanical Survey of India*, **6**: 353-420.

Castetter, E. F., 1944. The domain of ethnobiology. *American Naturalist*, **78**: 158-170.

Cerakova, M., Kotalova, D., 2002. Antimicrobial activity of berberine- a constituent of *Mahonia aquifolium*. *Folia Microbiologica*, **47** (4): 375-378.

Chakraborty, P., 2003. Wild edible plants sold in the daily market in and around of Imphal, Manipur. *Journal of Economic and Taxonomic Botany*, **27**(2): 481-485.

Chakraborty, P., Pal, G. D., Parmar, P. J., 2003. Some wild edible plants sold in the daily markets of Arunachal Pradesh. *Journal of Economic and Taxonomic Botany*, **27**(2): 489-495.

Champion, H. G., Seth, S. K., 1968. A revised survey of the forest types on India. Govt. of India, Delhi.

Chan-Yeo Chu, Shuenn-Jyi Sheu, 1996. Liquid Chromatographic separation of the alkaloids in coptis-evodia. *Journal of Chromatography* A, **756**: 137-144.

Chao, J., Lu, T. C., Liao, J. W., Huang, T. H., Lee, M. S., Cheng, H. Y., Ho, L. K., Kuo, C. L., Peng, W. H., 2009. Analgesic and anti-inflammatory activities of ethanol root extract of *Mahonia oiwakensis* in mice. *Journal of Ethnopharmacology*, **125**: 297-303.

Chatterjee, R., Guha, M. P., Sen, S. K., 1951. Studies on *Mahonia* genus III. *M. borealis* Takeda and *M. simonsii* Takeda. *Journal of the American Pharmaceutical Association*, **40**(1): 36-39.

Chatterjee, R., Guha, M. P., 1951. Studies on *Mahonia* genus IV. *M. leschenaultia* (Wall.) Takeda, *M. manipurensis* Takeda and *M. sikkimensis* Takeda. *Journal of the American Pharmaceutical Association*, **40**(5):229-232.

Chen, Z., Li, H., Jun-Sheng Ying, 2009. Two new species of *Mahonia*

(Berberidaceae) from Yunnan, China. *Annales Botanici Fennici*, **46**: 469-473.

Chopra, R. N., Nayer, S.L., Chopra, I.C., 1992. Glossary of Indian Medicinal Plants, 3rd edn. Council of Scientific and Industrial Research, New Delhi, 7-246.

Choudhary, K., Singh, M., Pillai, U., 2008. Ethnobotanical survey of Rajasthan-an update. *American-Eurasian Journal of Botany*, **1**(2): 38-45.

Chowdhury, N. I., Bandyopadhyay, S. K., Banerjee, S. N., Dutta, M. K., Das, P. C., 1995. Preliminary studies on the anti-inflammatory effects of *Swertia chirata* in albino rats. *Indian Journal of Pharmacology*, **27**: 37-39.

Clardy, J., Walsh, C., 2004. Lessons from natural molecules. *Nature*, **432**: 829-837.

Clarke, C. B., 1889. On the plants of Kohima and Muneypore. *Journal of Linnean Society Botany*, **25**: 1-207.

Committee on Chinese Medicine and Pharmacy, 2003. The catalogue of medicinal plant resources in Taiwan. Department of Health, Executive Yuan, T.O.C., Hanasty Printing Co. Ltd., Taiwan, Hanasty Printing Co. Ltd., Taipei.

Cordell, G. A., Quinn-Beattie, M. L., Farnsworth, N. R., 2001. The potential of alkaloids in drug discovery. *Phytotherapy Research*, **15**: 183-205.

Cordell, G. A., Colvard, M. D., 2012. Natural products and traditional medicine: turning on a paradigm. *Journal of Natural Products*, **75**: 514−525.

Costa-Lotufo, L., Khan, M., Ather, A., Wilke, D., Jimenez, P., Pessoa, C., de Moraes, M., de Moraes, M., 2005. Studies of the anticancer potential of plants used in Bangladeshi folk medicine. *Journal of Ethnopharmacology*, **999**: 21-30.

Cowan, M., 1999. Plant products as antimicrobial agents. *Clinical Microbiology Reviews*, **12**: 564-582.

Cox, A. P., Ballick, J. M., 1996. Ethnobotanical research and traditional healthcare in developing countries. Plants, People and Culture, New Work: Freeman, W. H. and Co.

Cragg, G. M., Newman, D. J., 2005. Biodiversity: a continue source of novel drug leads. *Pure Applied Chemistry*, **77**(1): 7-24.

Cushnie, T. P. T., Lamb, A. J., 2005. Antimicrobial activity of flavonoids. *International Journal of Antimicrobial Agent*, **26**: 343-356.

Dam, D. P., Hajra, P. K., 1981. Obseravtion on ethnobotany of the Monpas of Kameng district, Arunachal Pradesh. Glimpses of Indian Ethnobotany edited by S. K. Jain, Oxford and IBH publishing co. New Delhi, 107-114.

Das, A. K., Tag, H., 2006. Ethnobotanical studies on the Khamti tribe of Arunachal

Pradesh. *Indian Journal of Traditional Knowledge*, **5**(3): 317-322.

Das, A. K., Dutta, B. K., Sharma, G. D., 2008. Study of non-conventional edible plants used by different communities of Barak valley, Assam (Northeast India). *Journal of Economic and Taxonomic Botany*, **32**: 327-333.

Das, A. K., Dutta, B. K., Sharma, G. D., 2008. Medicinal plants used by the different tribes of Cachar district of Assam. *Indian Journal of Traditional Knowledge*, **7**(3): 446-454.

Deb, D. B., 1957. Studies of the flora of Manipur. *Bulletin Botanical Society of Bengal*, **11**(1):15-25.

Deb, D. B., 1961. *Bulletin Botanical Survey of India*, **3**: 318.

Deb, D. B., 1961a. Monocotyledonous plants of Manipur territory. *Bulletin Botanical Survey of India*, **3**(2): 115-138.

Deb, D. B., 1961b. Dicotyledonous plants of Manipur territory. *Ibid*, **3**(3 & 4): 253-350.

DeBruyne, T., Pieters, L., Deelstra, H., Vlietinck, A., 1999. Condensed vegetable tannins: biodiversity in structure and biology activities. *Biochemical Systematics and Ecology*, **27**: 445-459.

Devi, M., 2003. Wild edible plants of Sonitpur district, Assam. *Journal of Economic and Taxonomic Botany*, **27**(2): 396-409.

Devi, O. S., Komor, P., Das, D., 2010. A checklist of traditional edible bio-resources from Ima markets of Imphal valley, Manipur, India. *Journal of Threatened Taxa*, **2**(11): 1291-1296.

Devi, M. R., Singh, P. K., Dutta, B. K., 2011. Ethnomedicinal plants of Kabui Naga tribe of Manipur, India. *Pleione*, **5**(1): 115-128.

Devkota, K. P., Acharya, R., Baral, M. P., Adhikari, R. P., 1999. Antimicrobial activities of some herbal plants used in traditional medicine in Nepal. In: Anonymous (Ed.), proceeding of the third National Conference on Science and Technology. Nepal Academy of Science and Technology, Kathmandu, 1311-1317.

Duraiswamy, B., Kumar, S. M., Subhashini, V., Dhanraj, S. A., Suresh, B., 2006. Studies on the antimicrobial potential of *Mahonia leschenaultia* Takeda root and root bark. *India Journal of Pharmaceutical Sciences*, **68**(3): 389-391.

Dutta, B. K., Dutta, P. K., 2005. Potential of ethnobotanical studies in Northeast India: an overview. *Indian Journal of Traditonal Knowledge*, **6**: 7-14.

Dwivedi, A. K., Chowdhary, M., Sarine, T. P. S., 1990. Standardisation of a new spermicidal agent *Sapindus* saponin and its estimation in its formulation. *Indian Journal of Pharmaceutical Science*, **52**: 1657.

Edeoga, H. O., Okwu, D. E., Mbaebie, B. O., 2005. Phytochemical constituents of some Nigerian medicinal plants. *African Journal of Biotechnology*, **4**: 685-688.

Elangbam, J. S., Yadava, P. S., Thingbaijam, B. S., 1989. Ethnobotanical studies of the Tangkhul Naga tribe of Ukhrul, Manipur. *Journal of Economic and Taxonomic Botany*, **13**(1): 11-16.

Elangbam, V. D., 2002. Studies on various aspects of wild edible plants of Manipur valley. Ph.D Thesis, Department of Life Sciences, Manipur University, Manipur.

Escalante, A. M., Santecchia, C. B., Lopez, S. N., Gattuso, M. A., Ravelo, A. G., Monache, F. D., Sierra, M. G., Zacchino, S. A., 2002. Isolation of antifungal saponins from *Phytolacca tetramera*, an Argentinean species in critic risk. *Journal of Ethnopharmacology*, **82**: 29-34.

Fabricant, D. S., Farnsworth, N. R., 2001. The value of plants used in traditional medicine for drug discovery. *Environmental Health Perspectives*, **109**: 69-75.

Faizi, S., Khan, R. A., Azher, S., Khan, S. A., Tauseef, S., Ahmad, A., 2003. New antimicrobial alkaloids from the root of *Polyalthia longifolia* var. *pendula*. *Planta Medica*, **69**(4): 350-355.

Farnsworth, N. R., 1966. Biological and phytochemical screening of plants. *Journal of Pharmaceutical Science*, **55**: 225-276.

Farnsworth, N. R., Akerele, O., Bingel, A. S., 1985. Medicinal plants in therapy. *Bulletin of World Health Organization*, **63**: 965-981.

Farnsworth, N. R., Soejarto, D. D., 1991. Global importance of medicinal plants. The Conservation of Medicinal Plants edited by Akerele O., Heywood V., Synge H., Cambridge University Press, Cambridge, UK, 25-51.

Farooqi, A. A., Sreeramu, B. S., 2001. Cultivation of medicinal and aromatic crops, Universities Press (India) Ltd., Hyderabad, India, 1-18.

Faulks, P. J., 1958. An introduction to ethnobotany. London: Moredale Publication Ltd.

Ficker, C. E., Smith, M. L., Susiarti, S., Leaman, D. J., Irawati, C., Arnason, J. T., 2003. Inhibition of human pathogenic fungi by members of Zingiberaceae used by the Kenyah (Indonesian Borneo). *Journal of Ethnopharmacology*, **85**: 289–293.

Ford, R. L., 1978. The nature and status of ethnobotany. In Anthropological Papers edited by Ford R. L., Museum of Anthropology, University of Michigan, USA.

Gadgil, M., Rao, P. R. S., 1998. Nurturing biodiversity: an Indian agenda. Centre for Environment Education, Ahmedabad, India.

Gajurel, P. R., Rethy, P., Singh, B., Angami, A., 2006. Ethnobotanical studies on Adi tribes in Dehang Debang biosphere reserve in Arunachal Pradesh, Eastern Himalaya. *Ethnobotany*, **18**(1&2): 114-118.

Garcia da, O., 1563. Coloquios Des Simples e Drogas- The consassedicinai da India, Goa.

Gazzaneo, L., de Lucena, R., de Albuquerque, U., 2005. Knowledge and use of medicinal plants by local specialists in the region of Atlantic forests in the state of Pernambuco (North eastern Brazil). *Journal of Ethnobiology and Ethnomedicine*, **1**: 1-8.

Gelani, A. H., Atta-Ur-Rahman, 2005. Trends in Ethnopharmacology. *Journal of Ethnopharmacology*, **100**(1-2): 43-49.

Ghimire, S. K., Gimenez, O., Pradel, R., Mckey, D., Aumeeruddy-Thomas, Y., 2008. Demographic variation and population viability in a threatened Himalayan medicinal and aromatic herb Nardostachys grandiflora: matrix modelling of harvesting effects in two contrasting habitats. *Journal of Applied Ecology*, **45**: 41-51.

Giday, M., Asfaw, Z., Elmqvist, T., Woldu, Z., 2003. An ethnobotanical study of medicinal plants used by the Zay people in Ethiopia. *Journal of Ethnopharmacology*, **85**: 43-52.

Gogoi, M., Islam, M., 2010. Ethnomedicinal plants of upper Brahamaputra valley of Assam. *International Journal of Plant Sciences*, **5**(1): 10-12.

Gorman, P. M., Jiang, H., 2004. Isolation methods I: thin-layer chromatography. *Separation Science and Technology*, **5**: 203-230.

Grivetti, L. E., Ogle, B. M., 2000. Value of traditional foods in meeting macro and micronutrient needs: the wild plant connection. *Nutrition Research Reviews*, **13**: 31-46.

Gu, Y., Zhang, Y., Xiangzhe Shi, Xiaoying Li, Jie Hong, Jing Chen, Weiqiong Gu, Xin Lu, Guowang Xu, Guang Ning, 2010. Effect of traditional Chinese medicine berberine on type 2 diabetes based on comprehensive metabolomics. *Talanta*, **81**: 766-772.

Gupta and Vishal, 2006. Traditional medicinal plants of the Bangnis of east Kameng district, Arunachal Pradesh. *Journal of Economic and Taxonomic Botany*, **30**: 310-319.

Hahn, F. E., Ciak, J., 1976. Berberine. *Antibiotics*, **3**: 577-584.

Hajra, P. K., Baishya, A. K., 1981. Ethnobotanical notes on the Miris (Mishings) of

Assam plains. Glimpses of Indian Ethnobotany edited by S. K. Jain, Oxford and IBH publishing co. New Delhi, 159-169.

Harborne, J. B., 1973. Phytochemical methods: a guide to modern techniques of plant analysis. Chapman and Hall Ltd., London, UK.

Harborne, J. B., 1998. Phytochemical methods: a guide to modern techniques of plant analysis. 3rd edn. Chapman and Hall Publishers. London, UK.

Haridasan, K., Rao, R. R., 1985 & 1987. Forest Flora of Meghalaya. Vols 1-2, Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

Haridasan, K., Bhuyan, L. R., Deori, M. L., 1990. Wild edible plants of Arunachal Pradesh. *Arunachal Forest News*, **8**(1&2): 1-8.

Haridasan, K., Anupam, S., Bhuyan, L. R., Bisht, N. S., 2003. Medicinal Plants sector in Aruncahal Pradesh: an overview. *Indian Forster*, **129**:37-47.

Harshberger, J. W., 1896. The purposes of ethnobotany. *Botanical Gazette*, **21**: 146-154.

Iizuka, N., Miyamoto, K., Okita, K., 2000. Inhibitory effects of *Coptis* rhizome and berberine on the proliferation of human esophageal cancer cell lines. *Cancer Letter*, **148**: 19-25.

Heinrich, M., Ankli, A., Frei, B., Weimann, C., Sticher, O., 1998. Medicinal plants in Mexico: healer's consensus and cultural importance. *Social Science and Medicine*, **47**: 91-112.

Hooker, J. D., 1872-1897. The Flora of British India, Vols 1-7, London.

Hynniewta, S. R., Kumar, Y., 2008. Herbal remedies among the Khasi traditional healers and village folks in Meghalaya. *Indian Journal of Traditional Knowledge*, **7**: 581-586.

Ignacimuthu, S., Ayyanar, M., Sankara Sivaraman, K., 2006. Ethnobotanical investigations among tribes in Madurai district of Tamil Nadu (India). *Journal of Ethnobiology and Ethnomedicine*, **2**: 25.

Irshad Ali, A. N. M., Indranoshee Das, 2003. Tribal situation in Northeast India. *Stud Tribes Tribals*, **1**(2): 141-148.

Jadhav, D., 2007. Ethnomedicinal plants used by Bhil tribeof Bibdod, Madhya Pradesh. *Indian Journal of Traditional Knowledge*, **5**: 263-267.

Jain, S. K., 1963b. Observation on ethnobotany of the tribals of Madhya Pradesh. *Vanyajati*, **11**: 177-183.

Jain, S. K., 1964c. Wild plant foods of the tribals of Bastar (Madhya Pradesh). *Proceedings of the National Institute of Science*, **30**B: 56-80.

Jain, S. K., 1968. Medicinal plants. National Book Trust of India. Green Park, New Delhi.

Jain, S. K., Tarafder, C. R., 1970. Medicinal plantlore of the Santals (a revival of Bodding's work). *Economic Botany*. **24**: 241-278.

Jain, S. K., 1981. Glimpses of Indian Ethnobotany. Oxford and IBH publishing co. New Delhi, India.

Jain, S. K., Saklani, A., 1991. Observations on the ethnobotany of the Tons valley region in the Uttarkashi district of the Northwest Himalaya, India. *Mountain Research and Development*. **11**: 157-161.

Jain, S. K., 1996. Ethnobiology in human welfare. Proceeding IV International Congress of Ethnobiology (ICE), Lucknow, 1994. New Delhi: Deep Publication.

Jain, S. K., 2001. Ethnobotany in modern India. *Phytomorphology* golden jubilee issue, 39-54.

Jain, S. K., Srivastava, S., 2001. Indian ethnobotanical literature in last two decades: a graphic review and future directions. *Ethnobotany*, **13**: 1-8.

Jain, S.K., 2010. Ethnobotany in India: some thoughts on future work. *Ethnobotany*, **22**(1&2):1-4.

Jain, A., Sundriyal, M., Roshnibala, S., Kotoky, R., Kanjilal, P. B., Singh, H. B., Sundriyal, R. C., 2011. Dietary use and conservation concern of edible wetland plants at Indo-Burma hotspot: a case study from Northeast India. *Journal of Ethnobiology and Ethnomedicine*, **7**: 29.

Jamir, T. T., Sharma, H. K., Dolui, A. K., 1999. Folklore medicinal plants of Nagaland, India. *Fitoterapia*, **70**: 395-401.

Jamir, N. S., Limasemba, Jamir, N., 2008. Ethnomedicinal plants used by Konyak Naga tribes of Mon district in Nagaland. *Ethnobotany*, **20**(1-2): 48-53.

Jamir, N. S., Takatemjen, Limasemba, 2010. Traditional knowledge of Lotha-Naga tribes in Wokha district, Nagaland. *Indian Journal of Traditional Knowledge*, **9**(1): 45-48.

Jansen van Rensburg, W. S., Venter, S. L., Netschluvhi, T. R., Heever, E. van den, Vorster, H. J., de Ronde, J. A., 2004. Role of indigenous leafy vegetables in combating hunger and malnutrition. *South African Journal of Botany*, **70**: 52-59.

Ji, X., Li, Y., Liu, H., Yan, Y., Li, J., 2000. Determination of the alkaloid content in different parts of some *Mahonia* plants by HPCE. *Pharmaceutica Acta Helvetiae*, **74**: 387–391.

Jones, V., 1941. The nature and scope of ethnobotany. *Chronica Botanica*, **6**(10): 219-221.

Jon, C., Christopher, W., 2004. Lessons from natural molecules. *Nature*, **432**: 829-837.

Joseph, J., Kharkongor, P., 1981. A preliminary ethnobotanical survey in the Khasi and Jaintia Hills, Meghalaya. Glimpses of Indian Ethnobotany. New Delhi: Oxford and IBH publishing co., 115-123.

Joshi, A.R., Edington, J. M., 1990. The use of medicinal plants by two village communities in the Central Development Region of Nepal. *Economic Botany*, **44**: 71–83.

Just, M. J., Recio, M. C., Giner, R. M., Cuellar, M. J., Manez, S., Bilia, A. R., Rios, J. L., 1998. Anti-inflammatory activity of unusual lupine saponins from *Bupleurum fruticescens*. *Planta Medica*, **64**: 404-407.

Kala, P. C., 2005. Ethnomedicinal botany of the Apatani in the Eastern Himalaya region of India. *Journal of Ethnobiology and Ethnomedicine*, **1**: 11.

Kala, C. P., 2007. Prioritization of cultivated and wild edibles by local people in the Uttaranchal hills of Indian Himalaya. *Indian Journal of Traditional Knowledge*, **6**: 239-243

Kan, W. S., 1980. Manual of medicinal plants in Taiwan (1). National Research Institute of Chinese Medicine, Taipei, 154.

Kanjilal, U. N., Kanjilal, P. C., Das, A., De, R. N., Bor, N. L., 1934-1940. Flora of Assam, Vols 1-5, Government Press, Shillong, Meghalaya.

Kapoor, L. D., Singh, A., Kapoor, S. L., Srivastava, S. N., 1969. Survey of Indian plants for saponins, alkaloids and flavonoids –I. *Lloydia*, **32**: 297-304.

Kar, A., Borthakur, S. K., 2008. Wild vegetables of Karbi-Anglong district, Assam. *Natural Product Radiance*, **7**: 448-260.

Kayang, H., 2007. Tribal knowledge on wild edible plants of Meghalaya, Northeast India. *Indian Journal of Traditonal Knowledge*, **6**: 177-181.

Kemp, R., 2003. Ethno-medicinal plants used by the Rengma tribe in Dimapur district, Nagaland (India). *Journal of Economic and Taxonomic Botany*, **27**(2): 485-488.

Khan, M. H., Yadava, P. S., 2010. Herbal remedies of asthma in Thoubal district of Manipur in Northeast India. *Indian Journal of Natural Products and Resources*, **1**(1):

80-84.

Kharkongor, P., Joseph, J., 1981. Folklore medico-botany of rural Khasi and Jaintia tribes in Meghalaya. Glimpses of Indian Ethnobotany. New Delhi: Oxford and IBH Publishing Co., 124-136.

Khongsai, M., Saikia, S. P., Kayang, H., 2011. Ethnomedicinal plants used by different tribes of Arunachal Pradesh. *Indian Journal of Traditional Knowledge*, **10**(3): 541-546.

Kim, H. S., 2005. Do not put too much value on conventional medicines. *Journal of Ethnopharmacology*, **100**: 37-39.

Khumbongmayum, A. D., Khan, M. L., Tripathi, R.S., 2005. Ethnomedicinal plants in the sacred grooves of Manipur. *Indian Journal of Traditional Knowledge*, **4**: 21-32.

Kirtikar, K. R., Basu, B. D., 1935. Indian Medicinal Plants, vols. 1–4. Lalit Mohan Basu, Allahabad, India.

Kirtika, K. R., Basu, B. D., 2001. Indian medicinal plants-with illustrations, 2nd edition, Oriental Enterprises, Dehra Doon, India.

Kokate, C. K., 1999. Practical pharmacognosy, 4th edn. Vallabh Prakashan publication, New Delhi, India.

Kokwaro, J.O., 1976. Medicinal Plants of East Africa. East Africa Literature Bureau, Nairobi.

Kong, J. M., Chia, L. S., Goh, N. K., Chia, T. F., Brouillard, R., 2003. Analysis and biological activities of anthocyanins. *Phytochemistry*, **64**: 923-933.

Konishi, T., Fujiwara, Y., Konoshima, T., Kiwosawa, S., Nishi, M., Miyahara, K., 1998. Steroidal saponins from *Hemerocallis fulva* var. *kwanso*. *Chemical and Pharmaceutical Bulletin*, **49**: 318-320.

Kumar, Y., Fancy, S., Rao, R. R., 1987. Further contribution to the ethnobotany of Meghalaya plants used by the "War Jaintia" of Jaintia Hill district. *Journal of Economic and Taxonomic Botany*, **11**(1): 65-70.

Kumar, S., Singh, J. P., Kumar, S., 1990. Phytochemical screening of some plants of Manipur-1. *Journal of Economic Botany and Phytochemistry*, **1**: 13-16.

Kunwar, R. M., Nepal, B. K., Kshhetri, H. B., Rai, S. K., Bussmann, R. W., 2006. Ethnomedicine in Himalaya: a case study from Dolpa, Humla, Jumla and Mustang districts of Nepal. *Journal of Ethnobiology and Ethnomedicine*, **2**: 27.

Kupeli, E., Kosar, M., Yesilada, E., Husnu, K., Baser, C., 2002. A comparative study on the anti-inflammatory, anti-conceptive and antipyretic effects of isoquinoline alkaloids from the root of Turkish *Berberis* species. *Life Science*, **72**: 645-657.

Kutchan, T., 2000. Alkaloids: in biochemistry and molecular biology of plants edited by Buchanan B. B., Gruissem W., Jones R. L., Rockville: *American Society of Plant physiologists*, 1268-1286.

Lacaille-Dubois, M. A., Wagner, H., 1996. A review of the biological and pharmacological activities of saponins. *Phytomedicine*, **2**: 363-386.

Lambertini, E., Piva, R., Khan, M. T. H., Lampronti, I., Bianchi, N., Borgatti, M., Gambari, R., 2004. Effects of extracts from Bangladeshi medicinal plants on *in vitro* proliferation of human breast cancer cell lines and expression of estrogen receptor alpha gene. *International Journal of Oncology*, **24**: 419–423.

Lavergne, R., Vera, R., 1989. Etude ethnobotaniques des plants utilises dans la Pharmacopee traditional a la reunion. Agenec de cooperation culturulle et technique, Paris.

Lavergne, R., 2001. Tisaneurs et plants medicinales indigenes de la reunion. Saint de la reunion, Orphie.

Lee, S. J., Sung, J. H., Lee, S. J., Moon, C. K., Lee, B. H., 1999. Antitumor activity of a novel ginseng saponin metabolite in human pulmonary adenocarcinoma cells resistant to cisplatin. *Cancer letters*, **144**: 39-43.

Lewington, A., 1990. Plant for people. Oxford University Press, New york, USA.

Li, Y., Ji. X., Liu, H., Yan, Y., Li, J., 2000. Characterization of 10 species of *Mahonia* by Capillary Electrophoresis. *Chromatographia*, **51**(5-6): 357-361.

Li, D. W., Lee, E. B., Kang, S. S., Hyun, J. E., Whang, W. K., 2002. Activity guided isolation of saponins from *Kalopanax pictus* with anti-inflammatory activity. *Chemical and Pharmaceutical Bulletin*, **50**: 900-903.

Lindeberg, S., Cordain, L., Eaton, S. B., 2003. Biological and clinical potential of a paleolitic diet. *Journal of Nutritional and Environmental Medicine*, **13**: 149-160.

Lindsay, B. S., Christiansen, H. C., Copp, B. R., 2000. Structural studies of cytotoxic marine alkaloids: synthesis of novel ring-E analogues of ascididemin and their *in vitro* and *in vivo* biological evaluation. *Tetrahedron*, **56**(3): 497-505.

Luo, X., Chen, B., Yao, S., 2005. Simultaneous analysis of protoberberine, indolequinoline and quinolone alkaloids in *Coptis evodia* herb couple and the Chinese herbal preparations by high-performance liquid chromatography–electrospray mass spectrometry. *Talanta*, **66**: 103-110.

Luo, Y. C., Yeh, L. F., Zhang, K. C., Lu, F. Y., 2007. Ethnobotany in north Tsou tribe. *Nature Conservation Quarterly*, **58**: 27-31.

Mace, M. E., 1963. Histochemical localization of phenols in healthy and diseased tomato roots. *Phytopathology*, **16**: 915-925.

Maheshwari, J. K., Singh, J. P., 1984. Contribution to the ethnobotany of Bhoxa tribe of Bijnor and Pauri Garhwal districts, U.P. *Journal of Economic and Taxonomic Botany*, 5: 251-259.

Maikhuri, R. K., Nautiyal, S., Rao, K. S., Semwal, R. L., 2000. Indigenous knowledge of medicinal plants and wild edibles among three tribal sub communities of the central Himalayas, India. *Indigenous Knowledge and Development Monitor*, **8**: 7-13.

Maikhuri, R. K., Rao, K. S., Chauhan, K., Kandari, L. S., Prasad, P., Rajasekharan, C., 2003. Development of marketing of medicinal plants and other forest products - can it be a pathway for effective management and conservation? *Indian Forester*, **129**: 169-178.

Maikhuri, R. K, Rao, K. S., Saxena, K. G., 2004. Bio-prospecting of wild edibles for rural development in central Himalaya. *Mountain Research and Development*, **24**: 110-113.

Majumdar, R., Bharoli, B. K., 1997. Medicinal plants from Chandel, Churachanpur, Ukhrul forest areas of Manipur state, part-1. *Bulletin of Medico-Ethnobotanical Research*, **18**(1-2): 35-42.

Manandhar, N. P., 1991. Medicinal plant-lore of Tamang tribe of Kabhrepalanchok District, Nepal. *Economic Botany*, **45**: 58–71.

Manandhar, N. P., 1992. Folklore medicine of Dhading District, Nepal. *Fitoterapia*, **63**: 163-177.

Manandhar, N. P., 1993. Ethnobotanical note on folk-lore remedies of Baglung district, Nepal. *Contributions to Nepalese Studies*, **20**: 183-196.

Manadhar, N. P., 2002. Plants and people of Nepal. Timber Press Inc., Portland, Oregon.

Mao, A. A., 1993. A preliminary report on the folklore botany of Mao Naga of Manipur. *Ethnobotany*, **5**: 143-147.

Mao, A.A., 2003. Some symbolic and superstitious botanical folklore about Mao Naga tribe of Manipur (India). In J. K. Maheswari (Ed.) *Ethnobotany and Medicinal Plants of Indian Subcontinent*, Scientific publication, New Delhi, 625-628.

Mao, A. A., Hynneiwta, T. M., Sanjappa, M., 2009. Plant wealth of Northeast India with reference to ethnobotany. *Indian Journal of Traditional Knowledge*, **8**(1): 96-103.

Marles, M. A. S., Ray, H., Gruber, M. Y., 2003. New perspectives on proanthocyanidin biochemistry and molecular regulation. *Phytochemistry*, **64**: 367-383.

Martin, G. J., 1995. Ethnobotany: a conservation manual, Chapman and Hall, London.

Maundu, P. M., Ngugi, G. W., Kabuye, C. H. S., 1999. Traditional food plants of Kenya, Nairobi: National Museums of Kenya. A report **12**: 83-93.

McCutcheon, A. R., Ellis, S. M., Hancock, R. E. W., Towers, G. H. N., 1994. Antifungal screening of medicinal plants of British Columbian native peoples. *Journal of Ethnopharmacology*, **44**: 157-169.

Megoneitso, Rao, R. R., 1983. Ethnobotanical studies in Nagaland. *Journal of Economic and Taxonomic Botany*, **4**: 167-172.

Merschjohann, K., Sporer, F., Steverding, D., Wink, M., 2001. *In vitro* effect of alkaloids on bloodstream forms of *Trypanosoma brucei and Trypanosoma conglolense. Planta Medica*, **67**: 623-627.

Ming-Wei, W., Xiaojiang, H., Kaixian, C., 2007. Biological screening of natural products and drug innovation in China. *Philosophical Transactions of the Royal Society B*, **362**: 1093-1105.

Misik, V., Bezakova, L., Malekova, L., Kostaloya, D., 1995. Lipoxygenase inhibition and antioxidant properties of protoberberine and aporphine alkaloids isolated from *Mahonia aquifolium. Planta Medica*, **61**: 372-373.

Mittermeier, R. A., Gil, P. R., Hoffmann, M., Pilgrim, J., Brooks, T., Mittermeier, C. G., Lamoreux, J., da Fonseca, G. A. B., 2004. Hotspots revisited. Earth's biologically richest and most endangered terrestrial ecoregions. Cemex Books on Nature series, USA, 497.

Molinski, T. F., 1993. Marine pyridoacridines alkaloids: structure, synthesis and biological chemistry. *Chemical Reviews*, **93**(5): 1825-1838.

Mozhui, R., Rongsensashi, Limasenla, Changkija, S., 2011. Wild edible fruits used by the tribals of Dimapur district of Nagaland, India. *Pleione*, **5**(1): 54-64.

Mukherjee, T. K., 2005. Editorial. *Indian Journal of Taditional Knowledge*, **4**: 3-4.

Muller, K., Ziereis, K., 1994. The antipsoriatic *Mahonia aquifolium* and its active Constituents-I. Pro- and antioxidant properties and inhibition of 5-lipoxygenase. *Planta Medica*, **60**: 421-424.

Muller, K., Ziereis, K., Gawkil, I., 1995. The antipsoriatic *Mahonia aquifolium* and its active constituents-II. Antiproliferative activity against cell growth of human keratinocytes. *Planta Medica*, **61**: 74-75.

Myers, N., Mittermeier, R., Mittermeier, G., da Fonseca, G., Kent, J., 2000. Biodiversity hotspots for conservation priorities. *Nature*, **403**: 853-858.

Namsa, N. D., Mandal, M., Tangjang, S., Mandal, S. C., 2011. Ethnobotany of the Monpa ethnic group in Arunachal Pradesh, India. *Journal of Ethnobiology and Ethnomedicine*, **7**: 31.

Nath, S. C., Bordoloi, D. N., 1989. Ethnobotanical observation on some medicinal folklore of Tirap district, Arunachal Pradesh. *Journal of Economic and Taxonomic Botany*, **13**: 321-325.

Nazrullaev, S. S., Bessonova, I. A., Akhmeddkhodzhaeva, K. S., 2001. Estrogen activity as a function of chemical structure in *Haplophyllum* quinoline alkaloids. *Chemistry of Natural Compounds*, **37**(6): 551-555.

Nayer, M. P., 1996. Hotspots of endemic plants of India, Nepal and Bhutan, S. B. Press, Trivandrum.

Ncube, N. S., Afolayan, A. J., Okoh, A. I., 2008. Assessment techniques of antimicrobial properties of natural compounds of plant origin: current methods and future trends. *African Journal of Biotechnology*, 7(12): 1797-1806.

Newman, D. J., Cragg, G. M., Snader, K. M., 2003. Natural products as a source of new drugs over the period 1981-2002. *Natural Product Reports*, **66**: 1022-1037.

Newman, D. J., Cragg, G. M. J. 2007. Natural products as sources of new drugs over the last 25 years. *Journal of Natural Products*, **70**: 461–477.

Newton, S. M., Lau, C., Gurcha, S. S., Besra, G.S., Wright, C. W., 2002. The evaluation of forty-three plant species for *in vitro* antimycobacterial activities: isolation of active constituents from *Psoralea corylifolia* and *Sanguinariacanadensis*. *Journal of Ethnopharmacology*, **79**: 57–67.

Nordeide, M. B., Hatloy, A., Folling, M., Lied, E., Oshoug, A., 1996. Nutrient composition and nutritional importance of green leaves and wild foods in an agricultural district, Koutiala, in southern Mali. *International Journal of Food Science and Nutrition*, **47**(6): 455-468.

Odebiyi, O. O., Sofowora, E. A., 1978. Phytochemical sceening of Nigerian medicinal plants II. *Lloydia*, **41**: 234-246.

Ogoye-Ndegwa, C., Aagaard-Hansen, J., 2003. Traditional gathering of wild vegetables among the Luo of western Kenya – a nutritional anthropology project. *Journal of Ecology of Food Nutrition*. **42**: 69-89.

Ogunleye, D. S., Ibitoye, S. F., 2003. Studies of antimicrobial activity and chemical constituents of *Ximenia Americana*. *Tropical Journal of Pharmaceutical Research*, **2**(2): 239-241.

Okigbo, R. N., Anuagasi, C. L., Amadi, J. E., 2009. Advances in selected medicinal and aromatic plants indigenous to Africa. *Journal of Medicinal Plants Research*, **3**(2): 086-095.

Okwu, D. E., 2005. Phytochemicals, vitamins and mineral contents of two Nigeria medicinal plants. *International Journal of Molecular Medicine and Advance Sciences*, **1**(4): 375-381.

Omulokoli, E., Khan, B., Chhabra, S. C., 1997. Antiplasmodial activity of four Kenyan medicinal plants. *Journal of Ethnopharmacology*, **56**: 133-137.

Orech, F. O., Aagaard-Hansen, J., Friis., H., 2007. Ethnoecology of traditional leafy vegetables of the Luo people of Bondo district, western Kenya. *International Journal of Food Science and Nutrition*, **58**(7): 522-530.

Palombo, E. A., 2006. Phytochemicals from traditional medicinal plants used in the treatment of diarrhoea: modes of action and effects on intestinal function. *Phytotherapy Research*, **20**: 717-724.

Patiri, B., Borah, A., 2007. Wild edible plants of Assam. Director Forest Communication, Guwahati.

Pfoze, N. L., Chiezou, D. N., 2006. *Dicentra scandens* (D. Don) Walp. A highly potent ethnomedicinal plant against, malaria, high blood pressure and diabetes. *Indian Journal of Traditional Knowledge*, **52**: 268-270.

Pfoze, N. L., Kumar, Y., Myrboh, B., Bhagobaty, R. K., Joshi, S. R., 2011. *In vitro* antibacterial activity of alkaloid extract from stem bark of *Mahonia manipurensis* Takeda. *Journal of Medicinal Plants Research*, **5**(5): 859-861.

Pfoze, N. L., Kumar, Y., Myrboh, B., 2011. Survey and assessment of floral diversity on wild edible plants from Senapati district of Manipur, Northeast India. *Journal of Biodiversity and Environmental Sciences*, **1**(6): 50-62.

Pharmacopoeia Committee, 1990. Pharmacopoeia of people republic of China, Guangdong Science and Technology Press. Guangzhou.

Philip, K., Sri Nurestri, A. M., Wirakarnain, S., Sim, K. S., Kumar, S., 2009. Antimicrobial activity of some medicinal plants from Malaysia. *American Journal of Applied Sciences*, **6**(8): 1613-1617.

Phillips, O., 1993. The potent for harvesting fruits in the tropical rainforests: New data from Amazonian Peru. *Biodiversity and Conservation*, **2**: 18-38.

Phillips, O., Gentry, A. H., Revnel, C., Wilki, P., Gavez-Durand, C. B., 1994. Quantitative ethnobotany and Amazonian conservation. *Conservation Biology*, **8**: 225-248.

Pieroni, A., Price, L.L., 2005. Eating and healing: traditional food as medicine. New York: Haworth Press.

Powers, S., 1873-1875. Aboriginal botany. California Academy of Science Proceedings, **5**: 373-379.

Pradhan, B. K., Badola, H. K., 2008. Ethnomedicinal plants used by the Lepchas tribe of Dzungo valley, bordering Khangchendzonga biosphere reserve, in north Sikkim, India. *Journal of Ethnobiology and Ethnomedicine*, **4**: 22.

Pranay, B., Ritu, R., 2009. Studies on ethnobotanical plants used by traditional practitioners, Jhankri, Bijuwa and Phedangma in Darjeeling Himalaya. *Natural Product Radiance*, **8**(5): 537-541.

Purkayastha, J., Dutta, M., Nath, S. C., 2007. Ethnomedicinal plants from Dibru-Saikhowa biosphere reserve, Assam. *Indian Journal of Traditional Knowledge*, **6**(3): 477-480.

Pushpgandhan, P., 1994. Ethnobiology in India. A status report, Ministry of Environment and Forest, Govt. of India, New Delhi.

Pushpangdan, P., Kumar, B., 2005. Ethnobotany, CBD, WTO and the Biodiversity Act of India. *Ethnobotany*, **17**: 2-12.

Puyvelde, L. V., Ntawukiliyayo, J. D., Portaels, F., Hakizamungu, E., 1994. *In vitro* inhibition of mycobacteria by Rwandese medicinal plants. *Phytotherapy Research*, **8**: 65–69.

Quiroga, E. N., Sampietro, A. R., Vattuone, M. A., 2001. Screening antifungal activities of selected medicinal plants. *Journal of Ethnopharmacology*, **74**: 89-96.

Rajkumar, N., Shivanna, M. B., 2009. Ethno-medicinal application of plants in the Eastern region of Shimoga district, Karnataka, India. *Journal of Ethnopharmacology*, **126**: 64-73.

Ramakrishnan, P. S., 1992. Tropical forests, exploitation, conservation and management. *Impact of Science and Society*, **42**: 149-162.

Rao, R. R., Jamir, N. S., 1990. Ethnobotany of the Ao and Angami Nagas of Nagaland. *Journal of Economic and Taxonomic Botany*, **14**: 593-604.

Rao, S. S., 2006. Indigenous knowledge organization: an Indian scenario. *International Journal of Information Management*, **26**: 224–233.

Rastogi, R. P., Dhawan, B. N., 1982. Research on medicinal plants at the Central Drug Research Institute, Lucknow (India). *Indian Journal of Medicinal Research*, **76**: 27-45.

Rastogi, R. P., Mehrotra, B. N., 1999. Compendium of Indian Medicinal Plants, vol.2, CDRI publication, New Delhi, 609-610.

Ravikumar, P. R., Hammesfahr, P., Charles, J., 1979. Cytotoxic saponins from the Chinese herbal drug Yunnan Bai Yao. *Journal of Pharmaceutical Sciences*, **68**: 900-903.

Ren, L., Xue, X., Zhang, F., Xu, Q., Liang, X., 2007. High performance liquid chromatography mass- spectrometry analysis of protoberberine alkaloids in medicine herbs. *Journal of Separation Sciences*, **30**: 833-842.

Renfrew, J. M., 1963. Palaeo-ethnobotany: the pre-historic food plants of the Near East and Europe, Columbia University Press.

Rethy, P., Singh, B., Kagyung, R., Gajurel, P. R., 2010. Ethnobotanical studies of Dehang-Debang biosphere reserve of Arunachal Pradesh with special reference to *Memba* tribe. *Indian journal of Traditional Knowledge*, **9**: 61-67.

Robbins, W., Harrington, J., Freire-Marreco, B., 1916. Ethnobotany of the Tewa Indians. *Bureau of American Ethnology Bulletin*, pp 55.

Robert, M. F., Wink, M., 1998. Alkaloids: biochemistry, ecology and medicinal application, Plenum Press, New York, 1-7.

Rohrer, U., Kunz, E. M., Lenkeit, K., Schaffner, W., Meyer, J., 2007. Antimicrobial activity of *Mahonia aquifolium* and two of its alkaloids against oral bacteria. *Schweiz Monatsschr Zahnmed*, **117**: 1126-1131.

Rokaya, M. B., Miinzbergova, Z., Timsina, B., 2010. Ethnobotanical study of medicinal plants from the Humla district of Western Nepal. *Journal of Ethnopharmacology*, **130**: 485-504.

Rosangkima, G., Prasad, S. B., 2004. Antitumour activity of some plants from Meghalaya and Mizoram against murine ascites Dalton's Lymphoma. *Indian Journal of Experimental Biology*, **42**: 981-988.

Sabu, M., 2006. Zingiberaceae and Costaceae of South India. Indian Association for Angiosperm Taxonomy, Calicut University, Kerala, India.

Saha, J., Sarkar, P. K., Chattopadhyay, S., 2011. A survey of ethnomedicinal plants of Darjeeling hills for their antimicrobial and antioxidant activities. *Indian Journal of Natural Products and Resources*, **2**(4): 479-492.

Saikia, A. P., Ryakala, V. K., Sharma, P., Goswami, P., Bora, U., 2006. Ethnobotany of medicinal plants used by Assamese people for various skin ailments and cosmatics. *Journal of Ethnopharmacology*, **106**: 149-157.

Sajem, A. L., Gosai, K., 2006. Traditional use of medicinal plants by the Jaintia tribes in North Cachar Hills district of Assam, Northeast India. *Journal of Ethnobiology and Ethnomedicine*, **2**: 33.

Sajem, A. L., Gosai, K., 2010. Ethnobotanical investigation among the Lushai tribes in North Cachar Hills district of Assam, Northeast India. *Indian Journal of Traditional Knowledge*, **9**: 108-113.

Saklani, A., Jain, S. K., 1989. Ethnobotanical observations on plants used in Northeastern India. *International Journal of Crude Drug Research*, **27**(2): 65-73.

Salam, S., Kumar, P., Jamir, N. S., 2010. Wild edible plants used by the Tangkhul Naga tribe of Ukhrul district in Manipur. *Pleione*, **4**(2): 284-287.

Samant, S. S., Dhar, U., 1997. Diversity, endemism and economic potential of wild edible plants of Indian Himalaya. *International Journal of Sustainable Development and World Ecology*, **4**: 179-191.

Sarma, B. K., Pandey, V. B., Mishra, G. D., Singh, U. P., 1999. Antifungal activity of berberine iodide, a constituent of *Fumaria indica*. *Folia Microbiologica*, **44**: 164-166.

Sarma, H., Tripathi, A. K., Borah, S., Kumar, D., 2010. Updated estimates of wild edible and threatened plants of Assam: a meta-analysis. *International journal of Botany*, **6**(4): 414-423.

Sawian, J. T., Jeeva, S., Lyndem, F. G., 2007. Wild edible plants of Meghalaya, Northeast India. *Natural Product Radiance*, **6**(5): 410-426.

Schiff, P. L., 1987. Alkaloids: Chemical and Biological Perspectives (Pelletier, S. W. ed.) vol. 5, Wiley, New York.

Schmeller, T., Latz-Broning, B., Wink, M., 1997. Biochemical activities of berberine, palmatine and sanguinarine mediating chemical defence against microorganisms and herbivores. *Phytochemistry*, **44**: 257-266.

Schultes, R. E., 1960. Tapping our heritage of ethnobotanical lore. *Economic Botany*, **14**(2): 257-262.

Schultes, R. E., 1962. The role of ethnobotanists in search for new medicinal plants. *Lloydia*, **25**: 257-266.

Schultes, R. E., Von Reis, S., 1995. Ethnobotany: evolution of a discipline, Chapman and Hall, London.

Shackleton, S. E., Dzerefos, C. M., Shackleton, C. M., Mathabala, F. R., 1998. Use and trading of wild edible herbs in Central Lowveld Savannah region, South Africa. *Economic Botany*, **52**: 251-259.

Shah, N. C., Joshi, M. C., 1971. An ethnobotanical study of Kumaon region of India. *Economic Botany*, 25: 414–422.

Shanker, R., Singh, V. K., Rawat, M. S., 1998. Some medicinal plants of district Tirap (Arunachal Pradesh) with a note on the ethnobotany of Nocte tribe. *Bulletin of Medico-Ethnbotanical Research*, **19**: 12-22.

Shanshan, W., Wenyuang, G., Hongquan, D., 2004. Advances in studies on chemical constituents and pharmacological activites of *Rhizoma paridis*. *Chinese Traditional Herbal Drugs*, **35**: 344-347.

Sharma, H. K., Chhangte, L., Dolui, A. K., 2001. Traditional medicinal plants in Mizoram, India. *Fitoterapia*, 72: 146–161.

Shi, X. F., Du, D. J., Xie, D. C., 1992. Effects of steroidal saponins in *Rhizoma paridis* on H_{22} animal transplant tumor. *Journal of Chinese Materia Medica*, **15**: 33-36.

Shi, P., Zhang, Y., Shi, Q., Zhang, W., Cheng, Y., 2006. Quantitative determination of three protoberberine alkaloids in Jin-Guo-Lan by HPLC-DAD. *Chromatographia*, **64**(3/4): 163-168.

Shiva, M. P., 1996. Inventory of forestry resources for sustainable management and bio-diversity conservation, Indus Publishing Company, New Delhi, India.

Shinwari, M. I., Khan, M. A., 2000. Folk use of medicinal herbs of Margalla hills national park, Islamabad. *Journal of Ethnopharmacology*, **69**: 45-56.

Shrestha, P. M., Dhillion, S. S., 2003. Medicinal plant diversity and use in the highlands of Dolakha district of Nepal. *Journal of Ethnopharmacology*, **86**: 81-96.

Singh, H. B., Arora, R. K., 1978. Wild edible plants of India (1st ed.). ICAR publication, New Delhi.

Singh, M. P., Malla, S. B., Rajbhandari, S. B., Manandhar, A., 1979. Medicinal plants of Nepal: retrospects and prospects. *Economic Botany*, **33**: 185–193.

Singh, R. S, Singh, N. I., 1985. A preliminary ethnobotanical studies on wild edible plants in the markets of Manipur-I. *Journal of Economic and Taxonomic Botany*, **6**(3): 699-703.

Singh, P. K., Singh, N. I., Singh, L. J., 1988. Ethnobotanical studies on wild edible plants in the markets of Manipur II. *Journal of Economic and Taxonomic Botany*, **12**(1): 113-119.

Singh, O. K., 1990. Flora of Tamenlong district and its ethnobotanical notes. Ph. D Thesis, Manipur University, Manipur.

Singh, J., Bhuyan, T. C., Ahmed, A., 1996. Ethnobotanical studies on the Mishing tribe of Assam with special reference to food and medicinal plants. *Journal of Economic and Taxonomic Botany*, **12**: 35-356.

Singh, N.P., Chauhan, A. S., Mondal, M. S., 2000. Flora of Manipur, vol. 1, Botanical Survey of India, Calcutta, India.

Singh, H. B., Singh, R. S., Sandhu, J. S., 2003. Herbal Medicine of Manipur: a colour encyclopeadia, Daya publishing house, New Delhi.

Singh, S. P., Tripathi, S., Shukla, K. S., 2003. Ethnomedicinal heritage for bioprospecting and drug development in N-E states of India. *Journal of Economic and Taxonomic Botany*, **27**: 384- 395.

Sinha, S. C., 1996. Medicinal Plants of Manipur published by Manipur Association for Science & Society (MASS), Imphal.

Smith, D. B., 1986. The independence domestication of indigenous seed-bearing plants in eastern North America, Centre for Archaeological Research, Southern Illinois University, occasional papers 7.

Smolenski, S. J., Silinis, H., Farnsworth, N. R., 1972. Alkaloids Screening I. *Lloydia*, **35**(1): 1-34.

Soe, K., Myo Ngwe, T., 2004. Medicinal plants of Myanmar. Myanmar Forest

Resource Environment Development and Conservation Association, Myanmar.

Song, L., Hong, X., Ding, Z., 2001. Paris plants. In: modern grand dictionary of Chinese Materia Medica. Beijing: People's Sanitation Press, 1619-1622.

Southon, I. W., Bucklngham, J., 1989. Dictionary of Alkaloids. London: Chapman and Hall Ltd.

Sparg, S. G., Light, M. E., Van Staden, J., 2004. Biological activities and distribution of plant saponins. *Journal of Ethnopharmacology*, **94**: 219-243.

Stockwell, C., 1989. Nature's pharmacy: a history of plants and healing arrow books limited, London, UK.

Sumitra, S., Jamir, N. S., Singh, P. K., 2009. Traditional uses of medicinal plants by the Tangkhul Naga tribe in Manipur, India. *Pleione*, **3**(2): 157-162.

Sundriyal, M., Sundriyal, R. C., Sharma, E., Purohit, A. N., 1998. Wild edible and other useful plants from the Sikkim Himalaya, India. *Oecologia Montana*, **7**: 43-54.

Sundriyal, M., Sundruyal, R. C., 2001. Wild edible plants of the Sikkim Himalaya: nutritive value of selected species. *Economic Botany*, **55**(3): 377-390.

Sundriyal, M., Sundriyal, R. C., Sharma, E., 2004. Dietary use of wild plant resources in the Sikkim Himalaya, India. *Economic Botany*, **58**(4): 626-638.

Surya, H., Bremner, J. B., 2001. Initial studies on alkaloids from Lombok medicinal plants. *Molecules*, **6**: 117-129.

Syiem, D., Syngai, C., Kharbuli, B., Kayang, H., Khongwir, B. S., 2003. Anti-tumor activity of crude root extract of *Potentilla fulgens*. *Indian Drugs*, **40**: 124-125.

Syiem, D., Syngai, C., Khup, P. Z., Khongwir, B. S., Kharbuli, B., Kayang, H., 2002. Hypoglycemic effects of *Potentilla fulgens* L. in normal and alloxan-induced diabetic mice. *Journal of Ethnopharmacology*, **83**: 55-61.

Tamang, B., Tamang, J. P., 2009. Traditional knowledge of biopreservation of perishable vegetables and bamboo shoots in Northeast India as food resources. *Indian Journal of Traditional Knowledge*, **8**(1): 89-95.

Taylor, R. S. L., Manandhar, N. P., Towers, G. H. N., 1995. Screeninig of selected medicinal plants of Nepal for antimicrobial activities. *Journal of Ethnopharmacology*, **46**: 153–159.

Teklehaymanot, T., Giday, M., 2007. Ethnobotanical study of medicinal plants used by people in Zegie Peninsula, Northwestern Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, **3**: 12.

Tene, V., Malagon, O., Finzi, P. V., Vidari, G., Armijos, C., Zaragoza, T., 2007. An ethnobotanical survey of medicinal plants used in Loja and Zamora-Chinchipe, Ecuador. *Journal of Ethnopharmacology*, **111**: 63–81.

Terry, R. S., Frank, R. S., 1981. Alkaloids of *Mahonia repens* with a brief review of previous work in the genus *Mahonia*. *Journal of Natural Products*, **44**(6): 680-687.

Tona, L., Kambu, K., Ngimbi, N., Cimanga, K., Vlietinck, A. J., (1998). Antiamoebic and phytoch- emical screening of some Congolese medicinal plants. *Journal of Ethnopharmacology*, **61**: 57-65.

Traore, F., Faure, R., Olivier, E., Gasquet, M., Azas, N., Debrauwer, L., Keita, A., Timon-David, P., Balansard, G., 2000. Structure and antiprotozoal activity of triterpenoid saponins from *Glinus oppositifolius*. *Planta Medica*, **66**: 368-371.

Tseng, S. H., Chien, T. Y., Tzeng, C. F., Lin, Y. H., Wu, C. H., Wang, C. C., 2007. Prevention of hepatic oxidative injury by Xiao-Chen-Chi-tang in mice. *Journal of Ethnopharmacology*, **111**: 232-239.

Tushar, Basak, S., Sarma, G. C., Rangan, L., 2010. Ethnomedical uses of Zingiberaceous plants of Northeast India. *Journal of Ethnopharmacology*, **132**: 286-296.

Ugulu, I., Baslar, S., Yorek, N., Dogan, Y., 2009. The investigation and quantitative ethnobotanical evaluation of medicinal plants used around Izmir province, Turkey. *Journal of Medicinal Plants Research*, **3**: 345-367.

Uniyal, S. K., Singh, K. N., Jamwal, P., Lal, B., 2006. Traditional use of medicinal plants among the tribal communities of Chhota Bhangal, Western Himalaya. *Journal of Ethnobiology and Ethnomedicine*, **2**: 14.

Upadhyay, B., Parveen, Dhaker, A. K., Kumar, A., 2010. Ethnomedicinal and ethnopharmaco -statistical studies of eastern Rajasthan, India. *Journal of Ethnopharmacology*, **129**: 64-86.

Uprety, Y., Asselin, H., Boon, E. K., Yadave, S., Shrestha, K. K., 2010. Indigenous use and bio-efficacy of medicinal plants in the Rasuwa district, Central Nepal. *Journal of Ethnobiology and Ethnomedicine* **6**: 3.

Vartak, V. D., Gadgil, M., 1980. Studies in ethnobotany-a new vistas in botanical science. *Biovigyanam*, **6**: 151-156.

Verpoorte, R., 1998. Antimicrobially active alkaloids in Alkaloids: Biochemistry, Ecology and Medicinal Applications, edited by MF Roberts M. F., Wink M., Plenum Press, New York, 397-426.

Virtanen, P., Lassila, V., Njimi, T., Mengata, D. E., 1988. Natural protoberberine alkaloids from *Enantia chlorantha*, palmatine, columbamine and jatrorrhizine for thioacetamide-traumatized rat liver. *Acta Anatomica*, **131**: 166-170.

Warrier, P. K., Nambiar, V. P. K., Ramankutty, C., 1993. Indian Medicinal Plants, vol.1-5.Orient Longman Ltd., Madras.

Watt, G., 1888. Forest of Manipur. *Ibid*, **14**: 291-299, 339-334 & 387-394.

Watt, G., 1890. Forests of Manipur. *Indian Forester*, **14**:291-339 & 387.

Wealth of India, 1976. Publications and Information Directorate. CSIR, New Delhi, **11**: 21-22.

Weimann, C., Heinrich, M., 1997. Indigenous medical plants in Mexico: the example of the Nahua (Sierra de Zongolica). *Pharmaceutical Biology*, **110**: 62-72.

WHO, 2001. Legal status of traditional medicine and complementary/alternative medicine. A world wide review, WHO publishing.

Wickens, G. E., 1990. What is economic botany? *Economic Botany*, **44**: 12-28.

Wong, B. S., Yung-Chin Hsiao, Ta-Wei Lin, kuo-Shuen Chen, Pei-Ni Chen, Wu-Hsien Kuo, Shu-Chen Chu, Yih-Shou Hsieh, 2009. The *in vitro* and *in vivo* apoptotic effects of *Mahonia oiwakensis* on human lung cancer cells. *Chemico-Biological Interactions*, **180**(2): 165-174.

Xiao, K., Yi, Y. H., Wang, Z. Z., Tang, H. F., Li, Y. Q., Lin, H. W., 1999. A cytotoxic triterpene saponin from the root bark of *Aralia dasyphylla*. *Journal of Natural Products*, **62**: 1030-1032.

Yilmaz, Y., Toledo, R. T., 2004. Health aspects of functional grape seed constituents. *Trends in Food Science and Technology*, **15**: 422-433.

Yumkham, S. D., Singh, P.K., 2011. Less known ferns and fern-allies of Manipur with ethnobotanic uses. *Indian Journal of Traditional Knowledge*, **10**(2): 287-291.

Zhang, L. T., Zuo, Y. T., Gao, W. Y., 2007. Anti-tumor effects of extracts and chemical constituents from *Paris polyphylla* var. *yunnanensis*. *Chinese Traditional Herbal Drugs*, **38**: 422-424.

Zhank, R. X., Dougherty, D. V., Rosenblum, M. L., 1990. Laboratory studies of berberine used alone and in combination with 3-Bis (2-Chloroethyl)-I-Nitrosourea to treat malignant brain tumors. *British Medical Journal*, **103**: 658-665.

Zhu, J. J., Zhang, J. J., Zhao, G.C., Chen, H. Y., 1998. Study of interaction of berberine with DNA in the presence of β-cyclodextrin. *Spectroscopy Letter*, **31**: 1705-1718.

CURRICULUM VITAE

1. Name: Neli Lokho Pfoze
2. S/o: Late Nepuni Neli
3. Date of Birth: 01-03-1976
4. Sex/marital status: Male/Married
5. ST/SC: ST
6. Religion: Christian
7. Permanent Address: Neli Lokho Pfoze, Kayinu village, PO Mao Gate Senapati district, Manipur.
8. Email: nelilokho@yahoo.com
9. Educational Qualifications

SN.	Examination passed	Year of passing	Board/ University	Division	%	Subject
1.	HSLC	1991	BSEM	II	51%	Physics, Maths, Chemistry, Social Studies, English, Biology, etc.
2.	HSSLC	1993	CHSSEM	II	56%	Physics, Biology, Chemistry, English, etc.
3.	TDC Hons.	1996	Manipur University	I	67%	Chemistry, Geology with Botany Honours
4.	M.Sc.	2000	NEHU	II	58.6%	Biochemistry

10. **Research Papers Published**

a. **Pfoze**, N. L., Kumar, Y., Myrboh, B., 2010. Phytochemical screening to validate the ethnomedicinal uses of *Dicentra scandens* (D. Don) Walp. leaf and root tuber. *Journal of Non-Timber Forest Products,* **17**(3): 335-338.

c. **Pfoze**, N. L., Kumar, Y., Myrboh, B., Bhagobaty, R. K., Joshi, S. R., 2011. *In vitro* antibacterial activity of alkaloid extract from stem bark of *Mahonia manipurensis* Takeda. *Journal of Medicinal Plant Research,* **5**(5): 859-861, 2011.

d. **Pfoze**, N. L., Kumar, Y., Myrboh, B., 2011. Survey and assessment of floral diversity on wild edible plants from Senapati district of Manipur, Northeast India. *Journal of Biodiversity and Environmental Sciences*, **1**(6): 50-62.

e. **Pfoze**, N. L., Kumar, Y., Myrboh, B., 2012. Survey and assessment of ethnomedicinal plants used in Senapati district of Manipur state, northeast India. *Phytopharmacology*, **2**(2): 285-311.

f. **Daimei**, P., Kumar, Y., Sheikh, N., Pfoze, N. L., Paduna, S., 2012. The finest Lakadong variety of turmeric from the Jaintia Hills of Meghalaya, India. *Pleione*, **6**(1): 141-148.

11. **Training/Seminar/Symposium attended**

(a) Participated in the CIMAP (Lucknow) Training School on Advanced Instrumentation and Analytical Techniques for Natural Products during 10-16th June, 2009.

(b) Attended a National Seminar on "Recent Trends in Phytochemical and Phytopharmaceutical Research and Future Prospects" March 26th -27th , 2010, organized by the Department of Chemistry, Gauhati University (GU) and presented a POSTER on "Evaluation of antimicrobial activity of alkaloidal extract from *Dicentra scandens* D.Don (Walp) root tuber."

(c) Participated in the National Symposium on "Assessment and Conservation of Plant Genetic Resources under Changing Environment" organised by UGC-Centre for Advance Studies in Botany, Department of Botany, North Eastern

Hill University (NEHU) from September 8-10th, 2010 and presented an ORAL on "*In Vitro* Antibacterial Activity of Alkaloid Extract from Stem Bark of *Mahonia manipurensis* Takeda".

(d) Participated a Lecture Series on "Biodiversity: Prospects and Concerns" 14th-15th March, 2012 organized by School of Life Sciences under UPE (Biosciences) Programme, North Eastern Hill University and presented an ORAL on "Isolation of Protoberberine Alkaloids from Stem Bark Crude Extract of *Mahonia manipurensis* Takeda"

PHYTOCHEMICAL SCREENING TO VALIDATE THE ETHNOMEDICINAL USES OF *DICENTRA SCANDENS* (D. DON) WALP. LEAF AND ROOT TUBER

N.L. Pfoze, Y. Kumar and B. Myrboh*

Department of Botany,
North Eastern Hill University,
Shillong (Meghalaya).

Abstract: *Dicentra scandense* (D. Don) Walp. have been used traditionally as an important ethnomedicinal plant by certain tribal communities living in the North East India and Nepal. The extract of the plant from root tuber and leaf is prescribed as remedy against fevers, high blood pressure, gastrointestinal disorders and diuretic. Recognising the importance of this lesser known ethnomedicinal plant as a potential source for further investigation into scientific validations of the uses as claimed by these tribal communities, a preliminary screening of the various phytochemical constituents from both the root tuber and leaf was under taken. The results of this investigation showed that the plant contains alkaloids, steroids, terpenoids, tannins and cardiac glycosides. Flavonoids and saponins were not detected in the present investigation.

INTRODUCTION

Dicentra scandens (D. Don) Walp. (Fumariaceae) is a climbing herb found in temperate and subtropical region of Central and Eastern Himalayan region viz. Bhutan and Sikkim (Grierson and Long, 1984), Nepal, Arunachal Pradesh and Nagaland between altitudes ranges from 1500-2500m amsl. The leaves are stalked, decompound with sub-sessile leaflets, elliptic to ovate, acute, entire and membranous; flowers yellow in racemes opposite to the leaf stalk; fruits are capsules pendulous, lanceolate and are found in both open as well as in shady places.

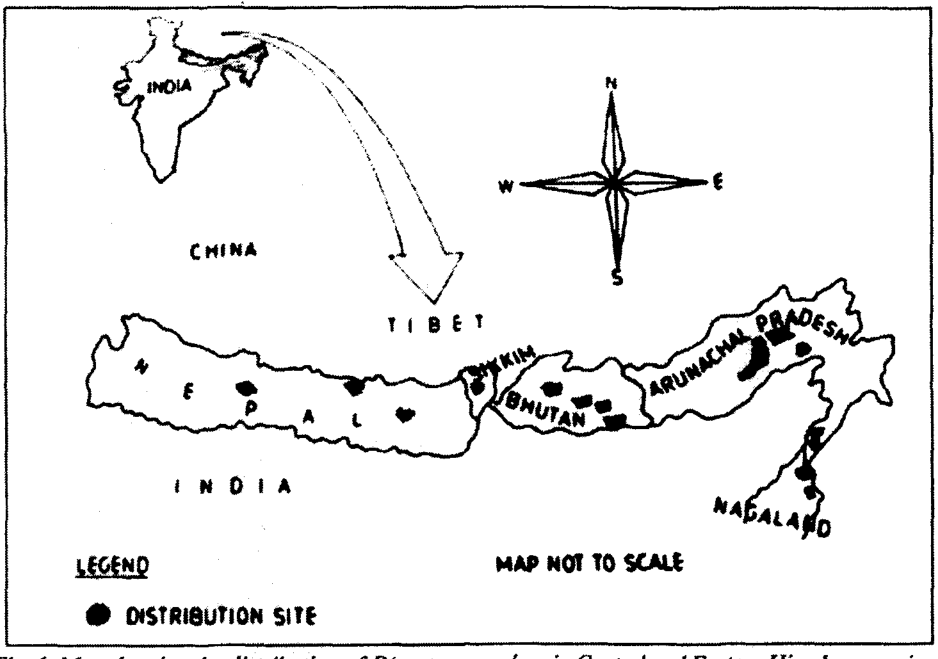


Fig. 1. Map showing the distribution of *Dicentra scandens* in Central and Eastern Himalayan region.

*Department of Chemistry, North Eastern Hill University, Shillong (Meghalaya).

The extract of the plant preparation from the leaves and root tubers is reported to have been used by certain tribal communities of the Nagas of Nagaland as an effective remedy for variety of diseases like fevers, high blood pressure, gastrointestinal disorders, etc. In addition, the bruised leaf paste is applied on cut and injury to control bleeding and wound healing. The paste from crushed root tuber is also applied to relieve against tooth ache (Pfoze and Chiezou, 2006). Paste of fresh tuber is applied in snake bite; the powder made from dried tubers is taken in case of gastric problem by certain tribal people of Arunachal Pradesh (Hajra *et al.*, 1996). The decoction of rhizome is taken to treat diarrhoea (Purkayastha *et al.*, 2005). In Nepal, plant is fed to animals as an anthelmintic medicine; juice extract is given as remedy to treat fever, relieve indigestion and applied to healing wounds, culms are diuretic and used for dysentery. It is also used in religious ceremonies such as Shradda, that is, rituals and offering to the dead (Manandhar, 1993, 1995; and Manandhar and Manandhar, 2002). The boiled decoction of crushed root is given to stop excessive bleeding in females by Lepcha of Sikkim (Pradhan and Badola, 2008). However no experimental or clinical studies are available to support the pharmacological activities exhibited by this plant. Also very little is known about the chemical constituents of the plant belonging to this genus which require further investigation. Therefore the objective of the present investigation was designed to screen the phytochemical constituents of the various classes of plant secondary metabolites so as to validate and support the claimed of ethnomedicinal uses of this plant.

MATERIALS AND METHODS

Collection of Plant Material

The root tubers of *Dicentra scandens* (Fig. 2) were collected in the month of August, 2008 growing by the local people in Senapati district, Manipur. Samples of the plant were collected when they were at the flowering and fruit setting phenological stage and herbarium specimens were prepared. A voucher specimen of the plant has been deposited in the herbarium of the Department of Botany, North Eastern Hill University, Shillong (Collection No. 160 and accession No. NEHU 11,877).

Chemicals

The reagents and solvents used are of analytical grade purchased from Sd. Fine Chem-Lab., Mumbai and CDH, New Delhi, India.

Preparation of Plant Extract

The root tubers and leaves of the plant were washed thoroughly in running tape water. The tubers are then cut into thin slices and the two are dried in the oven at temperature 35°C for 48 hours. The well dried plant material is then ground into fine powder using grinder. About 15 gms each of the powder plant sample was extracted in 150 ml in three different solvents viz. methanol, ethyl acetate and n-hexane in 250 ml conical flasks with stirring at interval for 24 hours. The extract is filtered using Whatman No.42 filter paper. 25 ml filtrate of each solvent was kept separately for testing flavonoids, steroids and

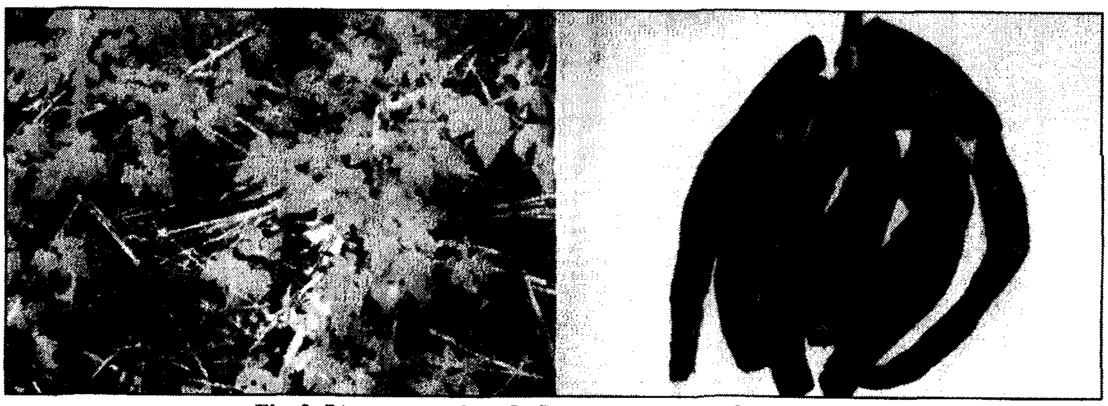


Fig. 2. *Dicentra scandens* (D. Don) Walp. plant and root tubers.

terpenoids. The remaining portion of the filtrate was concentrated to 1/10th volume at 40°C in a Buchi rotary vacuum evaporator. The concentrated extract is then transfer to a petri dish and dried in the oven at 30°C for overnight. The dried extract obtained from the filtrate is collected and then subjected to qualitative test for the presence of other groups of plant secondary metabolites like alkaloids,saponins, tannins and cardiac glycosides.

Phytochemical Screening

Screening of the presence of major constituents of the plant secondary metabolites was undertaken in both the tuber and leaf extracts following the standard qualitative detection methods. The test for flavonoids was carried out by adding a few drops of concentrated HCl and Mg ribbon. Alkaloid was detected using alkaloidal precipitating reagents such as Mayer's and Dragendorff's in the extracts of both fresh and dried plant material. Frothing in aqueous solution was performed for testing saponin. 5% $FeCl_3$ reagent was used for detection of tannins. The presence of steroids was detected following Liebermann-Buchard reaction test. Keller-Kiliani test was adopted for testing the presence of cardiac glycosides in the crude extract. Salkowski test was used for the detection of terpenoids.

RESULTS AND DISCUSSION

The result of the preliminary phytochemical screening from the root tuber and leaf (Tables -1 and 2) of the crude extract of three different solvents showed the presence of alkaloids, tannins, steroids, cardiac glycosides and terpenoids. Flavonoids and saponins were not detected in all the three solvent extracts. Quantitative assessment of the different classes of compounds present was graded as +ve to ++++ve.

Modern scientific evaluation of medicinal plants and herbs is mainly concerned with validating the traditional use of plants and identifying the active components of extracts and preparation (Palombo, 2006). Screening of plant extracts against pharmacological activity has resulted in identification of a large number of plant secondary metabolites such as phenolics and polyphenols, alkaloids, terpenoids, essential oils, etc. exhibiting such activity.

From Tables -1and 2, it is observed that alkaloid (++++ve and +++ve) is present in large amount in the root tuber and leaf extracts of this plant. The alkaloids sanguinarine, berberine and palmatine are known to occur in the genus *Dicentra* of the family Fumariaceae (Schmeller *et al.*, 1997). The antimicrobial properties of alkaloids have been well established. Berberine, a quaternary alkaloid for instant inhibits the growth of many microorganisms including fungi, protozoa and bacteria (Amin *et al.*, 1969; Hahn and Ciak, 1976) and is also potentially effective against plasmodia (Omulokoli *et al.*, 1997). Studies further suggest that this substance have shown fever reducing and hypotensive causing a reduction in blood pressure (Arayne *et al.*, 2007). Although not presence in significant amount however both tannins and terpenoids are detected in the methanolic extract. Tannins have been traditionally used for a wide range

Table -1: Phytochemical screening of *Dicentra scandens* root tuber extracts

Secondary metabolites	Methanol extract	Ethyl acetate extract	n-Hexane extract
Flavonoids	–	–	–
Alkaloids	++++	++	++
Saponins	–	–	–
Tannins	+	–	–
Steroids	–	+	+
Cardiac glycosides	+++	++	–
Terpenoids	++	+	–

Table -2: Phytochemical screening of *Dicentra scandens* leaf extracts

Secondary metabolites	Methanol extract	Ethyl acetate extract	n-Hexane extract
Flavonoids	–	–	–
Alkaloids	+++	++	–
Saponins	–	–	–
Tannins	++	–	–
Steroids	–	–	++
Cardiac glycosides	++	+	–
Terpenoids	+	+	–

Key: absence, + presence, ++ fairly good amount, +++ good amount, ++++ large amount of anti-infective actions. They are known to exhibits the properties of antidiarrhoe, antihaemorrhagic and wound healing activities (Asquith and Butler, 1986; Ogunleye and Ibitoye, 2003). Further terpenes or terpenoids are active against bacteria (Barre *et al.*, 1997; Habtemariam *et al.*, 1993; Scortichini and Pia Rossi, 1991). Therefore the traditional used of this plant against gastrointestinal disorders such as diarrhoea and dysentery, fever, tooth ache and wound healing may be attributed mainly due to the presence of these three classes of plant secondary metabolites. Cardiac glycosides content is also found high in both the root and leaf (+++ve and ++ve) in the methanol extract. Cardiac glycosides have been used for over two centuries as stimulants in cases of cardiac failure (Trease and Evans, 1978; Olayinki *et al.*, 1992). Moreover alkaloids are also known to possess antihypertensive properties Verpoorte (1998). This perhaps could probably support and justify the information about the traditional use of this plant in the treatment and management of hypertension by the tribal communities of this region.

REFERENCES

Amin, A.H.; Subbaiah, T.V. and Abbasi, K.M. (1969). Berberine sulphate: antimicrobial activity, bioassay and mode of action. *Can. J. Microbiol*, **15**: 1067-1076.

Arayne, M.S.; Sultana, N. and Bahadur, S.S. (2007).The Berberis story: *Berberis vulgaris* in therapeutics. *Pakistan Journal of Pharmaceutical Science*, **20**(1): 83-92.

Asquith, T.N. and Butler, L.G. (1986). Interaction of condensed tannins with selected proteins. *Phytochemistry*, **25**(7): 1591-1593.

Barre, J.T.; Bowden, F.B.; Coll, J.C.; Jesus, J.; Fuente, V.E.; Janairo, G.C. and Ragasa, C.Y. (1997). A bioactive triterpene from *Lantana camara*. *Phytochemistry*, **45**: 321-324.

Grierson, A.J.C. and Long, D.G. (1984). *Flora of Bhutan Including a Record of Plants from Sikkim*, Royal Botanic Garden, Edinburgh, **1**(2): 382-383.

Habtemariam, S.; Gray, A.I. and Waterman, P.G. (1993). A new antibacterial sesquiterpene from *Prema oligotricha*. *Journal of Natural Products*, **56**: 140-143.

Hahn, F.E. and Ciak, J. (1976). Berberine. *Antibiotics*, **3**: 577-584.

Hajra, P.K.; Verma, D.M. and Giri, G.S. (1996). *Materials for the Flora of Arunachal Pradesh*, Botanical Survey of India, Calcutta, **1**: 124-126.

Manandhar, N.P. (1993). Ethnobotanical note on folklore-remedies of Baglung district, Nepal. *Contribution to Nepalese Studies Journal*, **20**(2): 183.

Manandhar, N.P. (1995). An inventory of some herbal drugs of Myagdi district, Nepal. *Economic Botany*, **49**(4): 371-379.

Manandhar, N.P. and Manandhar, S. (2002). *Plants and People of Nepal*, Timber Press, Inc. Portland, USA, 198.

Ogunleye, D.S. and Ibitoye, S.F. (2003). Studies of antimicrobial activity and chemical constituents of *Ximenia Americana*. *Tropical Journal of Pharmaceutical Research*, **2**(2): 239-241.

Olayinki, A.O.; Onuruvwe, O. and Lot, T.Y. (1992). Cardiovascular effects of the methanolic extract of the stem bark of *Khaya sengaensis*. *Phytotherapy Research*, **6**(5): 282-284.

Omulokoli, E.; Khan, B. and Chhabra, S.C. (1997). Antiplasmodial activity of four Kenyan medicinal plants. *Journal of Ethnopharmacology*, **56**: 133-137.

Palombo, E. A. (2006). Phytochemicals from traditional medicinal plants used in the treatment of diarrhoea: modes of action and effects on intestinal function. *Phytotherapy Research*, **20**: 717-724.

Pfoze, N.L. and Chiezou, D.N. (2006). *Dicentra scandens* (D. Don) Walp. A highly potent ethnomedicinal plant against, malaria, high blood pressure and diabetes. *Indian Journal of Traditional Knowledge*, **52**(2): 268-270.

Pradhan, B.K. and Badola, H.K. (2008). Ethnomedicinal plant use by Lepcha tribe of Dzongu valley, bordering Khangchendzonga biosphere reserve, in North Sikkim, India. *Journal of Ethnobiology and Ethnomedicine*, **4**(22): 1-18.

Purkayastha, J.; Subhan, C.N. and Islam, M. (2005). Ethnobotany of medicinal plants from Dibru-Saikhowa biosphere reserve of Northeast India. *Fitoterapia*, **76**(1): 121-127.

Schmeller, T.; Latz Bruning, B. and Wink, M. (1997). Biochemical activities of berberine, palmatine and sanguinarine mediating chemical defence against microorganisms and herbivores. *Phytochemistry*, **44**(2): 257-266.

Scortichini, M. and Pia Rossi, M. (1991). Preliminary *in vitro* evaluation of the antimicrobial activity of terpenes and terpenoids toward *Erwinia amylovora* (Burrill) Winslow *et al. Journal of Applied Bacteriology*, **71**: 109-112.

Trease, G.E. and Evans, W.C. (1978). *Pharmacology* 11th ed. Braillieriere Tindall Ltd., London, 60-75.

Verpoorte, R. (1998). Antimicrobially active alkaloids in *Alkaloids: Biochemistry, Ecology and Medicinal Applications*, edited by MF Roberts and M Wink, Plenum press, New York, 397-426.

Journal of Medicinal Plants Research Vol. 5(5), pp. 859-861, 4 March, 2011
Available online at http://www.academicjournals.org/JMPR
ISSN 1996-0875 ©2011 Academic Journals

Short Communication

In vitro antibacterial activity of alkaloid extract from stem bark of *Mahonia manipurensis* Takeda

Neli Lokho Pfoze[1]*, Yogendra Kumar[1], Berington Myrboh[2], Ranjan Kumar Bhagobaty[3] and Santa Ram Joshi[3]

[1]Department of Botany, NEHU, Shillong-793022, Meghalaya, India.
[2]Department of chemistry, NEHU, Shillong-793022, Meghalaya, India.
[3]Department of Biotechnology and Bioinformatics, Microbiology Laboratory, NEHU, Shillong-793022, Meghalaya, India.

Accepted 21 January, 2011

The genus *Mahonia* belongs to one of the primitive groups of plant family Berberidaceae. A number of species from this genus are widely used in traditional and folk medicine systems in different parts of the world. *Mahonia manipurensis* crude alkaloid extract was obtained from the stem bark by extracting from 80% of methanol extract. *In vitro* antibacterial activity of the alkaloid extract was screened against five different pathogenic bacteria of clinical origin including two species of gram-negative and three species of gram-positive bacteria. Using agar well diffusion method, growth inhibition was observed in four of the five tested pathogens at two different concentrations (5 and 2.5 mg/ml). The result indicates that the alkaloid extract exhibited significant antibacterial activity. Similar antimicrobial activity was also reported from other species of this genus by previous workers. Minimum inhibitory concentration (MIC) was also determined using agar dilution method, following two-fold serial dilution and observed that the lowest value was exhibited by *Bacillus cereus* and *Enterococcus faecalis* each corresponding to 256 µg/ml concentration.

Key words: *Mahonia manipurensis*, antibacterial activity, alkaloid extract, Minimum inhibitory concentration.

INTRODUCTION

Mahonia manipurensis Takeda belongs to the family Berberidaceae. The plant is endemic to the Northeastern region of India in the states of Manipur and Nagaland. Although there is merger report about the local used of this plant against diarrhoea, fever and jaundice, however, a number of species of this genus are widely used as folk medicine in different parts of the world. For instance the dried stems of *Mahonia bealei* and *Mahonia fortuner* are commonly used in traditional Chinese medicine against fever, swelling, inflammation, jaundice, dysentery and constipation (Pharmacopoeia Committee, 1990). Extract from the stem of *Mahonia acanthifolia* is given against dysentery, diarrhoea and jaundice by traditional practitioners in Darjeeling Himalaya (Pranay and Ritu, 2009). Alkaloids are the main active compounds in *Mahonia* plants (Ji et al., 2000). Berberine, palmatine and jatrorrhizine are the principal alkaloids found in this genus and these compounds are known to have *in vitro* antibacterial and antifungal activities (Schiff, 1987). Considering the important applications of some plant species belonging to this genus in folk and traditional medicine systems, the present study was designed to investigate the antibacterial properties of *M. manipurensis* Takeda against certain pathogenic bacterial strains of clinical origin.

*Corresponding author. E-mail: nelilokho@yahoo.com. Tel: 09612305215.

MATERIALS AND METHODS

Plant material collection and identification

The stem bark of *M. manipurensis* and herbarium specimens were collected from Mao area, Senapati District, Manipur in the month of April-2009, identified from Flora of Manipur 1: 410-411, 1993 and verified from Kew Herbarium, Edinburgh 6: 222. 1917. A voucher specimen (Collection No. 188) was prepared from the collected plant and deposited in the herbarium of the Department of Botany, NEHU, Shillong, India.

Detection of alkaloid

The presence of alkaloid in plant sample (stem bark) was detected following the standard qualitative detection methods as described by Culvenor and Fitzgerald (1963) and Kapoor et al. (1969) using alkaloidal precipitating reagents such as Mayer's, Dragendorff's and Silicotungstic acid.

Extraction of alkaloids

The plant stem bark was removed, dried in oven at 35°C for overnight and ground into fine powder using grinder. About 100 g of the powder plant sample was extracted with 800 ml of 80% methanol in 1.5 L beaker with stirring at interval in room temperature for 36 h. The extract is filtered using Whatman No. 42 filter paper. The filtrate was then concentrated to 1/10th of the original volume in a Buchi rotavapor under reduced pressure at 40°C. The concentrated extract was then used for extraction of alkaloid following Harborne principle (1998) and yielded 1.12 g crude alkaloid extracts corresponding to 1.12% in terms of dry weight starting materials. The alkaloid extract thus obtained is stored at 4°C until further use.

Preparation of test extracts

About 25 mg of alkaloid extract is dissolved in 5 ml of 10% DMSO (% v/v) solution and filtered through 0.22 µm nylon-66 membrane filter (Axiva). 1 ml of this solution which corresponds to 5 mg/ml concentration is diluted with 1 ml of autoclaved sterile distilled water to make another solution of 2.5 mg/ml concentration. The two different concentrations of the solution thus prepared freshly are used to test for antibacterial activity.

Experimental microorganisms

Five different pathogenic bacterial strains were obtained from Institute of Microbial Technology, Chandigarh, India. Three Gram-positive (*Bacillus cereus* MTCC 430, *Enterococus faecalis* MTCC 439 and *Enterobacter cloacae* MTCC 7408), two Gram-negative (*Eschrerichia coli* MTCC 116 and *Shigella flexneri* MTCC 1457) bacteria were used for the study.

Chemicals and culture media for antibacterial assay

The culture media Mueller Hinton Agar (MHA), Mueller Hinton Broth (MHB) and Nutrient Agar (NA) are used for evaluating the antimicrobial activity of the alkaloid extract. These culture media are obtained from Himedia (MHA) and SRL (MHB and NA), Mumbia, India. The standard antibiotics disc Streptomycin 25 mcg (Himedia) was used as positive control against tested bacterial strains. All other reagents and solvents used are of analytical grade purchased from Sd. Fine Chem. Mumbia and CDH, New Delhi, India.

Susceptibility test method

Standardisation of bacterial suspension

A cell suspension of about 1.5 x 10^6 CFU/ml was obtained from a McFarland 0.5 $BaSO_4$ turbidity standard. The cell suspension was standardised by adjusting the optical density (OD) to 0.11 at 625 nm using Lambda-35 UV-VIS Spectrophotometer. 1 ml of this standardised cell suspension culture (within 30 min) was then used to inoculate by spreading the surface of overnight prepared NA plates and incubated at 37°C (MHA and at 30°C for *E. cloacae*) for 24 h.

Agar well diffusion assay

The antibacterial diffusion assay was carried out using Agar well diffusion method as described by Perez et al. (1990) and Ahmad et al. (1998). One Streptomycin antibiotic drug standard disc (Himedia) of concentration 25 mcg was placed in the centre of each plate as positive control. The assessment of antibacterial activity of the plant alkaloid extract was based on the measurement of diameter of inhibition zone (IZ) in mm formed around the well.

Each well was loaded alternately with 100 µl one with 5 mg/ml and the other with 2.5 mg/ml concentration. The assay was carried out in triplicates and the result thus obtained is taken as the mean of the three readings (Table 1) for each concentration and not statistical tools were used to measure the standard deviation.

Minimum inhibitory concentration

Minimum inhibitory concentration (MIC) was carried out using Agar dilution assay (Irith et al., 2008) following the twofold serial dilution. Concentrations of 2.48, 1.24, 0.512, 0.256 and 0.128 mg/ml of the crude alkaloid extract were prepared separately by dissolving the sample in 10% DMSO (v/v) autoclaved distilled water and filter sterilized through 0.22 µm nylon-66 membrane filter. The MIC was recorded as lowest concentration of the alkaloid extract showing no visible growth of the test bacterial strains on the agar plate after 24 h incubation.

RESULTS

The total alkaloid extract showed significant zone of inhibition against Gram-positive bacteria *B. cereus, E. cloacae and E. faecalis* and one Gram-negative bacterium *S. flexneri* (Table 1). The other Gram-negative bacterium *Escherichia coli* were not observed inhibition at these two different concentrations (5 and 2.5 mg/ml). Also observation of the result from the table indicates that there is not significant variation of the inhibition zone for all the four bacteria which are tested with positive inhibitions. The solvent 10% aqueous DMSO (% v/v) used for dissolving the alkaloid extract always gave negative inhibition showing that it did not influence the antibacterial activities observed for the test sample of the plant extract. Further MIC was determined again all the four bacterial strains that showed positive inhibition and found that the lowest value was exhibited by *B. cereus* and *E. faecalis* each corresponding to 256 µg/ml concentration.

DISCUSSION

The alkaloids are known to have antimicrobial and antiparasitic properties. Verpoorte (1998) have reported

Table 1. Antibacterial activity of alkaloids extract from *M. manipurensis* stem bark.

Bacterial strains	Concentration (mg/ml)	Diameter zone of inhibition (mm)				With Streptomycin standard (mm)	MIC in μg
		R_1	R_2	R_3	Mean		
B. cereus MTCC 430	5	18.5	19	19	18.8		
	2.5	15	14.5	15	14.8	25	256
E. coli MTCC 116	5	NI	NI	NI	NI		
	2.5	NI	NI	NI	NI	16.5	O
E. cloacae MTCC7408	5	18	18	18	18		
	2.5	15	15	14.5	14.8	24.5	512
E. faecalis MTCC 439	5	19	19	19.5	19.2		
	2.5	15	15	15	15	28	256
S. flexneri MTCC 1457	5	19.5	20	20	19.8		
	2.5	16	16	16	16	27	512

NI = No inhibition, NO = No observed and R = reading.

about 300 alkaloids showing such activity. Similar results on antibacterial activity were reported on related species of the genus *Mahonia* by Duraiswamy et al. (2006), Livia et al. (2004) and Li et al. (2007). Generally, the plant extracts inhibited the Gram-positive bacteria better than the Gram-negative ones. This is in agreement with reports on plant extracts by Tomas-Barberan et al. (1988), Vlietinck et al. (1995), Rabe and Van Staden (1997). The reason could be attributed to the presence of extra outer membrane in their cell wall acting as barrier for the compound(s) to diffuse into the bacterial cells. The alkaloids sanguinarine, berberine, jatrorrhizine and palmatine are known to inhibit the multiplication of bacteria, fungi and viruses (Schiff, 1987; Schmeller et al., 1997). Therefore the antibacterial activity observed in the present investigation is attributed to the alkaloids berberine, palmatine and jatrorrhizine which have been widely known to occur in different species of this genus.

REFERENCES

Ahmad I, Mahmood Z, Mohammad F (1998). Screening of some Indian medicinal plants for their antimicrobial properties. J. Ethnopharmacol., 62: 183-193.

Culvenor CCJ, Fitzgerald SJ (1963). A field method for alkaloid screening of plants. J. Pharmaceut. Sci., 53: 303-304.

Duraiswamy B, Sagar KM, Subhashini V, Dhanraj SA, Suresh B (2006). Studies on the antimicrobial potential of *Mahonia leschenaultia* Takeda root and root bark. Ind. J. Pharmaceut. Sci., 68(3): 389-391.

Harborne JB (1998). Phytochemical methods: A guide to modern techniques of plant analysis, 3rd edn. Chapman and Hall publishers, London, U.K.

Irith W, Kai H, Robert EWH (2008). Agar and broth dilution methods to determine the minimal inhibitory concentration (MIC) of antimicrobial substances. Nat. Protoc., 3(2): 163-175.

Kapoor LD, Singh A, Kapoor SL, Srivastava SN (1969). Survey of Indian plants for saponins, alkaloids and flavonoids I. Lloydia, 32: 297-304.

Li A, Zhu Y, Li X, Tian X (2007). Antimicrobial activity of four species of Berberidaceae. Fitoterapia, 78: 379–381.

Livia S, Daniela K, Darina L, Daniela K, Viktor K (2004). Antimicrobial activity of *Mahonia aquifolium* crude extract and its major isolated alkaloids. Phytoth. Res., 18: 674-676.

Perez C, Pauli M, Bazerque P (1990). An antibiotic assay by the well agar method. Acta Biologiae et Medicine Experimentalis. 15: 113-115.

Pharmacopoeia Committee (Editor) (1990). Pharmacopoeia of People Republic of China,Guangdong Science and Technology Press, Guangzhou, 68: 7.

Pranay B, Ritu R (2009). Studies on ethnobotanical plants used by traditional practitioners, Jhankri, Bijuwa and Phedangma in Darjeeling Himalaya. Nat. Prod. Rad., 8(5): 537-541.

Rabe T, Van Staden J (1997). Antibacterial activity of South African plants used for medicinal purposes. J. Ethnopharmacol., 56: 81–87.

Schiff PL (1987). Alkaloids: Chemical and Biological Perspectives (Pelletier SW ed.) vol. 5, Wiley, New York.

Schmeller T, Latz Brunin B, Wink M (1997). Biochemical activities of berberine, palmatine and sanguinarine mediating chemical defence against microorganisms and herbivores. Phytochem., 44: 257-266.

Tomas-Barberan FA, Msonthi JD, Hostettman NK (1988). Antifungal epicuticular methylated flavonoids from three Spanish *Helichrysum* species. Phytochem., 27: 753–755.

Verpoorte R (1998). Antimicrobially active alkaloids in Alkaloids: biochemistry, ecology and medicinal applications, ed. Margaret F. Robert and Michael Wink, Springer publication. pp. 397-426.

Vlietinck AJ, Van Hoof L, Totte'J, Lasure A, Vanden Berghe D, Rwangabo PC, Mvukiyumwami J (1995). Screening of hundred Rwandese medicinal plants for antimicrobial and antiviral properties. J. Ethnopharmacol., 46: 31–47.

Ji X, Li Y, Liu H, Yan Y, Li J (2000). Determination of the alkaloid content in different parts of some *Mahonia* plants by HPCE. Pharmaceut. Acta Helv., 74: 387–391.

INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 1, No. 6, p. 50-62, 2011
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Survey and assessment of floral diversity on wild edible plants from Senapati district of Manipur, Northeast India

Neli Lokho Pfoze[1*], Yogendra Kumar[1], Bekington Myrboh[2]

[1]*Department of Botany, North Eastern Hill University, Shillong-793022, Meghalaya, India*

[2]*Department of chemistry, North Eastern Hill University, Shillong-793022, Meghalaya, India*

Received: 10 October 2011
Revised: 27 October 2011
Accepted: 29 October 2011

Key words: Floral diversity, wild edible plants and fruits, Nagas and Kukis, indigenous communities, informants, Senapati district.

Abstract

The floristic composition of the state Manipur falls under the Indo-Malayan type ranges from tropical to sub-tropical and temperate deciduous forests. It has rich floral diversity as well as high degree of endemism including a number of valuable medicinal plants. The Nagas and Kukis are the dominant hill tribal communities living in Senapati district. These two communities possessed rich valuable reservoirs of traditional knowledge on plant uses. A wide range of wild plant species are used by both the communities as vegetable food and edible fruit during the growing seasons. The present investigation recorded 89 different species of edible plants and fruits including 3 different species of edible mushroom belonging to 56 families and 75 genera from the district. Of these 23 species (42.59%) of edible plants and 10 species (28.57%) of edible fruits is a new record which has not been reported earlier from the state. A fairly good number of these plants, about 23 species (25.84%) are also used as medicinal food remedy by the local people in the study areas. Further, assessment of overall local availability status of 22 different selected species of edible plants and fruits showed that 12 species (54.55%) are graded to the category of not so common, follow by common and rare or scanty category with 4 species each. Thus, the study provides new records of the edibility of some wild plants into the state ethnobotanical database, assists in understanding the dependency of local community and the role of wild edible plants in the local economy and also provides preliminary information about the local availability status of some selected plants in the study area and the needs for conservation if any of those species.

*Corresponding Author: Neli Lokho Pfoze ✉ nelilokho@yahoo.com

Introduction

The use of wild plants as food has been formed an integral part of the culture and tradition of many indigenous communities of the world. It constitutes an essential component in the diet and food security of many tribal communities particularly people living around the forest fringe or in its vicinity. They collect and consumed a wide variety of wild plant leaves and other plant parts as well as edible mushrooms for sustenance their livelihood. Of the Earth's half million plant species, about 3000 species have been used as agricultural crops and of this only 150 species have been cultivated on a large scale (Mohammed *et al.*, 2008). Also more than 85-90% of world's caloric intake is contributed by 12 crops (Misra *et al.*, 2008). However, of late there has been a renewed and increasing interest in studying the consumption of wild food plants and its importance to conservation and development for sustainable use and management. Millions of people in many developing countries still depend on wild plant resources to meet their food requirements especially during food crisis (FAO, 2004; Balemie and Kebebew, 2006) and plays a vital role in the diets security of many rural communities. Even in our country India, a considerable proportion of rural population and those people living in remote areas do not produce enough food grains to meet yearly food requirement. Therefore, a large share of rural population is meeting their nutritional requirement through unconventional means, by consuming various wild plants and animal resources (Singh and Arora, 1978).

Fig.1. *Emblica officinalis* in fruiting stage Gartn.

Fig.2. *Prunus nepalensis* (Ser.) Steud. fruit in Senapati market.

Fig. 3. *Lentinula edodes* (Berk.)Pegler in Kangpokpi market.

Fig.4. Vegetable sellers in Senapati market.

			colebrookianum Walp.			MPK			Eaten as cooked vegetable	
Letikorei	NR	NR	*Crawfurdia fasciculata* Wall.	Gentianaceae	Climber	173-M	January-April	Leaves and flowers	Cook along with rice and eaten	*
Kodziiapa	Kuturapa	NR	*Curcuma angustifolia* Roxb.	Zingiberaceae	Herb	170-MPK	April-May	Inflorescences	Eaten as cook vegetable	
Kophrehro	NR	NR	*Dioscorea pentaphylla* Linn.	Dioscoreaceae	Climber	026-M	August-November	Bulbils	Roasted bulbils is taken	*
Pfochouchojii	Machuovu	Gamchekoh	*Diplazium esculentum* (Retz.) Sw.	Athyriaceae	Herb	106-MPK	Almost round the year	Leaves	Eaten as cook vegetable	
Edeio	Dai-vu	Solunche	*Elatostema lineolatum* Wight	Urticaceae	Herb	140-MPK	June-October	Leaves	Eaten as cook vegetable	
Burmadonia	Padaiku	NR	*Eryngium foetidum* Linn.	Apiaceae	Herb	192-MPK	June-September	Whole plant	Added to meat curry to give more flavour and test. Also used for making chutney	
Moriisii	NR	Shizou	*Eurya acuminate* DC.	Theaceae	Small tree	106-MK	August-November	Leaves	Eaten as cook vegetable	
Rapro	Raprou	NR	*Globba clarkei* Baker.	Zingiberaceae	Herb	16-MP	July-October	Tender shoot	Eaten as cook vegetable or boiled with rice and eaten	*
Shekra bu	NR	NR	*Hedychium coronarium* Koening	Zingiberaceae	Herb	189-MPK	July-October	Tender shoot	Tender shoot eaten as cook vegetable	
Eshakama	Tuningko	Aithanglou	*Houttuynia cordata* Thumb.	Saururaceae	Herb	035-MPK	July-October	Whole plant	Eaten as cooked vegetable or used for making chutney	
Eshou-vu	Shou-vu	NR	*Impatiens annulifera* Linn.	Balsaminaceae	Herb	018-MP	July-September	Leaves	Boiled with rice and eaten as food	*
Papinii	Veipa	Cipa	*Lentinula edodes* (Berk.) Pegler	Polyporaceae	Saprophyte	141-MPK	February-April	Whole plant	Whole plant body, fresh or dried form is taken as vegetable food	
Shingainisii	NR	Thing-Thing	*Litsea citrata* Bl.	Lauraceae	Tree	064-MPK	November-June	Fruit	Roasted fruits are use in making chutney	Yes
Kohra-o	Hra-vu	NR	*Maesa chisia* (non D. Don) Clarke	Myrsinaceae	Shrub	183-MP	June-October	Tender leaves	Tender leaves is boiled with rice and taken	*
Heimio	Levuyemarai	Anthrulhem	*Momordica dioica* Roxb. ex Willd.	Cucurbitaceae	Climber	024-M	June-September	Tender leaves	Tender fruits and leaves is boiled with rice and taken	*
Huhreshiibu	NR	Thingteimi	*Morus alba* Linn.	Moraceae	Small tree	040-M	March-July	Tender leaves	Leaves are eaten as boiled vegetable	*
Ovii	Vii	Changlou	*Musa sapientum* Linn.	Musaceae	Herb	136-MPK		Tender shoot and pseudostem	Boiled and eaten as vegetable and also use in making chutney	
NR	Thrai-vu	Andum	*Oenanthe javanica* (Blume) DC.	Umbelliferae	Herb	142-PK	July-October	Whole plant	Fresh plant is chops into pieces for making Sinju with chilli powder	
Ekhrou	Tru-vu	Andum	*Oenanthe stolonifera* Wall.	Umbelliferae	Herb	009-MP	July-September	Whole plant	Boiled and eaten as vegetable	Yes
Katheimeidokre	Phasii	Bahlong	*Oroxylum indicum* (Linn.) Vent.	Bignoniaceae	Tree	066-K	June-January	Tender pods	Slices into pieces for making chutney	Yes

Pighiirai/Borei	Shiveirei	Guidup	*Paederia foetida* Linn.	Rubiaceae	Climber	154-MPK	June-October	Leaves	Eaten as cooked vegetable	Yes/*
Totsiipa	Heyavu	Kolhou	*Phlogacanthus curviflorus* Nees.	Acanthaceae	Shrub	056-MPK	February-May	Flowers	Boiled with rice and eaten as cooked vegetable	Yes
Dziipao	Pah-vu	Vobilche	*Plantago erosa* Wall.	Plantaginaceae	Herb	137-MPK	June-September	Whole plant	Boiled and eaten as vegetable	
Phiziio	NR	NR	*Pogostemon elsholtzoides* Benth	Lamiaceae	Shrub	185-MP	November-February	Tender leaves	Boiled with rice and eaten as cooked vegetable	*
Obiovu	Bai-vu	Theidon	*Polygonum chinense* Linn.	Polygonaceae	Herb	178-MPK	July-October	Tender shoot and leaves	Boiled with rice and eaten as cooked vegetable	
Evau	Vah-vu	Anbongalenpa	*Polygonum molle* D. Don	Polygonaceae	Herb	151-MPK	August-February	Tender shoot and leaves	Boiled along with dried meat or fish and taken	
NR	NR	Lingthuh	*Polygonum perfoliatum* Linn.	Polygonaceae	Climber	170-K	June-November	Leaves	Boiled with rice and eaten as cooked vegetable	*
Nobito	Houpei-vu	NR	*Polygonum runcinatum* Ham.	Polygonaceae	Herb	182-MP	June-September	Leaves	Boiled along with dried meat or fish and taken	*
Othukoshi	NR	NR	*Ranunculus sceleratus* Linn.	Ranunculaceae	Herb	006-M	April-October	Root stock	Boiled with rice and eaten as cooked vegetable	Yes/*
Lidainipa	Daipa	Ngeisoh	*Rhododendron arboreum* Sm. Clarke	Ericaceae	Tree	044-MP	March-June	Flowers	Flower petals are eaten raw	Yes
Emoshi	Moushi	Khongma	*Rhus semialata* Murry. DC.	Anacardiaceae	Small tree	023-K	August-December	Tender leaves	Boiled with rice and eaten as cooked vegetable	Yes/*
Kosabio	Theshuvi	Chenkup	*Rhynchotechum ellipticum* (Wall. ex Dietr.) DC.	Gesneriaceae	Herb	175-MPK	June-September	Leaves	Boiled with rice and eaten as cooked vegetable	
Zhokhaikhaima	Khaimasii	Khengthing	*Schima wallichii* (DC.) Korth.	Theaceae	Tree	174-K	February-April	Tender leaves	Boiled with rice and eaten as cooked vegetable	*
	Pa-nghii	Pashi	*Schizophyllum commune* Fr.	Schizophyllaceae	Saprophyte	171-MPK	September-April	Whole plant	Boiled along with dried meat or fish and taken	
Khekhra	Roushu	Kangvah	*Smilax ovalifolia* Roxb.	Smilaxcaceae	Climber	108-MPK		Tender shoot	Half cooked and prepared chutney with dried fish	*
Chiivio	Kuvi-vu	Ansha	*Spilanthes paniculata* Wall. ex DC.	Compositae	Herb	007-MPK	June-October	Leaves	Eaten as cooked vegetable along with dried meat	Yes/*
Ohuphirapro	Humara-soupru	Anjou	*Solanum nigrum* Linn.	Solanaceae	Herb	027-MPK	August-December	Leaves	Eaten as boiled vegetable or along with rice and taken	
Ehiishikhokha	Rakhokha	Khamchok-raling	*Solanum torvum* Swartz.	Solanaceae	Shrub	156-MPK	May-October	Fruit	Roasted fruits are use for making chutney	
Eleo-vu	Loe-vu	Anthurul	*Trichodesma nudiflora* Hinse	Cucurbitaceae	Climber	017-MPK	July-September	Leave	Eaten as boiled vegetable or along with rice and taken as food	
Eveikoreio	NR	NR	*Viola distans* Wall.	Violaceae	Herb	002-M	March-July	Tender leaves	Boiled with rice and eaten as cooked vegetable	*
Houkhusii	NR	Ahthiphung	*Wendlandia glabra* DC	Rubiaceae	Small tree	114-MPK	February-April	Tender inflorescences	Cooked inflorescences is chopped into pieces for making chutney with dried fish	

Khemomou	Khaongashi	Lingnamse	*Zanthoxylum acanthopodium* DC.	Rutaceae	Shrub	116-MP	March-July	Tender leaves and fruit	Fresh or dried fruits are use for making chutney along with dried fish or meat. Leaves eaten as cooked vegetable along with rice	
Oramomoshi	NR	NR	*Zanthoxylum armatum*	Rutaceae	Shrub	123-MP	May-October	Fruit	Dried or powder fruits are used for making chutney with dried fish or meat	Yes

Table 2. List of wild edible fruit plants reported by the Nagas and Kukis from Senapati district of Manipur.

Naga		Kuki	Botanical name	Family	Habit	Voucher No.	Phenology and fruiting period	Nature of use	Locally used as medicine (Yes/No)
Mao	Poumei								
Leribu	Reivii	Aigeju	*Amomum dealbatum* Roxb	Zingiberaceae	Herb	180-MPK	May-September	Eaten raw	
NR	NR	Heipan	*Baccaurea sapida* (Roxb.) Muell.-Arg.	Euphorbiaceae	Tree	199-K	April-July	Ripe fruit eaten raw	
Kohre-hrechu	NR	Buhtomkolkai	*Bryonopsis heterophylla* (Lour.) Cogn.	Cucurbitaceae	Climber	039-MK	May-September	Ripe fruit eaten raw	*
Okhrashi	Khrashi	Ting-ga	*Calamus floribundus* Griff.	Arecaceae	Shrub	115-MPK	August-March	Ripe fruit eaten raw	
Thadziisii	Mabashi	Sega	*Castanopsis hystrix* A. DC.	Fagaceae	Tree	150-MP	June-November	Nut is roasted and eaten	
Madeilo	Kowlousii	Lingsi	*Debregeasia longifolia* (Burm.f.) Wedd.	Urticaceae	Small tree	102-M	June-October	Ripe fruit eaten raw	Yes/*
Shiteishi	Siiteishi	NR	*Diospyros lanceoefolia* Roxb.	Ebenaceae	Tree	147-MP	June-December	Ripe fruit eaten raw	
Khradashi	Khradashi	Theipan	*Diospyros kaki* Linn.	Ebenaceae	Tree	121-MP	April-November	Ripe fruit eaten raw	*
Chipfoshi	Phoshi	Theithup	*Docynia indica* Dcne.	Rosaceae	Tree	135-MPK	March-November	Ripe fruit eaten raw and for making pickles	
Likhodaphrushi	NR	NR	*Duchesnea indica* (And.) Focke	Rosaceae	Creeper	169-MP	April-September	Ripe fruit eaten raw	
Shikeshi	Kieshi	Zonmot	*Elaeocarpus floribundus* Bl.	Elaeocarpaceae	Tree	073-MPK	March-December	Ripe fruit eaten raw	Yes
Chishoshikajii	Shoushi-ajii	Buiehthei	*Elaeagnus latifolia* Linn.	Elaeagnaceae	Shrub	193-MPK	April-September	Ripe fruit eaten raw	
Chishoshikati	Shoushi	Buiehthei	*Elaeagnus pyriformis* Hk. f.	Elaeagnaceae	Shrub	177-MP	April-July	Ripe fruit eaten raw and for making jams	
Chohroshi	Rihaushi	Sohlu	*Emblica officinalis* Gartn.	Euphorbiaceae	Small tree	080-MPK	May-December	Fruit is eaten raw and for making jams or pickles	Yes
Chodoshi	Doshi	Theichang	*Ficus auriculata* Lour.	Moraceae	Tree	082-MPK	May-October	Ripe fruit eaten raw and making jams	
Ovachidoshi	Radoshi	NR	*Ficus hispida* Linn.	Moraceae	Tree	191-MP		Fruit is eaten raw	*
Moboshi	Maboushi	NR	*Ficus roxburghii* Wall.	Moraceae	Tree	181-MP	July-October	Ripe fruit eaten raw	
Likhodaphroshi	NR	NR	*Fragaria indica* Andr.	Rosaceae	Creeper	190-MP	April-August	Ripe fruit eaten raw	
Okhusii	Khushi	Makha	*Juglans regia* Linn.	Juglandaceae	Tree	162-MPK	May-November	Lobed cotyledons are eaten raw	Yes
Shilasii	Lashi	Theikhomchom	*Melia birmanica* Kurz.	Meliaceae	Tree	146-MPK	March-December	Ripe fruit eaten raw	*
Kheloshi	Makaloshi	Thingteimi	*Morus alba* Linn.	Moraceae	Small tree	040-M	March-July	Ripe fruit eaten raw	
Piyeh-shi	Zheashi	Makingat	*Myrica nagi* (Thunb.) Hook.	Myricaceae	Tree	077-MP	February-May	Ripe fruit eaten raw	Yes

Ovopishu	NR	NR	*Ophiopogon wallichianus* Hk. f.	Haemodoriaceae	Herb	124-M	May-September	Ripe fruit eaten raw	*
Chaghashi	Ghashi	Lusu	*Phoenix humilis* Royle.	Arecaceae	Shrub	163-MPK	July-November	Ripe fruit cotyledon is eaten raw	
Korelashii	Khaokhashi	Buhkol	*Physalis peruviane* Linn.	Solanaceae	Herb	041-MPK	April-October	Ripe fruit eaten raw	Yes/*
Mokhoshi	Ngourashi	NR	*Prunus cornuta* (Wallich ex Royle) Steud.	Rosaceae	Tree	149-MP	March-October	Ripe fruit eaten raw	*
Chitishi	Taoshi	Balthing	*Pyrus pashia* D. Don	Rosaceaae	Tree	25-MP	February-November	Ripe fruit eaten raw	
Pfovashi	Vashi	NR	*Prunus cerasoides* D. Don.	Rasaceae	Tree	185-MP	March-August	Ripe fruit eaten raw	
Mokhoshi	Khashi	NR	*Prunus nepaulensis* (Ser.) Steud.	Rosaceae	Tree	148-M	March-October	Ripe fruit eaten raw	
Mikriashi	Krishi	Vaisohlu	*Prunus persiaca* (Linn.)Batsch	Rosaceae	Small tree	049-MPK	February-August	Ripe fruit eaten raw	Yes
Omosii	Moushi	Khongma	*Rhus semialata* Murry. DC.	Anacardiaceae	Small tree	023-MPK	August-December	Ripe fruit boiled with sugar and drink as herbal tea	Yes
Shiinghoshi	Ngushi	Theimi	*Rubus ellipticus* Smith	Rosaceae	Shrub	034-MPK	February-May	Ripe fruit eaten raw	Yes
Shiingukateishi	Chomoushushi	Theimivom	*Rubus lasiocarpus* Smith.	Rosaceae	Shrub	033-MPK	May-September	Ripe fruit eaten raw	Yes
Shiinghokoghoshi	Kohamoushushi	Naichin	*Rubus rugosus* Smith	Rosaceae	Shrub	032-MPK	May-September	Ripe fruit eaten raw	*
Shikriishi	Khuashi	NR	*Viburnum foetidum* Wall.	Caprifoliaceae	Shrub	050-M	May-September	Ripe fruit eaten raw	*

N.B: NR = Not recorded due to lacks of authentic local name.

Table 3. Assessment of local availability status of selected wild edible plants according to informants or collectors perception.

Village	Name of the species selected										
	Centella asiatica Linn.	*Chimonobambusa callosa* (Munro) Nakai	*Curcuma angustifolia* Roxb.	*Elatostema sessile* Forst.	*Houttuynia cordata* Thumb.	*Impatiens annulifera* Linn.	*Musa sapientum* Linn.	*Oenanthe stolonifera* Wall.	*Rhychotechum ellipticum* (Wall. ex Dietr.) DC.	*Solanum torvum* Sw.	*Trichodesma nudiflora* Hinse
Changloubung	Co	Nr	Nc	Nr	Nc	Nr	Nc	Nc	Ra	Nc	Ra
Chowainu	Ab	Nr	Co	Nr	Co	Nc	Nc	Co	Nr	Nc	Nc
Emeifiithumei	Ab	Ab	Co	Co	Ab	Co	Co	Ab	Nc	Nc	Co
Karong	Co	Nr	Co	Nc	Ra	Ra	Ra	Ra	Nc	Nc	Nr
Kayinu	Ab	Co	Nc	Co	Ab	Co	Co	Ab	Nr	Ra	Co
Liyai Khullen	Ab	Ab	Nc	Ab	Ab	Co	Co	Ab	Co	Nc	Co
Maopondung	Ab	Ab	Co	Co	Ab	Co	Co	Ab	Nc	Nc	Co
Motbung	Co	Nr	Co	Nr	Nc	Nr	Ra	Ra	Nr	Nc	Nr
Paomata Centre	Ab	Co	Co	Nc	Co	Nc	Co	Co	Nc	Nc	Co
Phaijang	Co	Nc	Co	Nr	Nc	Nc	Nc	Nc	Nc	Nc	Nc
Phoibung	Co	Nc	Co	Nc	Co	Nc	Co	Nc	Co	Nc	Co
Rikhumei Taphou	Co	Nr	Nc	Nr	Nc	Nr	Nc	Ra	Nr	Nc	Ra
Upper Khabung	Co	Nc	Ab	Nc	Nc	Nc	Nc	Co	Co	Nc	Nc
Status	**Ab**	**Nc**	**Co**	**Nc**	**Co**	**Nc**	**Nc**	**Co**	**Nc**	**Nc**	**Nc**

NB: Ab = Abundant, Co = Common, Nc = Not so common, Ra = Rare or scanty, Nr = Not reported.

Table 4. Assessment of local availability status of selected wild edible fruit plants according to informants or collectors perception.

Village	Name of the species selected										
	Baccuria sapida (Roxb.) Muell.	*Castanopsis tribuloides* A. DC.	*Docynia indica* Dcne.	*Elaeocarpus floribundus* Bl.	*Emblica officinalis* Gartn.	*Ficus auriculata* Lour.	*Juglans regia* Linn.	*Melia birmanica* *Kurz.*	*Prunus nepaulensis* (Ser.) Steud.	*Prunus persica* (Linn.) Batsch	*Rhus semialata* Murry. DC.
Changloubung	Ra	Nr	Ra	Nr	Nc	Nc	Ra	Nr	Nr	Nc	Co
Chowainu	Nr	Co	Co	Ra	Co	Co	Ra	Nc	Nr	Co	Co
Emeifiithumei	Nr	Nc	Co	Ra	Nc	Nc	Ra	Nc	Nr	Co	Ab
Karong	Nr	Nc	Ra	Nr	Co	Co	Ra	Nr	Nr	Nc	Co
Kayinu	Nr	Co	Co	Ra	Nr	Ra	Nr	Nc	Nr	Co	Co
Liyai Khullen	Nr	Nc	Nc	Ra	Co	Nc	Nr	Nc	Nc	Co	Ab
Maopondung	Nr	Nc	Co	Ra	Nc	Nc	Ra	Nc	Nr	Co	Ab
Motbung	Nr	Nr	Nr	Nr	Nc	Nc	Nc	Nr	Nr	Nc	Co
Paomata Centre	Nr	Co	Co	Nc	Co	Co	Ra	Nc	Nc	Co	Co
Phaijang	Ra	Ra	Nr	Nr	Co	Co	Ra	Ra	Nr	Nc	Co
Phoibung	Nc	Nc	Nc	Nr	Co	Co	Nc	Ra	Nr	Nc	Co
Rikhumei Taphou	Nr	Nr	Ra	Nr	Nc	Nc	Nr	Nr	Nr	Nc	Co
Upper Khabung	Ra	Co	Nc	Ra	Co	Co	Ra	Nc	Nc	Nc	Co
Status	**Ra**	**Nc**	**Nc**	**Ra**	**Co**	**Nc**	**Ra**	**Nc**	**Ra**	**Nc**	**Ab**

NB: Ab = Abundant, Co = Common, Nc = Not so common, Ra = Rare or scanty, Nr = Not reported.

FM = Flora of Manipur; FFM = Forest Flora of Meghalaya; BSI = Botanical Survey of India; M = Mao; P = Poumei; K = Kuki.

The present study further revealed that many of these edible plants are under tremendous pressure from various anthropogenic activities and lack of sustainable harvesting practices such as agricultural land expansion, practise of traditional shifting cultivation, forest fires and excessive extraction of some plants both for household consumption or sale in the local markets for income generation. Therefore, proper and organized documentation of local plants used, identification of potential species for prioritization of conservation through sustainable management so that the resources and knowledge can be preserved, managed and utilized. In other words, conservation and management of wild edible plants and fruits will help to enhance and maintain the regional biodiversity with minimal adverse impact on the biodiversity.

Acknowledgements

The Authors are grateful to Botanical Survey of India (BSI), Eastern Circle, Shillong and herbarium curator of the department of Botany, North Eastern Hill University (NEHU) for providing herbarium facilities in the identification of plants. We are also grateful to University Grant Commission (UGC), New Delhi for providing financial assistant in the form of monthly stipend through Rajiv's Gandhi National Scholarship for SC/ST candidates. Our sincere thanks are also goes to those village elders who readily help us to provide information's about the local names of the plants and the nature of its uses and also help to provides plant samples whenever require during our field tour to different villages in the district.

References

Angami A, Gajurel PR, Rethy P, Singh B, Kalita SK. 2006. Status and potential of wild edible plants of Arunachal Pradesh. Indian Journal of Traditional Knowledge **5(4)**, 541-450.

Balemie K, Kebebew F. 2006. Ethnobotanical study of wild edible plants in Derashe and Kucha

Districts, South Ethiopia. Journal of Ethnobiology and Ethnomedicine **2, 53**.

Devi OS, Komor P, Das D. 2010. A checklist of traditional edible bio-resources from Ima markets of Imphal Valley, Manipur, India. Journal of Threatened Taxa **2(11)**, 1291-1296.

Elangbam JS, Yadava PS, Thingbaijam BS. 1989. Ethnobotanical studies of the Tangkhul Naga tribe of Ukhrul Manipur. Journal of Economic and Taxonomic Botany **13(1)**, 11-16.

Elangbam VD. 2002. Studies on various aspects of wild edible plants of Manipur valley, Ph.D. Thesis, Department of Life Sciences, Manipur University, Canchipur, Manipur.

Food and Agriculture Organization of the United Nations (FAO). 2004. Annual Report: The state of food insecurity in the world, Monitoring the progress towards the world food summit and mellennium development goals, Rome.

Gajurel PR, Rethy P, Singh B, Angami A. 2006. Ethnobotanical studies on Adi tribes in Dehang Debang Biosphere Reserve in Arunachal Pradesh, Eastern Himalaya. Ethnobotany **18(1&2)**, 114-118.

Haridasan K, Rao RR. 1985. Forest Flora of Meghalaya, Vol. 1, Botanical Survey of India, Dehra Dun, India.

Haridasan K, Rao RR. 1987. Forest Flora of Meghalaya, Vol. 2, Botanical Survey of India, Dehra Dun, India.

Jain SK. 1989. Methods and Approaches in ethnob otany. Society of Ethnobotany, Lucknow, India.

Jain SK. 1990. Contribution to ethnobotany of India, Scientific publishers, Jodhpur, India.

Kayang H. 2007. Tribal knowledge on wild edible plants of Meghalaya, Northeast India. Indian Journal of Traditional Knowledge **6(1)**, 177-181.

Martin GJ. 1995. Ethnobotany-a methods manual, Chapman and Hall, London.

Misra S, Maikhuri RK, Kala CP, Rao KS, Saxena KG. 2008. Wild leafy vegetables: A study of their subsistence dietetic support to the inhabitants of Nanda Devi Biosphere Reserve, India. Journal of Ethnobiology and Ethnomedicine **4,15**.

Mittermeier RA, Gil PR, Hoffmann M, Pilgrim J, Brooks T, Mittermeier CG, Lamoreux J, da Fonseca GAB. 2004. Hotspots revisited. Earth's biologically richest and most endangered terrestrial ecoregions. Cemex Books on Nature series, USA.

Mohammed SAS, Rana MJ, Jehan HAS, Wafa AE, Fatemah AK, Kifayeh HQ, Isra SK, Israa MS, Aseel AM, Buthainah AI, Hanan MH, Rasha BK, Samiah MA, Ghadah MS, Muna AA, Maha MHA, Nehaya AS, Hebah KA, Hanadi AN. 2008. Traditional knowledge of wild edible plants used in Palestine (Northern West Bank): A comparative study. Journal of Ethnobiology and Ethnomedicine 2008, **4**, 13.

Myers N, Mittermeier R, Mittermeier G, da Fonseca G, Kent J. 2000. Biodiversity hotspots for conservation priorities. Nature **403**, 853-858.

Nordeide MB, Hatloy A, Folling M, Lied E, Oshoug A. 1996. Nutrient Composition and nutritional importance of green leaves and wild foods in an agricultural district, Koutiala, in Southern Mali. International Journal of Food Science and Nutrition **47(6)**, 455-468.

Sawian JT, Jeeva S, Lyndem FG. 2007. Wild edible plants of Meghalaya, North-east India. Natural Product Radiance **6(5)**, 410-426.

Singh HB, Arora RK. 1978. Wild edible plants of India (1st ed.). ICAR Publication, New Delhi.

Singh NP, Chauhan AS, Mondal MS. 2000. Flora of Manipur, Vol. 1, Botanical Survey of India, Calcutta, India.

Singh PK, Singh NI, Singh LJ. 1988. Ethnobotanical studies on wild edible plants in the markets of Manipur II. Journal of Economic and Taxonomic Botany **12(1),** 113-119.

Singh RS, Singh NI. 1985. A preliminary ethnobotanical studies on wild edible plants in the markets of Manipur-I. Journal of Economic and Taxonomic Botany **6(3),** 699-703.

Sundriyal M, Sundriyal RC, Sharma E, Purohit AN. 1998. Wild edible and other useful plants from the Sikkim Himalaya, India. Oecologia Montana **7,** 43-54.

Sundriyal M, Sundriyal RC. 2001. Wild edible plants of the Sikkim Himalaya: Nutritive values of selected species. Economic Botany **55(3),** 377-390.

Sundriyal M, Sundriyal RC, Sharma E. 2004. Dietary use of wild plant resources in the Sikkim Himalaya, India. Economic Botany **58(4),** 626-638.

on plant use. These two tribal communities formed the dominant groups that inhabit the district. They possessed rich valuable reservoirs of traditional knowledge on plants used largely due to the prevalence of rich diversity of vegetations as the study area falls in the Indo-Burma global biodiversity hotspot (Myers *et al.*, 2000; Mittermeier *et al.*, 2004). Consumption of wild food plant resources formed not only an important part of the culture and tradition of these two communities but also contributes a significant amount to the diet and economy of the local people. A wide range of wild plant species are used by local people as green leafy vegetables, roots, shoots, flowers and fruits. Also many of these wild edible plant species are found to be sold in the local markets particularly by poor and economically marginalised families, thereby generating a supplementary income to their household economy. Moreover, a fairly good number of these edible plants are also reported to have both therapeutic and dietary functions and hence are used as medicinal food remedy. But the nutritional values and toxic side effects of these wild edible bio-resources of the region have not yet been investigated. Therefore, some of the recorded wild edible plants may serve as baseline data for future studies on nutritional values and possible side effects. It will also be helpful to identify and prioritise plants that may improve nutritional values and increase dietary diversity. Some of these wild edible plants may have the potential to be valuable food sources if brought into cultivation and could be part of a strategy to be used as sources of supplementary food.

Table 1. List of wild edible plants reported by the Nagas and Kukis from Senapati district, Manipur.

Vernacular name			Botanical name	Family	Habit	Voucher No.	Phenology and fruiting period	Edible part	Nature of use	Locally used as medicine/ new record (Yes/*)
Naga		Kuki								
Mao	Poumei									
Kashapro	Shiraprou	Aigidon	*Alpinia nigra* (Gaertn) Burth.	Zingiberaceae	Herb	113-MPK	May-August	Whole plant	Tender shoot and leaves are eaten as cook vegetable	
Tobophavu	Dalekhao-Khao	Banglache	*Amaranthus viridis* Linn.	Amaranthaceae	Herb	021-MPK	July-October	Leaves	Leaves are eaten cook as vegetable	
Khollomotsii	NR	NR	*Aneilema protensum* Wall	Commelanaceae	Herb	179-M	July-September	Root	Root stock eaten as cooked vegetable	*
Chiteba	Teiba	Leivah	*Arundinaria callosa* Munro.	Bambusoideae	Shrub	128-K	July-September	Tender shoot	Eaten as cooked vegetable	
Ozenabi	Yaonupa	Pachop	*Auricularia delicata* (Fr.) P. Henn.	Auriculariaceae	Saprophyte	127-MPK	April-July	Whole plant	Eaten as cooked vegetable either in fresh or dried forms	
Levosii	Shivapa	Vaibeh	*Bauhinia purpurea* Linn.	Caesalpiniaceae	Tree	118-MPK	March-September	Flower	Eaten as cooked vegetable	Yes/*
Makhrabi	NR	Koltheidon	*Begonia picta* Sm.	Begoniaceae	Herb	025-M	July-September	Leaf petiole	The skin is peeled off and eaten raw	*
Kohrehrechu	NR	Buhtomkolkai	*Bryonopsis heterophylla* (Lour.) Cogn.	Cucurbitaceae	Climber	039-MK	May-September	Tender leaves	Eaten as cooked vegetable	*
Tosanini vu	NR	NR	*Cardamine hirsuta* Linn.	Brassicaceae	Herb	019-M	July-September	Whole plant	Eaten as cooked vegetable	*
Koreio	Reivu	Changkongcha	*Centella asiatica* (Linn.) Urban	Apiaceae	Creeper	133-MPK	March-June	Whole plant	Eaten as cooked vegetable or chopped into pieces for making Sinju or chutney	Yes
Oruo	Haba-vu	Houche	*Chenopodium album* Linn.	Chenopodiaceae	Herb	126-MPK	June-September	Tender leaves	Eaten as cooked vegetable	
Chiteiba	Teiba	Leivah or Vitou	*Chimonobambusa callosa* (Munro) Nakai	Bambusoideae	Shrub	144-MP		Tender shoot	Eaten as cooked vegetable	*
Kokheisii	Siisitou	Thingthal	*Cinnamomum tamala* Fr. Nees.	Lauraceae	Tree	125-MPK		Leaves	Added to curry to give more flavour and test	
Pejii-o	Piduvu	Anphui	*Clerodendrum*	Verbenaceae	Shrub	161-	August-November	Tender leaves		Yes

were arranged together in the form of tables (1 and 2) for analysis of its taxonomic richness and was found to be distributed in 56 families and 75 genera. Of this about 54 species belong to the category of wild edible plants and 35 species form edible fruits. Three different species viz. *Bryonopsis heterophylla* (Lour.) Cogn., *Morus alba* Linn. and *Rhus semialata* Murry. DC. are used both as edible plants and fruits. Out of the total plants documented from the present work, it was recorded that 73 species belong to dicots, 12 are monocots, 1 fern and 3 edible mushrooms namely *Auricularia delicate* (Fr.) P. Henn., *Lentinula edodes* (Berk.) Pegler and *Schizophyllum commune* Fr. are also popularly consumed by both the communities in the district. The families Rosaceae, Zingiberaceae and Polygonaceae had the highest number of edible plants and fruits each recorded with 11, 5 and 4 species respectively.

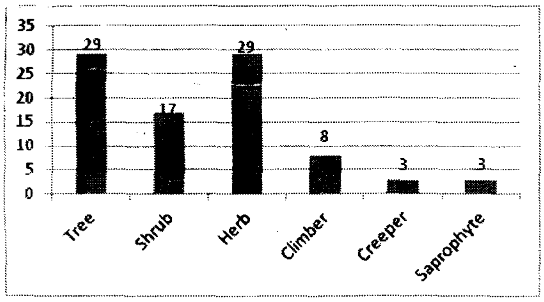


Fig. 7. Habit characteristic of different species of wild edible plant and fruit.

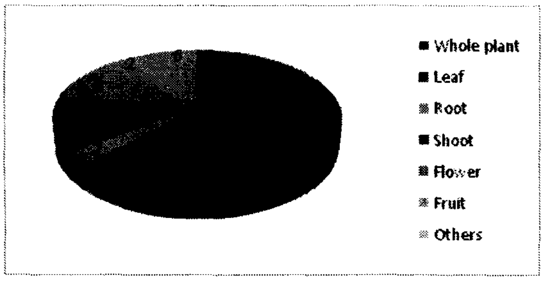


Fig. 8. Distribution of edible parts of the total species documented.

New records from the state

Although most of the edible species recorded in the present study have been reported earlier by other workers from the state (Singh and Singh, 1985; Singh *et al.*, 1988; Elangbam *et al.*, 1989; Devi, 2000; Elangbam, 2002; Devi *et al.*, 2010) however, about 23 species (42.59%) of edible plants and 10 species (28.57%) of edible fruits (mark in*, table 1 and 2) are a new record which has not been reported from the state. Further, similar reports on the use of most of these edible plants recorded in the present investigations are also reported by other workers from different tribal communities in other parts of northeast India (Sundriyal *et al.*, 2004; Gajurel *et al.*, 2006; Angami *et al.*, 2006; Sawian *et al.*, 2007; Kayang 2007).

Growth forms, edible parts and availability status

The growth forms of the plant species include tree, shrub, herb, climber, creeper and saprophytes. Herbs and trees make up the highest proportion of the edible species comprising 29 each (32.58%) from a total of 89 different species (Fig.7). Within the edible parts of the wild food plant, leaves with 27 species (30.34%) follow by whole plant and shoot each with 8 species (8.98%) were the plant parts most widely used (Fig. 8). These edible plant parts were collected from wild and consumed in different times of the year. Also from a total of 89 wild edible plants and fruits recorded, 23 species (25.84%) have been cited to be used as medicinal food remedy. Most of the medicinal food plants are herbs follow by shrubs. List of all the recorded plant species and its uses are presented on table (1 and 2). Further, assessment of the overall local availability status of 22 different species of selected wild edible food plants (11 species of edible plants and 11 species of edible fruits) showed that the maximum number of 12 species (54.55%) is graded to the category of not so common, follow by common and rare or scanty category with 4 species each. The remaining two species namely *Centella asiatica* Linn. and *Rhus semialata* Murry. DC. belongs to the category of abundant (table 3 & 4).

Discussions and conclusion

World over, the tribal population still stores a vast knowledge on utilization of local plants as food material and other specific uses (Sundriyal *et al.*, 1998). The Nagas and the Kukis are also not an exception in storing this rich traditional knowledge

Field survey

The ethnobotanical field survey was carried out at interval from July-2008 to January-2011 in Senapati district of Manipur. During this period field tours were conducted seven times in different seasons of the year i.e. July and December-2008; July-August and November -2009; March-April and December-2010 and January-2011. During the survey, data on local name, edible parts, available period, habit and habitat, phenology and fruiting period and nature of uses were collected and recorded. Also suitable plant samples were collected, given collection number and herbarium specimens were prepared for identification of the plants.

Informant selection and interview

Interview of the informants on the use of local flora on wild edible plants and fruits was conducted following a modified Jain (1989, 1990) and Martin (1995). A total of 84 elders (64 men and 20 females) from 14 different villages (9 Naga and 5 Kuki villages) were included in the present study (Fig. 9). The age of the informants ranges from 25-78 with an average of 47 years. Most of the selected informants belong to those families who have a strong connection with traditional agriculture for their day-to-day needs. In most cases selection of informants were based on recommendations made by local community members on those elders who were more knowledgeable about the use of local flora including traditional or folk medicine.

Plant collection and identification

Voucher specimens were collected during field survey in different villages, allotted collection numbers, poison with formalin, pressed and processed for future identification. GPS readings of latitudes, longitudes and altitudes were recorded in all the villages where the study was carried out. The collected plants were identified and confirmed by consulting the FFM vol. 1-2: (1985 & 1987); FM vol. 1: (2000); already identified herbarium specimens from BSI herbarium, Eastern Circle, Shillong and from NEHU herbarium. The identified voucher specimens were deposited at the NEHU herbarium.

Assessment of local availability status

It is a well known fact that the local people have the best knowledge about the flora in their locality. Preliminary assessment of the local availability status of potential species according to local people's perception is an important tool and should form an integral part for ethnobotanical field investigation. This exercise will be more relevant from the perspective of identification and prioritization of species for conservation and sustainable management of biodiversity resources. Considering this, the following criteria were designed to assess and determine the overall local availability status (village vicinity/forest area) of the selected species (table 3&4) in the study areas based on the informants or collectors perception conducted during the interviews and discussion with the local people.

Abundant: Reported from all the villages under study as abundant or common

Common: Reported from all the villages under study and recorded as common by more than 50% but less than 100% of the villages

Not so common:

(a) Not reported from all the villages under study and recorded as common by less than 50% of the villages.

(b) Reported from all the villages under study but recorded as common by less than 50% of the villages.

Rare: Reported from one third or less from the villages under study and recorded as few plants or less from the locality.

Results

Taxonomic diversity

The present study revealed the rich floral diversity and traditional knowledge of the uses of wild edible plant resources by both the Nagas and Kukis communities in the district. During ethnobotanical field surveys to different villages in the district, about 89 different species of wild edible plants and fruits including 3 species of wild edible mushrooms were recorded to be used for consumption by both the communities. These total edible species reported

Fig.5. *Clerodendron colebrookianum* Walp. flowering stage.

Fig.6. *Oroxylon indicum* (Linn.) Vent. fruiting stage.

Also the diversity of wild edible species offers variety in family diet and contributes to household food security as well as increase dietary diversity. Further, it provides rural households with supplemental income opportunities through their sale in the markets (Moreno-Black and Price, 1993). This marketing plays an important role in the socio-economic development of an area as it helps serve the people and the region. Moreover, many traditional leafy vegetables and fruits are rich in nutrient content and formed as good sources of protein, fat, vitamins, sugars and minerals. Analysis of the nutritional value of many traditional leafy vegetables showed that it is higher than several known common cultivated vegetables (Nordeide *et al.*, 1996; Sundriyal and Sundriyal, 2001). Therefore, evaluation of the nutritional content of some of the most commonly preferred and consumed wild plants will help to identify and prioritized species that can be included in traditional agriculture system based on their nutritional values. Such study could also form a part of a strategy to be used as sources of supplementary food. Although some studies on ethnomedicinal plants have been conducted in Manipur, however there is paucity of information's on wild edible plants of the state despite their diverse uses. Therefore the objective of the present investigation is to assess and evaluate the diversity of wild food plants used by the tribal communities in Senapati district and also to provide a baseline data that may be helpful for prioritization of conservation through sustainable use and management of the resources.

Materials and methods

Study area

Senapati is one of the 9-districts of Manipur covering an area of 3271 sq. km. or 14.63% out of the total geographical area of 22,356 sq. km. of the state. The district is located in the northern part of the state in between 24°37" and 25° 25" N latitudes and 93° 45" and 94° 29" E longitudes. The present ethnobotanical field investigation covered 14 different villages across the district from two different ethnic communities' viz. the Nagas (Mao and Poumei sub-tribes) and Kukis.

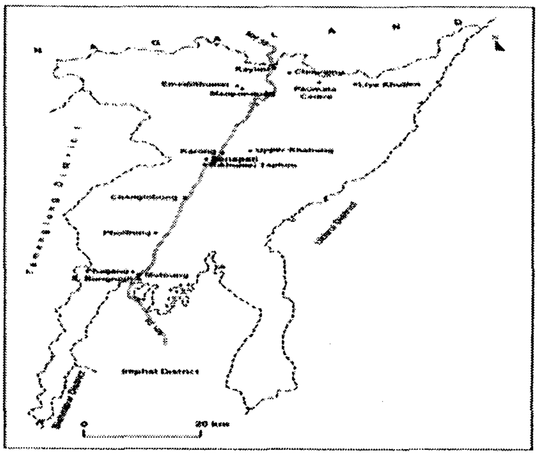


Fig. 9. Map of Senapati district showing location of the different study sites.

Phytopharmacology 2012, 2(2) 285-311

Phytopharmacology

Inforesights Publishing

Survey and assessment of ethnomedicinal plants used in Senapati District of Manipur State, Northeast India

Neli Lokho Pfoze[1]*, Yogendra Kumar[1], Bekington Myrboh[2]

[1]Department of Botany, School of Life Sciences, North Eastern Hill University, Mawlai Permanent Campus, Shillong-793022, Meghalaya, India
[2]Department of Chemistry, School of Physical Sciences, North Eastern Hill University, Mawlai Permanent Campus, Shillong-793022, Meghalaya, India

*Corresponding Author: nelilokho@yahoo.com

Received: 8 January 2012, **Revised**: 29 January 2012, **Accepted**: 2 February2012

Abstract

An ethnomedicinal field investigation was carried out in two ethnically and culturally distinct tribal communities namely the Nagas and the Kukis in Senapati district of Manipur. A total of 120 different species of plants belonging to 56 families and 109 genera were recorded to have been used by the local people of these two communities. The family Asteraceae had the highest number of species (14) followed by Solanaceae (7), Lamiaceae and Leguminosae each with 6 species. The most utilized growth forms were herbs 49 (40.83%) followed by trees 26 (21.67%) and shrubs 18 (15%). Out of the total 137 used plant parts, a leaf with 41 species (29.92%) was the most frequently used plant parts. Also calculation of the value of informant consensus factor showed the value ranges from 0.62-1.0 indicating that there is a well defined selection criterion of the plant used and also exchanged of information's among the different informants in the study area. The most cited diseases in the study area are gastro-intestinal ailments such as diarrhoea, dysentery, gastritis, stomachache and fevers. *Artemisia parviflora* Roxb, *Physalis peruviane* Linn. and *Clerodendron colebrookianum* Walp. has the highest fidelity values being used for cut or external injury, stomachache, dysentery and high BP. Also the most frequently used form of preparations were decoction 62 (41.61%) followed by crushing or grounding 41 (27.52%). The present study revealed a rich heritage of medicinal knowledge and high diversity of ethnomedicinal plants from the study areas.

Keywords: Ethnomedicine; informants; Senapati, traditional knowledge

Introduction

Since antiquity, man utilized plants as a source of medicine to ward off diseases or relieving suffering for millennia. Perhaps as early as the Neanderthal man, plants were believed to have healing powers, but as no mode of recording events existed in prehistoric times, there were no data on the methods of treatment practiced in that period (Jain, 1968). Even today, though tremendous advances have been made in the fields of synthetic organic chemistry, technology and biotechnology, still a large section of the population rely on traditional medicines. It is estimated that a total of 60% of the world population and 80% of the population in developing countries depend on traditional medicines mostly plant drugs for their primary health care needs (Baker *et al.*, 1995; Shrestha and Dhillion, 2003). In India an account of 70% of the population is dependent on traditional plant based medicines (Gadgil and Rao, 1998). Studies and documentation on ethnobotanical and traditional knowledge on medicinal plant uses has been considered as a high priority (Cox and Ballick, 1994; Dutta and Dutta, 2005; Hamil *et al.*, 2000; Pieroni, 2000), sometimes leading to the discovery of crude drugs (Cox and Ballick, 1996) or contributing to economic development. Further such studies are also important for species conservation and sustainable resource use (Gemedo *et al.*, 2005).

Manipur which is located in the North Eastern region of India is adorned with rich flora. The floristic composition of the state falls in the Indo-Burma global biodiversity hotspot

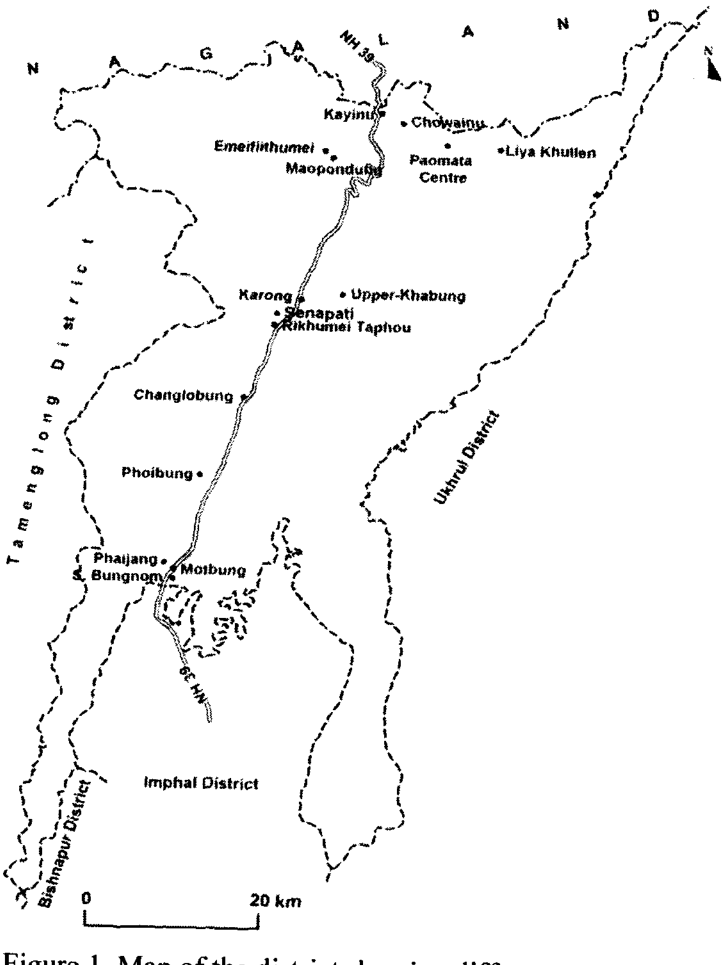


Figure 1. Map of the district showing different survey sites

(Myers *et al.*, 2000; Mittermeier *et al.*, 2004) and ranges from tropical to sub-tropical and temperate deciduous forests reflecting the region's rich floral diversity as well as high degree of endemism including valuable medicinal plants. The Nagas and Kukis are the two dominant hill tribal communities of the state and possessed rich valuable reservoirs of tradition to many sub-tribes together accounting to about 29 groups according to 2001 census. Although some early works on ethnobotanical studies listing wild edible plants, ethnomedicine and bio-folklore from the state have been reported (Singh *et al.*, 1988; Sinha 1996; Majumder and Bharroli, 1997; Ashalata *et al.*, 2005; Devi *et al.*, 2010), however with very few exceptions (Mao, 1993; 2003), not such organized documentation works on ethnobotanical studies have been taken up in the district. Also like any other traditional communities in the region and elsewhere, the knowledge of producing herbal medicine is often closely guarded with utmost secrecy among these ethnic tribal communities. This is because they believed that if the knowledge is divulged to others, then the healing or medicinal properties are lost. Further, impact of urbanization coupled with increasing dependence on modern medicine and health care system has given rise to negligence towards traditional knowledge and thereby leading to depletion of indigenous knowledge health system (Tushar *et al.*, 2010). Moreover, transmission of the knowledge is through oral and folklore tradition which is also partly attributed to the lost of knowledge.

In view of these an attempt has been made to study not only to collect, identify and document the various ethnomedicinal plants used by these two tribal communities in the district but also to assess and critically analysis the traditional knowledge of the used of these plants for treating different ailments. Therefore it is expected that the information documentted on the medicinal uses of some of these plants may be used as baseline data for future studies on phytochemical and pharmacological investigations.

Material and methods

Interview

The interviews were conducted based on the format of data sheet shown below. Before a formal interview was conducted, verbal or prior informed consent (Figure 2) was obtained from the concern village Chief or Chairman of the village and the objectives of the study were briefed to them. After obtaining the formal consent, the informants were gathered in one place (usually in community hall) and the interview was conducted to collect relevant data such as name of the informant, age, sex, occupation, local name of plants used, parts used, methods of preparation, route of administration, belief and indigenous knowledge transfer, etc. Wherever possible the informants were asked to collect and bring a plant sample which they used as medicine for easy identification and also to prepare for herbarium specimens. Moreover, the morphological characteristics, habit and habitat of the plants used were observed and recorded in the field note book.

Plant collection and identification

Voucher specimens were collected during field survey to different villages, allotted collection numbers, washed, poison with Formalin, pressed and processed for future identification. The collected plants were identified and confirmed by consulting the state flora of the

DATA SHEET FOR ETHNOMEDICINAL PLANTS COLLECTION

(A) INFORMANTS PROFILE

Name of the village .... Tribe: ....

S. No.	Name	Sex (Male/Female)	Age (in years)	Occupation
1.	....	....	....	....
2.	....	....	....	....
3.	....	....	....	....
4.	....	....	....	....
5.	....	....	....	....

(B) MEDICINAL PLANT USES

1. Plant (Local/Vernacular name)
a. Mao .... b) Poumei .... c) Kuki ....
2. Plant identified as .... (Botanical name)
3. Part(s) of plant used ....
4. Habit of the plant (Tree/Shrub/Herbs/Climber/Creeper/Others)
5. Phenology and fruiting period ....
6. Preparation method(s) ....
7. Use or nature of ailment treated ....
8. Number of citations or use-report for each ailment treated ....
9. Route of administration (i) External (ii) Oral (iii) Nasal (iv) Ear/eye
10. Response of the informant(s)/Patient(s)
(a) Effective /Good .... (b) Fair.................. (c) Poor ....

(C) INFORMANTS DECLARATION

We, the above mentioned hereby willingly accepted to participate in this study with our full consent and declare that the information and knowledge provided to Neli Lokho Pfoze during the course of interview and discussion is to the best of our knowledge and is accurate and complete.

Dated: ....

Figure 2. Performa used in survey of medicinal plants

region such as Flora of Assam (FA), vol. 1-5: (Kanjilal *et al.*, 1934-1940); Forest Flora of Meghalaya (FFM), vol. 1-2: (Haridasan and Rao, 1985-1987); Flora of Manipur (FM), vol. 1: (Singh *et al.*, 2000); already identified herbarium specimens from BSI herbarium, Eastern Circle, Shillong and from NEHU herbarium. The identified voucher specimens were deposited at the NEHU herbarium.

Data analysis

Informant consensus factor (ICF)

For data analysis, informant consensus factor (IFC) and relative importance of plant use according to (Heinrich *et al.*, 1998; Gazzaneo *et al.*, 2005) was employed to identify the agreements of the informants on the reported cures for the group of ailments. The ICF is calculated as in the following formula:

$$ICF = Nur - Nt/Nur-1,$$

Where Nur is the number of use citations in each category and Nt is the number of species used.

Use-value (UV)

A quantitative method that demonstrates the relative importance of species known locally was also calculated as according to (Phillips *et al.*, 1994) in the following formula.

$$UV = \sum U/N$$

Where UV is the use value of a species, U the number of citations per species; N the number of informants.

Fidelity level (FL)

The fidelity level (FL), the percentage of informants claiming the use of a certain plant for the same major purpose, was calculated for the most frequently reported diseases or ailments,

$$FL\ (\%) = Np/N \times 100$$

Where Np is the number of informants that claim a use of a plant species to treat a particular disease, and N is the number of informants that use the plants as a medicine to treat any given disease (Alexiades, 1996).

Results

Informant selection

A total of 139 elders (98 men and 40 females) from 14 different villages were participated in the present study. The age of the informants ranged from 18-78 with an average of 56.04 years for man and 48.80 years for female. Most of the selected informants belonged to those people who have a strong connection with traditional agriculture for their day-to-day needs. In most cases selection of informants were identified by community members on those elders who are more knowledgeable about the use of local flora including traditional or folk medicine. About 111 (80.43%) informants utilized medicinal plants and prepared only when require for themselves, 11 (7.97%) informants not only utilized for themselves when required but also prepared for other peoples on demand as requested, 3 persons are regular practitioners and treated as professional as they treat patients in full time while the remaining 13 (9.42%) informants reported that they do not utilized medicinal plants.

Taxonomic diversity

During the survey, a total of 120 different species of medicinal plant belonging to 56 families and 109 genera are reported to be used for treating 53 different diseases or ailments of both human and animal (table 1 and 2). In terms of number of medicinal plant, the family Asteraceae with 14 species is the highest follow by Solanaceae 7, Lamiaceae and Leguminosae 6 species each, Acanthaceae, Euphorbiaceae and Rosaceae each with 5 different species respectively. Also from the total number of species recorded, 105 are dicots and the remaining 14 species are from monocots including 1 species of pteridophyte i.e. *Lygodium japonicum* (Thunb.) Sw. The majority of the plants were wild 102 (85%) followed by cultivated 12 (10%) species while about 6 (5%) were recorded as wild or cultivated.

Medicinal plants parts, habits and uses reported by the informants

Different plant parts both underground and above ground such as leaf, root, barks, rhizome, flowers, shoot, fruits and whole plant are used to treat different ailments. Of the total 137 plant parts used as medicine, use of above ground plant parts is 99 (72.26%), underground plant parts 26 (18.98%) and whole plant with 12 (8.76%) species. Of the above ground parts, leaf is used in the majority of cases with 41 (46.1%) species follow by whole

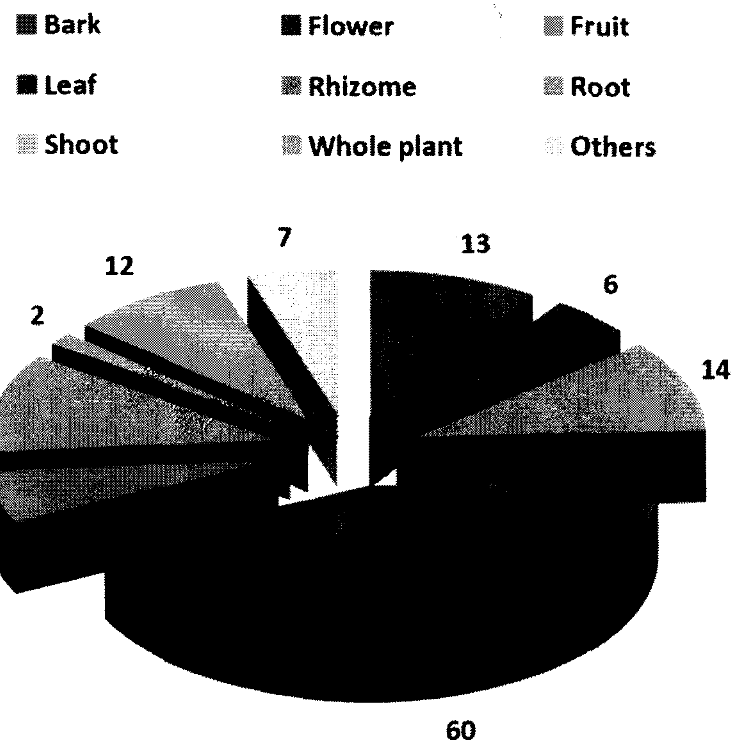


Figure 3. Showing different plant parts used.

Table-1: List of ethnomedicinal plants used by the tribal communities from Senapati District, Manipur

Family	Species	Part used	Type of ailments treated	Previously reported ethnomedicinal uses in literature	Total citations
Acanthaceae	*Achyranthes aspera* Linn.	Leaves	Body swelling and Toothache	Cut, wounds, skin diseases, bone fracture (Kala, 2005); pulmonary infections, cough, asthma and skin diseases (Newton *et al*., 2002)	8
	Adhatoda zeylanica Medic.	Leaves	Body ache, chest pain and joint dislocation	Asthma, cold, cough, fever (Ignacimuthu *et al*., 2006); fevers, headache and bodyache (Bantawa and Rai, 2009)	13
	Phlogacanthus curviflorus Nees.	Leaves	Gastritis, high BP, fevers, headache, body ache, joint dislocation and sprain	Cough, fever (Sinha, 1996)	84
	Scutellaria discolor Coleb.	Leaves	Intermittent fever	Gastric trouble (Manandhar, 1993); injuries, menstrual disorders (Khumbongmayum *et al*., 2005); cuts and wounds (Kunwar *et al*., 2010)	5
	Thunbergia coccinea Wall.	Leaves	Cut or injury	Decoration (Srivastava, 2009)	6
Anacardiaceae	*Psidium guajuva* Linn.	Leaves and fruits	Vomiting, diarrhea and dysentery	Cough (Maheshwari and Singh, 1984); astringent, diarrhea, ulcers, piles, cholera, vomiting (Chopra *et al*., 1992); diarrhea (Tene *et al*., 2007)	38
	Rhus semialata Murry.	Fruits	Dry cough, vomiting, diarrhea and dysentery	Dysentery (Shrestha and Dhillion, 2003); Appetizer (Manadhar, 1987a); asthma, food poison, stomachache, dysentery (Rokaya et al., 2010); cholera, dysentery (Hynniewta and Kumar, 2008)	57
Apocyanaceae	*Catharanthus roseus* (Linn.) G. Don.	Leaves	Fevers and dry cough	Cancer, diabetes, tonic (Jain, 1991); diabetes, high blood pressure (Sajem and Gosai, 2010)	4
Araceae	*Arisaema tortuosum* (Wall.) Schott.	Leaves petiole	Bee sting and snake bite	Headache, toothache, stomache, menstruation problems (Rokaya *et al*, 2010)	4
Araliaceae	*Eleutherococcus aculeatum* (Ait.) Seem.	Leaves	Ringworm and ear infections		6
	Panax psuodogiseng Wall.	Rhizome	Gastritis and other gastro-intestinal problems, high BP and aphrodisiac	Aphrodisiac, stimulate, dyspepsia, vomiting, antipyretic (Sinha, 1996); liver disorder, stomach colic, antipyretic, menstrual disorder (Saha *et al*., 2011)	10
Asteraceae	*Ageratum conyzoides* Linn.	Leaves	Cut or injury	Cut, wounds (Kala, 2005); Stomach pain (Tene *et al*., 2007); hair lotion (Khumbongmayum *et al*., 2005)	13
	Artemesia parviflora Roxb.	Leaves	Cut or injury and nose bleeding	Hair care lotion (Sinha, 1996)	57
	Artemesia nilagirica (Clarke) Pamp.	Leaves	Colic, diarrhea and dysentery	Cough, headache, sores (Kala, 2005); stomach ulcer, hair lotion, insect repellent (Khumbongmayum *et al*., 2005); mouth ulcer, dizziness, headache (Bantawa and Rai, 2009)	35
	Bidens pilosa	Leaves	Cut or injury and	Pulmonary diseases, leprosy	32

	Linn. *var. minor* (Bl.) Schertt.		uncontrolled bleeding after delivery	(Anon, 1986; Puyvelde *et al.*, 1994); Stomach pain, menstruation pain, scurvy, influenza, prostate disturbances, pneumonia (Tene *et al.*, 2007)	
	Blumeopsis flava (DC.) Gagnepain	Leaves	Fevers, high BP, dry cough, chest pain and body ache, cut or injury, skin diseases and killing maggots	Bronchial congestion, catarrh, cold (Sinha, 1996)	44
	Crassocephalum crepidioides (Benth.) Moore	Leaves and flowers	Gastritis, constipation, headache, high BP and Cut or injury	Cut, wounds (Hynniewta and Kumar, 2008), indigestion, headache, stomachache, (Kala, 2005)	34
	Eupatorium adenophorum Spreng.	Leaves	Cut or injury, diarrhea, dysentery and abortifacient	Cuts and wounds (Uprety *et al.*, 2010); Boils, fever, insomnia (Manadhar, 1991, 1992)	56
	Eupatorium riparium Regel. Gaertn.	Leaves	Skin diseases, cut or injury gastritis and diarrhea	High blood pressure, fever, flu, vomiting, nausea (Lavergne and Vera, 1989; Lavergne, 2001)	15
	Gynura bicolor (Roxb. ex Willd.) DC.	Leaves	Gastritis and other stomach disorders	Intestinal worms (Kala, 2005)	13
	Saussurea deltoidea (DC.) Sch. – Bip.	Leaves	Gastritis and stomachache		8
	Sonchus asper (Linn.) Hill.	Leaves	Stomachache and gastritis	Wounds, boils, emollient (Sinha, 1996)	6
	Spilanthes acmella Linn.	Flowers	Toothache and hookworm	Toothache, jaundice, sore throat, cut, injuries (Khumbongmayum *et al.*, 2005);	11
	Spilanthes paniculata wallich ex DC.	Leaves	Diarrhea, dysentery and high BP	Constipation (Kala, 2005); toothache and cure cavity formation (Sajem and Gosai, 2006; Rethy *et al.*, 2010); toothache (Hynniewta and Kumar, 2008)	13
	Tithonia diversifolia (Hemsl.) A. Gray	Leaves	Haemorrhoids, skin diseases and cut or injury	Leaf infusion: abdominal pains, indigestion, sore throat, and liver pain (Kokwaro, 1976)	13
Berberidaceae	*Mahonia manipurensis* Takeda	Bark	Fevers and jaundice	Dizziness (Sinha, 1996)	8
Betulaceae	*Alnus nepalensis* D. Don.	Bark	Cut or injury	Gastric (Shrestha and Dhillion, 2003); cuts, burns (Joshi and Edington, 1990)	3
	Betula alnoides Buch-Ham. ex D. Don	Bark	Diarrhea and dysentery	Antiseptic and used in snake bite (Sinha, 1996)	5
Bignoniaceae	*Oroxylum indicum* (Linn.) Vent.	Bark	Fevers, gastritis, high BP, liver disorders, cancer and killing maggots	Purgative, headache (Kala, 2005), epilepsy, muscular sprain and general weakness (Khumbongmayum *et al.*, 2005); control hypertension (Mao *et al.*, 2009)	58
Bombacaceae	*Bombax ceiba* Linn.	Bark	Toothache	Skin diseases, female diseases and snake bite (Khumbongmayum *et al.*, 2005)	5
Cannabinaceae	*Cannabis sativa* Linn.	Leaves	Diarrhea, dysentery and swine fever	Control bleeding (Kunwar *et al.*, 2010); Leprosy, cough, bronchitis (Kirtikar and Basu, 1935); indigestion, Rheumatic pain (Joshi and Edington, 1990; Shrestha and Dhillion, 2003)	21
Caprifoliaceae	*Sambucus*	Leaves	Bodyache, skin allergy		11

	javanica Bl.		and joint dislocation	Depurative, diuretic, purgative (Sinha, 1996)	
	Viburnum foetidum Wall.	Leaves	Heamorrhoids	Menorrhagia, uterine sedative (Sinha, 1996)	1
Caricaceae	*Carica papaya* Linn.	Fruit	Gastritis and other stomach complaints, diabetes, expulsion of intestinal worms and abortificent	Malaria (Teklehaymanot and Giday, 2007); expectorant (Kirtikar and Basu, 1935)	22
Caryophyllaceae	*Drymaria cordata (Linn.)* Roem. & Schult.	Leaves	Headache, cut or injury, snake bite, conjunctivitis and sinusitis	Cough, dysentery, muscular sprain (Khumbongmayum *et al.*, 2005); sinuses, tonsilitis (Bantawa and Rai, 2009)	27
Chenopodiaceae	*Chenopodium ambrosiodes* Linn.	Leaves	Killing maggots and wound healing	Toothache (Kala, 2005); Cough, pulmonary complaints (Kirtikar and Basu, 1935); Antiparasite, analgesic, lacerations, internal inflammation, stomach pain (Tene *et al.*, 2007)	16
Crassulaceae	*Bryophyllum pinnatum* (Lam.) Kruz.	Leaves	Burns and inflammation and gastritis	Blood purification, cancer, menstruation pain (Tene *et al.*, 2007)	6
Cucurbitaceae	*Gymnopetalum cochinensis (Lour.) Kurz.*	Whole plant	Jaundice, fevers and painful urination	Antidote in food poisoning, tetanus (Sinha, 1996)	19
	Melothria maderaspatana (Linn.) Cogn.	Leaves and fruits	Fevers, jaundice and bodyache	Toothache, jaundice, vertigo, biliousness (Khumbongmayum *et al.*, 2005)	16
Cuscutaceae	*Cuscuta reflexa* Roxb.	Whole plant	Body ache, sprain and joint dislocation	Purgative (Kala, 2005); Jaundice (Rokaya *et al.*, 2010), bone fracture and body swelling (Joshi and Edington, 1990; Shrestha and Dhillion, 2003)	12
Eleocarpaceae	*Elaeocarpus floribundus* Bl.	Fruits	Dry cough and indigestion	Antiseptic, mouth-wash in inflammed gum (Sinha, 1996)	5
Ericaceae	*Rhododendron arboreum* Sm.	Flowers	Removal of block fish bone	Fish bone problem (Bantawa and Rai, 2009), diarrhea and dysentery (Shrestha and Dhillion, 2003); nasal bleeding (Uniyal *et al.*, 2006)	18
Euphorbiaceae	*Emblica officinalis Gaertn.*	Bark and fruits	Gastritis, vomiting, diarrhea, dysentery, dry cough and body ache	Acrid, cooling, refrigerant, diuretic, diarrhea, dysentery, anaemia, jaundice, cough (Chopra *et al.*, 1992); dyspepsia, jaundice (Khumbongmayum *et al.*, 2005)	32
	Glochidion oblatum Hook. f.	Leaves	Diarrhea and dysentery	Dysentery (Sinha, 1996)	2
	Jatropha curcas Linn.	Branches	Burns and relieved inflammation	Boils, pimples (Manandhar, 1993); herpes, antiparasite (Tene *et al.*, 2007); toothache (Jadhav, 2006)	4
	Phyllanthus fraternus Web.	Whole plant	Diarrhea and kidneystone	Leucoderma (Khumbongmayum *et al.*, 2005)	2
	Ricinus communis Linn.	Leaves	Body ache, joint and chest pains, joint dislocation and sprain	Toothache (Teklehaymanot and Giday, 2007); Leprosy, asthma, bronchitis, sprains, wounds, injuries (Kirtikar and Basu, 1935)	38
Fagaceae	*Quercus serrata* Thunb.	Bark and extract from cut branches	Cut or injury, diarrhea, dysentery, vomiting, dry cough and analgesic against bee stink		20
Fumuriaceae	*Dicentra scandens* (D. Don.) Walp.	Root tubers	Fevers, stomachache and high BP	Anthelmintic, fever, wound healing (Manandahar, 1993); fevers, blood pressure, gastro-intestinal disorders, toothache (Pfoze and Chiezou, 2006)	14

Gentianaceae	*Swertia chiraita* Linn.	Leaves	Intermittent fever and relieved body ache	Fevers, headache and indigestion (Joshi and Edington, 1990; Shrestha and Dhillion, 2003; Uprety *et al.*, 2010); cough, cold, fevers, headache (Rokaya *et al.*, 2010; Manandhar, 2002); malaria (Hynniewta and Kumar, 2008)	8
	Swertia pulchella (D. Don) Clarke.	Whole plant	Fevers and abdominal flatulence	Cough, cold, fevers, headache (Rokaya *et al.*, 2010; Manandhar, 2002)	13
Geraniaceae	*Geranium nepalense* Sw.	Leaves	Crushed leaves paste is applied for cut or injury and wound healing	Toothache and gum bleeding (Hynniewta and Kumar, 2008); cuts and wounds (Uprety *et al.*, 2010)	6
Hypoxidaceae	*Curculigo orchioides* Gaertn.	Rhizomes	Cut or injury	Dysentery, peptic ulcer (Manandhar, 1991)	11
Juglandaceae	*Juglans regia* Linn.	Leaves and bark	Skin diseases and toothache	Astringent, tonic, anthelminthic (Ugulu *et al.*, 2009); toothache and gum problems (Rokaya *et al.*, 2010)	5
Lamiaceae or Labiatae	*Calamintha umbrosa* (Bieb.) Benth.	Leaves	Cut or injury and wound healing	Whole plant eaten to ensure good health (Saha *et al.*, 2011)	10
	Elsholtzia blanda Benth.	Leaves	Diarrhea, dysentery, stomachache, carminative and flatulence	Cough and cold (Taylor *et al.*, 1995); choleric diarrhea (Sinha, 1996)	18
	Mentha arvensis Linn.	Leaves	Flatulence and removed gas	Carminative, stomachic (Singh *et al.*, 1979); tongue infection (Shrestha and Dhillion, 2003)	4
	Leucus indica Linn.	Leaves	Cut and injury, killing maggots and bleeding piles		14
	Ocimum basilicum Linn.	Leaves	Carminative or flatulence and fever	Dyspepsia, carminative, Diuretic (Ugulu *et al.*, 2009); Stomach pain, fever, gastritis, influenza, high blood pressure, internal infections, relaxant (Tene *et al.*, 2007)	8
	Ocimum sanctum Linn.	Leaves and flowers	Fevers and dry cough	Asthma, bronchitis, expectorant, cough (Kirtikar and Basu, 1935); gastric disorders, bronchitis, earache antiseptic, diaphoretic, hepatic affection (Chopra *et al.*, 1992)	3
Lauraceae	*Litsea cubeba* (Lour.) Pers.	Bark	Emeting, diarrhea and dysentery	Cough, cold, hair tonic, indigestion, good sleep (Kala, 2005); foot and mouth diseases of cattle's (Mao et al., 2009)	4
Leguminosae	*Bauhinia purpurea* Linn.	Flowers and leaves	Diabetes, piles, gastritis, constipation, diarrhea, dysentery, menstrual problem and remove block fish bone from throat	Poisonous bite, leucorrhoea, menstrual disorder and leprosy (Khumbongmayum *et al.*, 2005)	24
	Desmodium triquetrum DC.	Leaves	Urinary bladder stone	Piles (Sinha, 1996); vermicide (Sajem and Gosai, 2010)	2
	Entada phaseoloides (Linn.) Merr.	Seed cotyledons	Toothache	Stomach ulcer, fevers and headache (Khumbongmayum *et al.*, 2005)	1
	Erythrina arborescens Roxb.	Stem bark	Stomachache	Toothache and preveny dental caries (Hynniewta and Kumar, 2008)	13
	Mimosa pudica Linn.	Leaves and root	Gastritis, haemorrhoid, painful urination	Piles (Sajem and Gosai, 2010)	11

	with *E. adenophorum*				
	Parkia roxburghii G. Don.	Pods cover	Gastritis, diarrhea , dysentery and piles	Intestinal disorders, bleeding piles, dirrhea, dysentery (Khumbongmayum *et al*., 2005)	13
Liliaceae	*Acorus calamus* Linn.	Rhizome	Stomachache, epilepsy, toothache, killing head lice's and insects repellant	Cough and cold (Uprety *et al*., 2010); cough/cold (Shrestha and Dhillion, 2003); Rheumatic pain, headache, snake bite (Joshi and Edington, 1990)	14
	Asparagus filicinus Buch.-Ham. Ex D. Don.	Root tuber	Womb and menstrual disorders	Antihelmintic, diuretic, diarrhea, skin diseases (Kunwar *et al*., 2006, Rokaya *et al*, 2010)	3
	Smilax ovalifolia Roxb.	Tender shoot and root	Cut or injury, arthritis and rheumatism	Rheumatic swellings, urinary complaints, dysentery (Sinha, 1996)	9
Lygodiaceae	*Lygodium japonicum* (Thumb.) sw.	Leaves	Jaundice	Expectorant (Anon., 1986); heart complaints (Khumbongmayum *et al*., 2005); diabetes, wounds and ulcers (Yumkham and Singh, 2011)	4
Melastomataceae	*Osbeckia stellata* Wall.	Leaves and roots	Diarrhea and dysentery	Antidiabetes (Khan and Yadava, 2010)	11
Meliaceae	*Cedrela serrata* Royle	Leaves and root bark	Joint dislocation, sprain and high BP	Fever, dysentery, diabetes, blood diseases, skin diseases (Awan *et al*., 2011)	4
	Melia composita Willd.	Leaves and fruits	Intermittent fever, anthelmintic and stomach ache	Stomach, liver troubles (Das *et al*., 2008)	17
Moraceae	*Ficus auriculata* Lour.	Fruits	Diarrhea and dysentery	Diarrhea and dysentery (Manandhar, 1991;Kunwar *et al*., 2010); wound healing (Shrestha and Dhillion, 2003)	9
Myricaceae	*Myrica nagi* (Thunb.) Hook.	Bark	Diarrhea and dysentery	Dysentery (Hynniewta and Kumar, 2008)	25
Nyctaginaceae	*Mirabilis jalapa* Linn.	Roots	Cut or injury	Fevers, discharge of semen through the urine (Manandhar, 1993)	5
Oxalidaceae	*Oxalis corniculata* Linn.	Whole plant	Tooth ache, cut or injury, dysentery and as washing soap for glossy hair	Stomach complaints, piles, colic, dysentery, hair lotion (Khumbongmayum *et al*., 2005); diarrhea (Tene *et al*., 2007); boils , skin problems, diarrhea (Rokaya *et al*., 2010)	20
Passifloraceae	*Passiflora edulis* Sims	Leaves	Stomachache, gastritis and dysentery	Tender ground leaves with Psidium guajava leaves is taken in blood dysentery (Hynniewta and Kumar, 2008)	22
Plantaginaceae	*Plantago erosa* Wall.	Whole plant	Dry cough	Constipation (Kala, 2005); Leprosy (Sharma *et al*., 2001); diarrhea, dysentery (Rokaya et al., 2010); muscular sprain, fever, boils (Khumbongmayum *et al*., 2005); earache, toothache, gum bleeding (Sajem and Gosai, 2010)	5
Poaceae	*Arundo donax* Linn.	Tender shoot and leaves of *P. persiaca*	Killing maggots and wound healing	Worm-affections, typhoid, pneumonia, asthma (Sinha, 1996)	7
	Cynodon dactylon Pers.	Whole aerial parts	Conjunctivitis	Nose bleeds, burns (Shrestha and Dhillion, 2003); diuretic, blood depurative (Ugulu *et al*., 2009); liver cirrhosis (Bantawa and Rai, 2009)	3

	Imperita cylindrica (Linn.) P. Beauv.	Roots	Worm expulsion	Gastric troubles (Manandhar, 1993); diarrhea, dysentery, gonorrhea, control bleeding (Khumbongmayum *et al.*, 2005)	4
	Thysanolaena maxima (Roxb.) Kuntz.	Roots	Gastro-intestinal worms	Mouth-wash in fever (Sinha, 1996); boils, cancer (Hynniewta and Kumar, 2008); rituals (Namsa *et al.*, 2011)	3
Punicaceae	*Punica granatum* Linn.	Roots	Blood dysentery	Bronchitis, sore throat, chest, troubles (Kirtikar and Basu, 1935); bronchitis, cough (Shah and Joshi, 1971; Anon., 1986); indigestion, diarrhea, dysentery, cough and cold, (Rokaya et al., 2010)	6
Rananculaceae	*Ranunculus sceleratus* Linn.	Roots	Boils	Urinary disorder, blisters, skin diseases (Khumbongmayum *et al.*, 2005)	
	Thalictrum foliolosum DC.	Roots and leaves	Fevers	Diuretic, antiperiodic, purgative (Sinha, 1996); stomach pain, gastric trouble (Uniyal *et al.*, 2006)	54
Rosaceae	*Fragaria nilgerrensis* Schldl.	Whole plant	Painful urination, diarrhea, dysentery, blood vomiting, bleeding nose and flatulence		12
	Potentilla fulgens Wall. ex Hook.	Roots	Burns and toothache	Stomach disorders, certain forms of cancer, diabetes mellitus (Syiem *et al.*, 2002, 2003; Rosangkima and Prasad, 2004; Chhetri *et al.*, 2005); gastro-intestinal disorders (Uprety *et al.*, 2010); dentrifrice (Kunwar *et al.*, 2010); high blood pressure (Hynniewta and Kumar, 2008)	42
	Prunus persica (Linn.) Batsch.	Leaves	Killing maggots, skin diseases and ear infections,	Cough, bronchitis, expectorant (Kirtikar and Basu, 1935); remove worms in animal wounds (Manandhar, 1993)	127
	Rubus ellipticus Smith.	Root bark	Dysentery and diarrhea	Stomach pain, typhoid (Shrestha and Dhillion, 2003) indigestion (Kala, 2005); sore throat, excessive thrist and weakness (Manandhar, 1992; Rokaya *et al.*, 2010)	102
	Rubus niveus Thunb.	Root	Dysentery and diarrhea	Excessive bleeding during menstrual cycle (Uniyal *et al.*, 2006); cough, cold, diarrhea (*Rokaya et al.*, 2010)	20
Rubiaceae	*Paederia foetida* Linn.	Leaves and roots	Stomachache, diarrhea, dysentery, gastritis, bodyache, joint dislocation and bone fracture	Gastritis, diarrhea, stomach disorder (Kala, 2005); piles, bone fracture (Khumbongmayum *et al.*, 2005)	118
Rutaceae	*Zanthoxylum armatum* DC.	Fruits	Carminative, flatulence and burns	Cold, cough, fever, appetizer (Kala, 2005); Gastro-intestinal disorders (Shrestha and Dhillion, 2003; Uprety *et al.*, 2010)	13
	Zanthoxylum rhetsa (Roxb.) DC.	Fruits and leaves	Carminative, flatulence, indigestion and gas formation	Cholera (Wealth of India, 1976; Ambasta, 1986)	44
Sapindaceae	*Sapindus mukorossi* Gaertn.	Fruit pulps and seed cotyledons	Tooth ache, epilepsy constipation, fevers and stomachache	Expectorant, emetic, alexipharmic, arbortificent (Kirtikar and Basu, 1991); spermicidal and used in contraceptive cream (Rastogi and Mehrotra, 1999; Dwivedi *et al.*, 1990)	29
Scruphulariaceae	*Pratia begonifolia*	Leaves	Tooth ache, epilepsy constipation, fevers and	Expectorant, emetic, alexipharmic, arbortificent (Kirtikar and Basu,	23

	(Wall.) Lindl.		stomachache	1991); spermicidal and used in contraceptive cream (Rastogi and Mehrotra, 1999; Dwivedi *et al.*, 1990)	
Solanaceae	*Datura arboreatum* Mettel	Stem and leaves	Sinusitis	Dysentery, tonsillitis, snake bite (Saha *et al.*, 2011)	2
	Nicotiana tabacum Linn.	Leaves	Snake bite, joint dislocation, sprain and bodyache	Antiamoebic (Tona *et al.*, 1998); constipation, gastritis, blood purification (Kala, 2005)	21
	Physalis peruviane Linn.	Leaves	Toothache, skin diseases and killing maggots and piles	Allergy, strokes, rheumatism (Tene *et al.*, 2007); skin infections (Sajem and Gosai, 2006, 2010)	23
	Sapindus mukorossi Gaertn.	Fruits	Stomachache and dysentery	Pain in pregnancy (Kala, 2005); Disinfectant, healing of wounds (Tene *et al.*, 2007)	29
	Solanum khasianum Clarke	Fruits	Washing soap and removal of leech	Toothache (Kala, 2005), leech killer, toothache (Rethy *et al.*, 2010)	15
	Solanum kurzii Br.	Fruits	High BP and headache	Cough, worms infestation (Kala, 2005); anti-allergy (Mao *et al.*, 2009)	22
	Solanum nigrum Linn.	Leaves	Mouth and nose diseases of chicken	Liver tonic, indigestion (Kala, 2005); Antispasmodic, antiallerjic, Sedative (Ugulu *et al.*, 2009); laxative, diuretic, tonic (Rokaya *et al.*, 2010)	9
	Solanum spirale Roxb.	Rhizomes	Headache	Narcotic, diuretic (Sinha, 1996)	5
Triliaceae	*Paris polyphylla* Sm.	Fruits	Cut or injury, gastritis, fevers and toothache	Fevers, headache and maternity problems (Joshi and Edington, 1990; Shrestha and Dhillion, 2003; Uprety *et al.*, 2010); cuts, wounds (Rokaya et al., 2010; Kunwar *et al.*, 2006	19
Theaceae	*Schima wallichii (DC.)* Korth.	Stem bark	Cut or injury	Anthelmintic (Manandhar, 1993); expulsion of intestinal worms, gonorrhoea (Khumbongmayum *et al.*, 2005)	4
Ubelliferae or Apiaceae	*Centella asiatica (Linn.)* Urban	Whole plant	Conjunctivitis and gastritis	Bronchitis, asthma, leprosy (Kirtikar and Basu, 1935); tuberculosis, cough, leprosy (Kharkhongor and Joseph, 1981); blood purification (Shrestha and Dhillion, 2003)	39
	Hydrocotyle sibthorpioides Lam.	Whole plant	Removing thorns	Relieve fevers (Manandhar, 1993); liver complaints, applied to boils to promote suppuration (Sinha, 1996)	2
	Oenanthe javanica (Bl.) DC ssp. *stolonifera* Wall.	Whole plant	Gastritis and low BP	Making Singju, a kind of local preparation (Jain et al., 2011)	34
Urticaceae	*Debregeasia longifolia* (Burm. f.) Wedd.	Leaves	Diabetes	Antidiabetic (Khan and Yadava, 2010)	8
	Pouzolzia bennettiana Wight	Roots	Cut or injury	Stomach disorder (Namsa *et al.*, 2011)	12
Verbenaceae	*Clerodendrum colebrookianum Walp. ex Walp.*	Leaves	High BP	High blood pressure (Rethy *et al.*, 2010; Namsa *et al.*, 2011), malaria, liver troubles (Hynniewta and Kumar, 2008); rheumatism (Kharkhongor and Joseph, 1981)	37
	Lantana	Leaves	Fevers, dry cough,	Malaria, atoxy, rheumatism	24

	camara Linn.	and flowers	jaundice, Joint dislocation and eye infections	(Chopra *et al.*, 1992); digestive, cold, flu, expectorant (Ugulu *et al.*, 2009)	
	Verbena officinalis Linn.	Leaves	Stomachache	Snake bite and stomachache (Teklehaymanot and Giday, 2007)	3
Viscaceae	*Viscum articulatum* Burm. f.	Whole plant	Bone fractured, body ache and joint dislocation	Febrifuge, aphrodisiac, cuts (Sinha, 1996); stomach troubles in new born baby (Hynniewta and Kumar, 2008)	14
Zingiberaceae	*Costus speciosus* (Koenig) Sm.	Stem	Ear infection	Sexual hormones and contraceptives (Warrier *et al.*, 1995); [illegible] diabetes (Bahtawa and Rai, 2009); urinary problems and ear-ache (Khumbongmayum *et al.*, 2005); jaundice (Rethy et al., 2010)	4
	Curcuma longa Linn.	Rhizomes	Cut or injury	Antispasmodic activity (Ammon and Wahl1991), anti-HIV, antioxidant, anti-tumour, antivenom (Araujo and Leon, 2001)	2
	Curcuma caesia Roxb.	Rhizomes	Stomachache and fevers	Cough, asthma (Kala, 2005); anti-inflammatory and anti-asthmatic, dysentery, wound healing (Tushar *et al.*, 2010)	23
	Zingiber purpureum Rosc.	Rhizomes	Killing head lice's	Antifungal (Ficker *et al.*, 2003)	5

Table 2. Additional details of ethnomedicinal plants used by the tribal communities from Senapati District, Manipur

Family	Species	Voucher specimen No.	Habit	Total informants interviewed	Use-value (UV)
Acanthaceae	*Achyranthes aspera* Linn.	086-MPK	H	55	0.14
	Adhatoda zeylanica Medic.	084-MPK	S	55	0.24
	Phlogacanthus curviflorus Nees.	056-MPK	S	125	0.67
	Scutellaria discolor Coleb.	075-P	H	14	0.36
	Thunbergia coccinea Wall.	028-MP	Cl	49	0.12
Anacardiaceae	*Psidium guajava* Linn.	081-MPK	T	108	0.35
	Rhus semialata Murry.	023-MPK	T	122	0.47
Apocyanaceae	*Catharanthus roseus* (Linn.) G. Don.	162-PK	H	5	0.8
Araceae	*Arisaema tortuosum* (Wall.) Schott.	061-MP	H	42	0.09
Araliaceae	*Eleutherococcus aculeatum* (Ait.) Seem.	112-M	S	42	0.14
Asteraceae	*Panax pseudoginseng* Wall.	165-P	H	16	0.62
	Ageratum conyzoides Linn.	022-MPK	H	72	0.18
	Artemesia parviflora Roxb.	047-MPK	Us	124	0.46
	Artemesia nilagirica (Clarke) Pamp.	060-MP	Us	87	0.40
	Bidens pilosa Linn. *var. minor* (Bl.) Scherff.	029-MPK	H	106	0.30
	Blumeopsis flava (DC) Gagnepain	085-MPK	H	125	0.35
	Crassocephalum crepidioides (Benth.) Moore	083-MPK	H	120	0.28

	Eupatorium adenophorum Spreng.	045-MPK	H	133	0.42
	Eupatorium riparium Regel. Gaertn.	063-MP	H	32	0.47
	Gynura bicolor (Roxb. ex Willd.) DC.	091-MP	H	49	0.26
	Saussurea deltoidea (DC.) Sch. –Bip.	052-M	Us	68	0.12
	Sonchus asper (Linn.) Hill.	053-MP	H	35	0.17
	Spilanthes acmella Linn.	097-K	H	22	0.50
	Spilanthes paniculata wallich ex DC.	007-M	H	66	0.20
	Tithonia diversifolia (Hemsl.) A. Gray	096-MPK	Us	20	0.65
Berberidaceae	*Mahonia manipurensis* Takeda	176-M	S	68	0.12
Betulaceae	*Alnus nepalensis* D. Don.	131-M	s	35	0.08
	Betula alnoides Buch-Ham. ex D. Don	202-P	T	28	0.18
Bignoniaceae	*Oroxylum indicum* (Linn.) Vent.	066-MPK	T	103	0.56
Bombacaceae	*Bombax ceiba* Linn.	201-MP	T	56	0.09
Cannabinaceae	*Cannabis sativa* Linn.	158-K	Us	48	0.44
Caprifoliaceae	*Sambucus javanica* Bl.	138-MP	S	53	0.21
	Viburnum foetidum Wall.	050-M	S	26	0.04
Caricaceae	*Carica papaya* Linn.	093-PK	T	69	0.32
Caryophyllaceae	*Drymaria cordata* (Linn.) Roem. & Schult.	015-MPK	Cr	116	0.23
Chenopodiaceae	*Chenopodium ambrosiodes* Linn.	011-M	Us	83	0.19
Crassulaceae	*Bryophyllum pinnatum* (Lam.) Kruz.	107-MP	H	44	0.14
Cucurbitaceae	*Gymnopetalum cochinensis* (Lour.) Kurz.	078-MPK	Cl	69	0.27
	Melothria maderaspatana (Linn.) Cogn.	172-MPK	Cl	74	0.22
Cuscutaceae	*Cuscuta reflexa* Roxb.	037-MK	Tw	48	0.25
Eleocarpaceae	*Elaeocarpus floribundus* Bl.	073-M	T	33	0.15
Ericaceae	*Rhododendron arboreum* Sm.	044-MP	T	82	0.22
Euphorbiaceae	*Emblica officinalis* Gaertn.	080-MPK	T	67	0.48
	Glochidion oblatum Hook. f.	088-M	S	5	0.4
	Jatropha curcas Linn.	188-MK	T	13	0.31
	Phyllanthus fraternus Web.	122-P	H	2	1.0
	Ricinus communis Linn.	055-MPK	S	126	0.30
Fagaceae	*Quercus serrata* Thunb.	117-MP	T	65	0.33
Fumuriaceae	*Dicentra scandens* (D. Don.) Walp.	160-M	Cl	28	0.50
Gentianaceae	*Swertia chiraita* Linn.	129-MP	H	75	0.11
	Swertia pulchella (D. Don) Clarke.	068-MP	H	44	0.29
Geraniaceae	*Geranium nepalense* Sw.	198-M	H	33	0.18
Hypoxidaceae	*Curculigo orchioides* Gaertn.	195-M	H	68	0.16
Juglandaceae	*Juglans regia* Linn.	162-PK	T	17	0.29
Lamiaceae or Labiatae	*Calamintha umbrosa* (Bieb.) Benth.	196-M	H	84	0.12
	Elsholtzia blanda Benth.	112-M	H	48	0.37

	Mentha arvensis Linn.	167-MP	H	16	0.48
	Leucus indica Linn.	004-M	H	77	0.4
	Ocimum basilicum Linn.	168-MPK	H	28	0.28
	Ocimum sanctum Linn.	132-MPK	H	2	
Lauraceae	*Litsea cubeba* (Lour.) Pers.	064-M	T	28	0.14
Leguminosae	*Bauhinia purpurea* Linn.	118-MPK	T	63	0.38
	Desmodium triquetrum DC.	101-MP	H	7	0.28
	Entada phaseoloides (Linn.) Merr.	159-P	Cl	2	0.5
	Erythrina arborescens Roxb.	098-K	T	27	0.48
	Mimosa pudica Linn. with *E. Adenophorum*	187-MPK	H	46	0.24
	Parkia roxburghii G. Don.	099-MPK		14	0.93
Liliaceae	*Acorus calamus* Linn.	111-MP	H	42	0.33
	Asparagus filicinus Buch.-Ham. Ex D. Don.	013-MP	Cl	33	0.09
	Smilax ovalifolia Roxb.	108-MPK	Cl	47	0.19
Lygodiaceae	*Lygodium japonicum* (Thunb.) sw.	164-M	Cl	20	0.20
Melastomataceae	*Osbeckia stellata* Wall.	130-M	S	42	0.26
Meliaceae	*Cedrela serrata* Royle	200-P	T	19	0.21
	Melia composita Willd.	090-M	T	89	0.19
Moraceae	*Ficus auriculata* Lour.	082-MPK	T	37	0.24
Myricaceae	*Myrica nagi* (Thunb.) Hook.	077-MPK	T	106	0.23
Nyctaginaceae	*Mirabilis jalapa* Linn.	031-P	H	21	0.24
Oxalidaceae	*Oxalis corniculata* Linn.	008-MK	Cr	106	0.19
Passifloraceae	*Passiflora edulis* Sims	104-MPK	Cl	90	0.24
Plantaginaceae	*Plantago erosa* Wall.	137-MPK	H	37	0.13
Poaceae	*Arundo donax* Linn.	014-M	Us	68	0.10
	Cynodon dactylon Pers.	100-MP	H	14	0.21
	Imperita cylindrica (Linn.) P. Beauv.	69-M	H	28	0.14
	Thysanolaena maxima (Roxb.) Kuntz.	186-P	Us	9	0.33
Punicaceae	*Punica granatum* Linn.	194-MPK	S	17	0.35
Rananculaceae	*Ranunculus scelaratus* Linn.	006-M	H	35	0.11
	Thalictrum foliolosum DC.	001-MP	H	87	0.62
Rosaceae	*Fragaria nilgerrensis* Schldl.	005-MP	Cr	37	0.32
	Potentilla fulgens Wall. ex Hook.	059-MP	H	42	0.12
	Prunus persica (Linn.) Batsch.	049-MPK	T	127	0.27
	Rubus ellipticus Smith.	034-MPK	S	102	0.18
	Rubus niveus Thunb.	212-PK	S	20	0.60
Rubiaceae	*Paederia foetida* Linn.	110-MPK	Cl	118	0.31
Rutaceae	*Zanthoxylum armatum* DC.	123-MP	S	13	0.46
	Zanthoxylum rhetsa (Roxb.) DC.	010-MP	T	44	0.54
Sapindaceae	*Sapindus mukorossi* Gaertn.	152-MP	T	29	0.80
Scruphulariaceae	*Pratia begonifolia* (Wall.) Lindl.	089-M	Cr	5	0.4
Solanaceae	*Datura arboreum* Mendl	046-MP	S	89	0.23
	Nicotiana tabacum Linn.	054-MPK	H	108	0.21
	Physalis peruviane Linn.	041-MP	H	82	0.35
	Sapindus mukorossi Gaertn.	042-MPK	Us	82	0.18

	Solanum khasianum Clarke	058-MPK	S	100	0.22
	Solanum kurzii Br.	027-MP	H	51	0.17
	Solanum nigrum Linn.	057-MP	Us	35	0.14
	Solanum spirale Roxb.	120-MP	H	86	0.22
Triliaceae	*Paris polyphylla* Sm.	174-K	T	20	0.20
Theaceae	*Schima wallichii* (DC.) Korth.	133-MPK	Cr	119	0.33
Ubelliferae or Apiaceae	*Centella asiatica* (Linn.) Urban	069-M	Cr	2	1.0
	Hydrocotyle sibthorpioides Lam.	009-MP	H	91	0.37
	Oenanthe javanica (Bl.) DC ssp. stolonifera Wall.	103-MPK	T	78	0.10
Urticaceae	*Debregeasia longifolia* (Burm. f.) Wedd.	003-MP	H	75	0.16
	Pouzolzia bennettiana Wight	161-MPK	S	91	0.41
Verbenaceae	*Clerodendrum colebrookianum* Walp. Ex Walp.	042-MPK	S	118	0.20
	Lantana camara Linn.	072-MPK	H	118	0.33
	Verbena officinalis Linn.	105-M	Us	9	0.18
Viscaceae	*Viscum articulatum* Burm. f.	051-MPK	S	65	0.21
Zingiberaceae	*Costus speciosus* (Koening) Sm.	076-MP	H	24	0.17
	Curcuma longa Linn.	155-MP	H	4	0.50
	Curcuma caesia Roxb.	092-MPK	H	52	0.20
	Zingiber purpureum Rosc.	139-P	H	19	0.26

N.B: M-Mao, P-Poumei, K-Kuki; H-herb, S-shrub, T-tree, Us-under shrub, Cl-climber, Cr-creeper, Tw-twinner

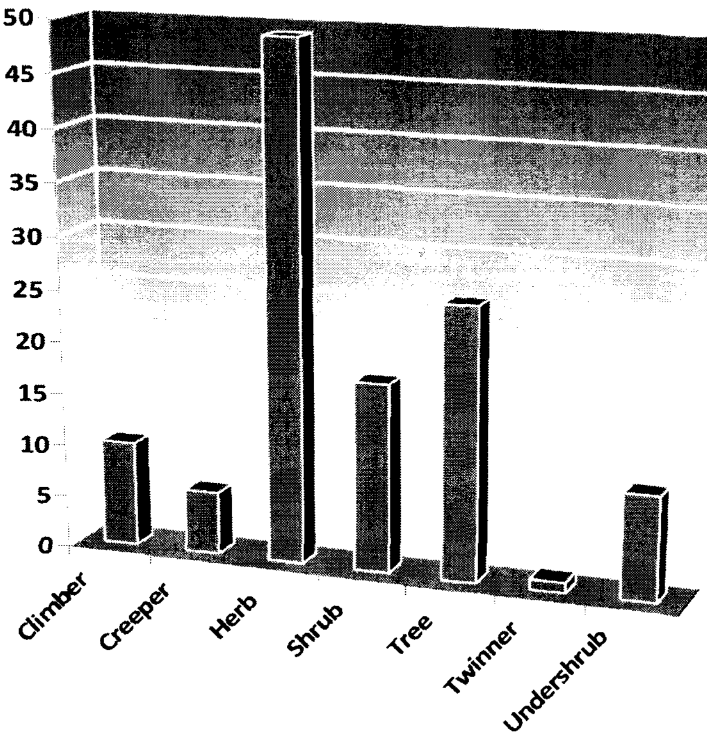


Figure 4. Number of species in terms of plant habits.

plants and fruit each with 11 (12.36%) species. The used of underground plant parts include root, root bark, tuber and rhizome. Fig.1 showed an outline of the different plant parts used. Also in terms of plant habits, herbs with 49 (40.83%) species constitute the largest number of species follow by trees 26 (21.67%) species (Figure 4). Removal of leaves is more sustainable (Giday *et al.*, 2003) as compared to the used of whole plant, root, fruit or seeds for medicine as this will caused an adverse negative effect on plant population growth which in turns will lead to decline of populations in nature (Ghimire *et al.*, 2008). The majority of the informants 84 (60.34%) mentioned *Phlagocanthus curviflorus* Nees as medicinal for the treatment of various ailments such as gastritis, fevers, headache, high blood pressure, body ache, joint dislocation and sprain, etc. and this species was recorded as the most popular remedy in the present study. This was followed by *Oroxylon indicum* (Linn.) Vent 58 (41.73%), *Rhus semialata* Murry. and *Artemesia parviflora* Roxb. with 57 (41%) citations each, *Eupatorium adenophorum* Spreng. 56 (40.28%) and *Thalictrum foliolosum* DC. 54 (38.85%) respectively.

Importance of ailments indicated

About 53 different ailments have been recorded in the present investigation. Out of this, the importance of only 10 most common or important ailments in the areas are evaluated based on the number of citations made by the informants during survey to different villages as shown in the (table 3). Figure 5 illustrates the relative importance of the specific ailment reco-rded: cut or injury and wound healing (CIWH) 15.47%, gastritis (G) 9.29%, dysentery (Dy) 9.14%, stomachache (S) 6.54, fevers (F) 6.54%, diarrhea (Di) 6.28%, blood pressure (BP) 6.12%, bodyache (B) 4.77%, killing maggots and wound healing (KMWH) 4.20%, bone fracture, dislocation or sprain (BFDS) 3.63%, etc. Further in terms of ailment categoryes, gastro-intestinal disorders (table 3) with 50 species constitute the highest number follow by fevers and circulatory system disorders with 22 species each.

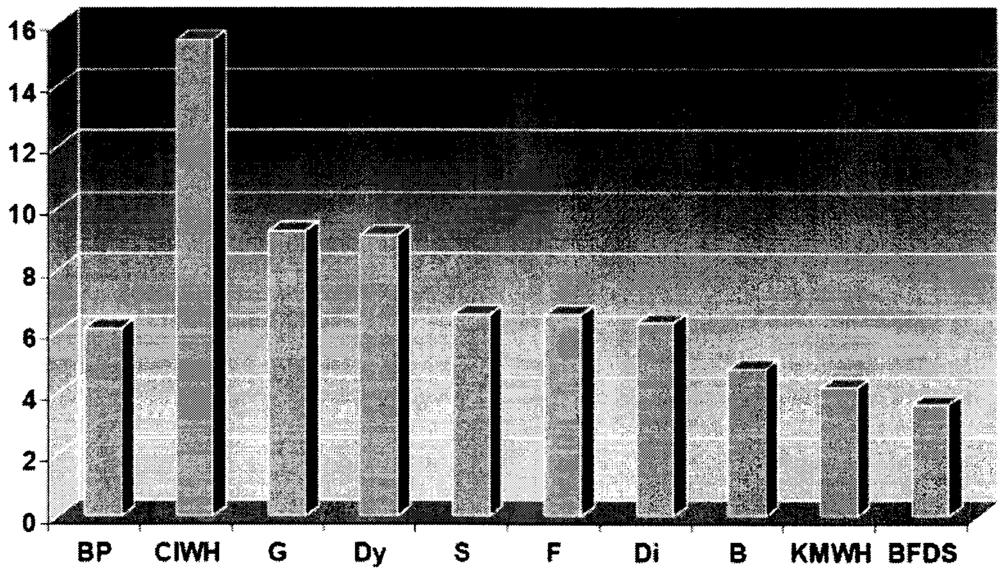


Figure 5. Relative importance of the specific ailments

Table 3. Informant consensus factors according to ailment categories

Ailment categories	Type of biomedical ailments in the category	Number of Species	% All species	Number of use citations	% All use citations	ICF
Intestinal diseases	Diarrhea	23	19.17	121	6.28	0.82
	Dysentery	25	20.83	176	9.14	0.86
Digestive disorders	Gastritis	19	15.83	179	9.29	0.90
	Indigestion	2	1.67	10	0.52	0.88
	Constipation	3	2.50	11	0.57	0.80
	Stomachache	16	13.33	126	6.54	0.88
	Flatulence or carminative	7	5.83	39	2.02	0.84
Antidote	Snake and insect bites	5	4.17	39	2.02	0.89
Cut and injury	Controlled bleeding, contusion and wound healing	26	21.67	298	15.47	0.91
	Bodyache	12	10.00	92	4.77	0.88
Skeleto- muscular system problems	Bone fracture, joint dislocation and sprain	10	8.33	70	3.63	0.87
	Body swelling, arthritis and rheumatism	3	2.50	9	0.47	0.75
Veterinary diseases	Killing maggots and wound healing	7	5.83	81	4.20	0.92
	Expulsion of leeches from animal nostril	1	0.83	8	0.41	1.0
Abnormal blood sugar level	Diabetes	4	3.33	19	0.98	0.83
Oncogenes	Cancer or tumours	1	0.83	5	0.26	1.0
Fevers	Malaria and intermittent	19	15.83	126	6.54	0.85
Circulatory system disorders	Blood pressures	12	10.00	118	6.12	0.91
	Jaundice and hepatic complaints	6	5.00	33	1.71	0.84
	Sinusitis	2	1.67	10	0.52	0.89
ENT problems	Epistaxis or bleeding nose	2	1.66	21	1.09	0.95
	Ear-infections	3	2.50	9	0.46	0.75
Opthalmological uses	Conjunctivitis and other eye diseases	5	4.17	16	0.83	0.73
	Boils, scabies and other skin diseases	9	7.50	43	2.23	0.81
Dermatological infections	Inflammation and burns	4	3.33	9	0.47	0.62
	Kidney and urinary bladder stones	3	2.50	8	0.41	0.71
Genito-urinary ailments	Menstrual disorders and white discharge,	2	1.67	5	0.26	0.75
	Diuretic or painful urination	3	2.50	7	0.36	0.67
Respiratory diseases	Chest pain	3	2.50	12	0.62	0.82
	Cough and cold	8	6.67	22	1.14	0.67
Dental problems	Toothache and other gum complaints	12	10.00	44	2.28	0.74
Neuro-muscular problems	*Epilepsy*	2	1.67	5	0.26	0.75
Deworming	Anthelmentic or worm expulsion	5	4.17	17	0.88	0.75
Vomiting		5	4.17	29	1.50	0.86
Headache		4	3.33	20	1.03	0.84
Abortificient	Foetus expulsion	2	1.67	8	0.41	0.86
Piles (haemorrhoid)		7	5.83	22	1.14	0.71
Fish bone removal		2	1.67	22	1.14	0.95
Hair care	Hair tonic, dandruff, lice problem	5	4.17	37	1.92	0.89

Veterinary use of medicinal plants

About 8 different species belonging to 6 families and 7 genera are reported to have veterinary applications. The diseases or an ailment treated includes killing maggots and wound healing, leeches expulsion from cattle's nostril and also as insects repellent e.g. ticks. The plant species recorded during survey are *Arundo donax* Linn., *Artemesia parviflora* Roxb., *Chenopodium ambrosioides* Linn., *Nicotiana tabacum* Linn., *Oroxylon indicum* (Linn.) Vent., *Prunus persiaca* (Linn.) Batsch, *Solanum khasianum* Clarke and *Solanum nigrum* Linn. With the exception of *Artemesia parviflora* Roxb. where it is used in fresh or dry form as insects repellent, in all other species the remedies are prepared from fresh plant parts either by crushing or ground and applied as paste.

Mode of preparation

The local people employed variety of methods such as decoction, infusion, crushing or grounding, squeezing or extraction and other unspecific methods to prepared remedies for treating different diseases or ailments. Boiled decoction and crushing or grounding are the predominant methods of preparation. Squeezing or extraction of juice from fresh plants parts particularly from the leaves is also not less common and were used mainly to treat ear, eye and nose ailments as well as controlled bleeding and wound healing due to cut and other external injuries. The ground plant parts are usually applied as paste on affected areas. The most frequently used form of preparations were decoction 62 (41.61%) followed by crushing or grounding 41 (27.52%), hot infusion 5 (3.35%), extraction or squeezing 24 (16.11%) and others 17 (11.41%).

Informant consensus, use value and fidelity level

Calculation of the value of informant consensus factor showed that it ranges from 0.62-1.0 indicating that there is a well defined selection criterion of the plant used and also exchanged of information's among the different informants in the study area. Leeches expulsion from animal nostril, cancer or tumours and epistaxis have the highest ICF value 1.0 each as there is well defined selection criterion in the community since only one species has been reported to be used for each ailments. The value is also high for removal of block fish bone from throat (0.95), killing maggots in cattle's wound (0.92), blood pressure and cut or external injury and wound healing (0.91), gastritis (0.90), etc. as there is information exchanged among the different informants indicated by the high number of use reports or citations 298, 179 and 81 for each category of these ailments. An outline of ICF values for other categories of diseases or ailments are presented in the (table 3). The lowest was observed for the ailment inflammation and burns in the category of dermatological infections with 0.62 ICF value and 9 citations from 4 different species. The three most cited disease categories are digestive disorders (stomachache, gastritis, indigestion, constipation, flatulence or carminative, etc.) with 31 species and 365 citations, intestinal illness (diarrhea and dysentery) with 25 species and 297 citations and cut or injury with 298 citations from 26 species of medicinal plants used as remedy. As calculated the use-value (UV), *Parkia roxburghii* G. Don., *Sapindus mukorossi* Gaernt., *Catharanthus roseus* (Linn.) G. Don., *Phlogacanthus curviflorus* Nees. and *Tithonia diversifolia* (Hemsl.) A. Gray were recorded to have the highest use value. *Parkia roxburghii* G. Don is used in gastritis, diarrhea , dysentery

Table 4. Some commonly use medicinal plants and their major uses with their Fidelity Level (FL)

Botanical name	Family	Major uses	Np	N	FL (%)
Artemisia parviflora Roxb.	Asteraceae or Compositae	Control bleeding in cut or injury and nose bleeding	57	57	100
Clerodendron colebrookianum Walp.	Verbenaceae	High BP	37	37	100
Physalis peruviane Linn.	Solanaceae	Stomachache and dysentery	29	29	100
Curcuma caesia Roxb.	Zingiberaceae	Stomachache	23	24	95.83
Prunus persiaca (Linn.) Batsch.	Rosaceae	Killing maggots in animal wounds and skin diseases	32	34	94.12
Artemesia nilagirica (Clarke) Pamp.	Asteraceae or Compositae	Diarrhae, dysentery, cut or injury	43	48	89.58
Gymnopetalum cochinensis (Lour.) Kurz.	Cucurbitaceae	Jaundice and fever	17	19	89.47
Rhus semillata Murry. DC.	Anacardiaceae	Dysentery and vomitting	51	63	87.30
Psidum gaujava Linn.	Myrtaceae	Diarrhae & dysentery	33	38	86.84
Thalictrum foliolosum DC.	Rananculaceae	Fever, high BP and stomachache	41	52	78.84
Eupatorium adenophorum Spreng.	Asteraceae or Compositae	Cut or external injury	44	56	78.57
Phlagocanthus curviflorus Nees	Acanthaceae	Fever, bodyache and high BP	64	84	76.19
Oroxylon Indicum (Linn.) Vent.	Bignoniaceae	Gastritis, killing maggots and wound healing	42	58	72.41

and piles with a UV of 0.93, *Sapindus mukorossi* Gaernt and *Catharanthus roseus* (Linn.) G. Don used against tooth ache, epilepsy, constipation, stomachache, fevers and dry cough have UV 0.80 each while *Phlogacanthus curviflorus* Nees used in gastritis, fevers, headache, high BP, body ache, joint dislocation or sprain and *Tithonia diversifolia* (Hemsl.) A. Gray used against heamorrhoids, skin diseases and cut or injury was reported with a UV of 0.67 and 0.65. The use value (UV) of all other species recorded in this study is presented on the (table 2). Also (table 4) showed an outlines of some commonly use medicinal plants in the surveyed areas and their major uses with fidelity level. The medicinal plants with 100% fidelity level such as *Artemisia parviflora* Roxb., *Clerodendron colebrookianum* Walp. and *Physalis peruviane* Linn. are reported as remedy for one or two diseases. The calculated level for each of this medicinal plant also agrees with ICF value. Obviously, the remedies for frequently reported ailments have the highest FL value and those with low number of reports have the lowest FL values.

Discussion and conclusion

The present study revealed a rich heritage of ethnomedicinal knowledge and high diversity of medicinal plants from the study areas. During the survey, about 120 medicinal plants including 8 species of plant having ethno veterinary importance were recorded. Few plant species such as *Clerodendron colebrookianum* Walp., *Dicentra scandens* (D. Don.) Walp., *Gymnopetalum cochinensis* (Lour.) Kurz., *Panax pseudoginseng* Wall., *Phlagocanthus curviflorus* Nees, *Oroxylon indicum* (Linn.) Vent., *Thalictrum foliolosum* DC., etc. used by the tribal people of the district against high BP, fevers, jaundice, gastritis, killing maggots and wound healing in cattle's have good evidence of effectiveness. The information's documented on the medicinal plants of these people does may be used as baseline data for future studies on phytochemical and pharmacological investigations. Many of the species documented in this study were previously reported to have phytochemical or pharmacological properties. For example the used of *Acorus calamus* L. for stomachache and throat problem is supported by other studies (Devkota *et al.*, 1999). *Oroxylon indicum* (L.) Vent was reported to have anticancer properties (Costa-Lotufo *et al.*, 2005). The plant is also used in Asian folk medicine for the treatment of abdominal tumors (Soe and Myongure, 2004). Similiarly *Swertia chirayita* used to cure cough, cold, fever, malaria and headache is mentioned as antipyretic or anti-inflammatory and antibacterial or anti-fungal in other studies (Chowdhury *et al.*, 1995; Devkota *et al.*, 1999; Bharyava *et al.*, 2009). Regarding medicinal preparations, infusion and decoction are the methods most commonly employed by the local people for the preparation of herbal medicines. Similarly on the basis of number of citations for medicinal uses, the most common ailments treated are gastrointestinal diseases such as (diarrhea, dysentery, stomachache, gastritis), fevers and cut or external injury.

The current investigation also showed leaves as the most collected plant parts for medicinal purposes and herbs as the most frequently utilized growth form followed by trees species. However, collection of leaves for medicinal preparations could be regarded as sustainable as far as some leaves are left over on the parent plant. Also in the study, it was observed that in almost all the cases the remedies were prepared from a single plant species. Moreover, there has been not report of cultivation of medicinal plants by the local people and the preparations are made by collecting the plants from the wild. This is a serious concern from the point of conservation and sustainability of the resources because such collection from the wild may lead to depletion of the population or even extinction of the resources particularly the rare and endangered species if it goes unabated. A good example of such case recorded from the district is *Panax pseudoginseng* Wall. and *Paris polyphylla* Sm. Excessive collection of this high value medicinal plants for trade outside the region in recent years leads to wipe out of the whole population from their natural habitats. In addition, the plant populations are also destroyed from their natural habitats by other anthropogenic activities like deforestation, habitat encroachment through shifting cultivation, forest fires, etc. Thus, in order to protect plants and indigenous knowledge for conservation and to ensure sustainable management, there is an urgent need for more documentation, identification and prioritizetion of important medicinal plants, development of database and proper harvesting techniques, formulation of cultivation techniques for potential species, community participatory management and awareness programs in the state and the region

Acknowledgements

The Authors are grateful to Botanical Survey of India (BSI), Eastern Circle, Shillong and herbarium curator of the department of Botany, North Eastern Hill University (NEHU) for providing herbarium facilities in the identification of plants. We are also grateful to University Grant Commission (UGC), New Delhi for giving financial assistant in the form of monthly stipend through Rajiv's Gandhi National Scholarship for SC/ST candidates. Our sincere thanks are also goes to those village elders and local herbal practitioners who readily help us to share informations about the local names of the plants, nature of its uses and also help to obtain plant samples whenever required during our field work. Last but not the least, we are also very much indebted particularly to those village headman for arranging logistic support during our field tour to different villages.

Conflict of Interest statement

There is no conflict of interest associated with the authors of this paper, and the fund *sponsors did not cause any inappropriate influence on this work.*

References

Alexiades MN. (1996). Selected guidelines for ethnobotanical research: A field manual. New York Botanical Garden, Bronx, NY, 306, i-xx.

Ambasta SP. (1986). The useful plants of India. Publication and Information Directorate, CSIR, New Delhi, 698-699.

Ammon HPT, Wahl MA. (1991). Pharmacology of *Curcuma longa*. *Planta Medica*, 57: 1–7.

Anon., 1986. The Useful Plants of India. Council of Scientific and Industrial Research, New Delhi, India.

Araújo CC, Leon LL, 2001. Biological Activities of *Curcuma longa* L. Memórias do Instituto Oswaldo Cruz 96, 723–728.

Ashalata DK, Khan ML, Tripathi RS. (2005). Ethnomedicinal plants in the sacred groves of Manipur. *Indian Journal of Traditional Knowledge* 4, 21-32.

Awan MR, Iqbal Z, Shah SM, Jamal Z, Jan G, Afzal M, Majid A, Gul A. (2011). Studies on traditional knowledge on economically important plants of Kaghan Valley, Mansehra district, Pakistan. *Journal of Medicinal Plant Research*, 5(16): 3958-3967.

Jain SK. (1968). Medicinal plants. National Book Trust of India. Green park, New Delhi.

Baker JT, Borris RP, Carte B, Cordell GA, Soejarto DD, Cragg GM, Gupta MP, Iwu MW, Maduud DR, Tyler VE. (1995). Natural product drug discovery and development new perspectives on international collaboration. *Journal of Natural Products* 58, 1325-1357.

Bantawa P, Rai R. (2009). Studies on ethnomedicinal plants used by traditional practitioners, *Jhankri*, *Bijuwa* and *Phedangma* in Darjeeling Himalaya. *Natural Product Radiance* 8, 537-541.

Bharyava S, Rao PS, Bhargava P, Shukla S. (2009). Antipyretic potential of *Swertia chirata* Buch. Ham. root extract. *Scientia Pharmaceutica* 77, 617-623.

Chopra RN, Nayer SL, Chopra IC. (1992). Glossary of Indian Medicinal Plants, 3rd edn. Council of Scientific and Industrial Research, new Delhi, 7-246.

Chowdhury NI, Bandyopadhyay SK, Banerjee SN, Dutta MK, Das PC. (1995). Preliminary studies on the anti-inflammatory effects of *Swertia chirata* in albino rats. *Inidan Journal of Pharmacology* 27, 37-39.

Costa-Lotufo L, Khan M, Ather A, Wilke D, Jimenez P, Pessoa C, de Moraes M. (2005). Studies of the anticancer potential of plants used in Bangladeshi folk medicine. *Journal of Ethnopharmacology* 99, 21-30.

Cox PA, Ballick MJ. (1994). The ethnobotanical approach to drug discovery. *Scientific American*, 82-87.

Cox AP, Ballick JM. (1996). Ethnobotanical research and traditional healthcare in developing countries. Plants, People and Culture, New Work: freeman, W. H. and Co.

Das AK, Dutta BK, Sharma GD. (2008). Medicinal plants use by different tribes of Cachar district, Assam. *Indian Journal of Traditional Knowledge* 7, 446-454.

Devi OS, Komor P, Das D. (2010). A checklist of traditional edible bio-resources from Ima markets of Imphal Valley, Manipur, India. *Journal of Threatened Taxa* 2, 1291-1296.

Devkota KP, Acharya R, Baral MP, Adhikari RP. (1999). Antimicrobial activities of some herbal plants used in traditional medicine in Nepal. In: Anonymous (Ed.), Proceeding of the Third National Conference on Science and Technology. Nepal Academy of Science and Technology, Kathmandu, 1311-1317.

Dutta BK, Dutta PK. (2005). Potential of ethnobotanical studies in Northeast India: An overview. *Indian Journal of Traditional Knowledge* 4, 7-14.

Dwivedi AK, Chowdhary M, Sarine TPS. (1990). Standardisation of a new spermicidal agent Sapindus saponin and its estimation in its formulation. *Indian Journal of Pharmaceutical Science* 52, 1657.

Ficker CE, Smith ML, Susiarti S, Leaman DJ, Irawati C, Arnason JT. (2003). Inhibition of human pathogenic fungi by members of Zingiberaceae used by theKenyah (Indonesian Borneo). *Journal of Ethnopharmacology* 85, 289–293.

Gadgil M, Rao PRS. (1998). Nurturing biodiversity: an Indian agenda. Centre for Environment Education, Ahmedabad, India.Gazzaneo L, de Lucena R, de Albuquerque U. (2005). Knowledge and use of medicinal plants by local specialists in an region of Atlantic Forests in the state of Pernambuco (Northeastern Brazil). *Journal of Ethnobiology and Ethnomedicine* 1, 8.

Gemedo-Dalle T, Maass BL, Isselstein J. (2005). Plant biodiversity and ethnobotany of Borana pastoralists in Southern Oromala, Ethiopia. *Economic Botany* 59, 43-65.

Ghimire SK, Lama YC, Tripathi GR, Schmitt S, Aumeeruddy-Thomas Y. (2008). Demographic variation and population viability in a threatened Himalayan medicinal and aromatic herb Nardostachys grandiflora: matrix modelling of harvesting effects in two contrasting habitats. *Journal of Applied Ecology* 45, 41-51.

Giday M, Asfaw Z, Elmqvist T, Woldu Z. (2003). An ethnobotanical study of medicinal plants used by the Zay people in Ethiopia. *Journal of Ethnopharmacology* 85, 43-52.

Hamil FA, Apio S, Mubiru NK, Mosango M, Bukenya-Ziraba R, Maganyi OW, Soejarto DD. (2000). Traditional herbal drugs of southern Uganda I. *Journal of Ethnopharmacology* 70, 281-300.

Haridasan K, Rao RR. (1985 & 1987). Forest Flora of Meghalaya, Vol. 1-2, Botanical Survey of India, Dehra Dun, India.

Heinrich M, Ankli A, Frei B, Weimann C, Sticher O. (1998). Medicinal plants in Mexico: healer's consensus and cultural importance. *Soc Sci Med* 47, 91-112.

Hynniewta SR, Kumar Y. (2008). Herbal remedies among the Khasi traditional healers and village folks in Meghalaya. *Indian journal of Traditional Knowledge* 7, 581-586.

Ignacimuthu S, Ayyanar M, Sankara Sivaraman K. (2006). Ethnobotanical investigations among tribes in Madurai District of Tamil Nadu (India). *Journal of Ethnobiology and Ethnomedicine* 2, 25.

Jadhav D. (2007). Ethnomedicinal plants used by Bhil tribeof Bibdod, Madhya Pradesh. *Indian journal of Traditional Knowledge* 5, 263-267.

Jain A, Sundriyal M, Roshnibala S, Kotoky R, Kanjilal PB, Sundriyal RC. (2011). Dietary use and conservation concern of edible wetland plants at Indo-Burma hotspot: a case study from Northeast India. *Journal of Ethnobiology and Ethnomedicine* 7, 29.

Jain SK. (1968). Medicinal plants. National Book Trust of India. Green Park, New Delhi.

Jain SK. (1991). Dictionary of Indian Folk Medicine and Ethnobotany. Deep Publications, New Delhi, India.

Joshi AR, Edington JM. (1990). The use of medicinal plants by two village communities in the Central Development Region of Nepal. *Economic Botany* 44, 71–83.

Kala CP. (2005). Ethnomedicinal botany of the Apatani in the Eastern Himalayan region of India. *Journal of Ethnobiology and Ethnomedicine* 1, 11.

Kanjilal UN, Kanjilal PC, Das A, De RN, Bor NL. (1934-1940). Flora of Assam, 5 vols. Government Press, Shillong.

Khan MH, Yadava PS. (2010). Antidiabetic plants used in Thoubal district of Manipur, Northeast India. *Indian journal of Traditional Knowledge*, 9(3): 510-514.
Kharkhongor P, Joseph J. (1981). Folklore medicobotany of rural Khasi and Jaintia tribes in Meghalaya. In: Jain, S.K. (Ed.), Glimpses of Indian Ethnobotany. Oxford and IBH, New Delhi, India, 115.
Kharkhongor P, Joseph J. (1981). Folklore medico-ethnobotany of rural Khasi and Jaintia tribes in Meghalaya. In: Jain, S.K. (Ed.), Glimpses of Indian Ethnobotany. Oxford and IBH, New Delhi, India.
Khumbongmayum AD, Khan ML, Tripathi RS. (2005). Ethnomedicinal plants in the sacred grooves of Manipur. *Indian journal of Traditional Knowledge* 4, 21-32.
Kirtikar KR, Basu BD. (1935). Indian Medicinal Plants, vols. 1–4. Lalit Mohan Basu, Allahabad, India.
Kirtikar KR, Basu BD. (1991). Indian Medicinal Plants, vols.1. Allahabad, India: BLM Basu publication, 633.
Kokwaro JO. (1976). Medicinal Plants of East Africa. East Africa Literature Bureau, Nairobi.
Kunwar RM, Nepal BK, Kshhetri HB, Rai SK, Bussmann RW. (2006). Ethnomedicine in Himalaya: a case study from Dolpa, Humla, Jumla and Mustang districts of Nepal. *Journal of Ethnobiology and Ethnomedicine* 2, 27.
Lavergne R, Vera R. (1989). Etude ethnobotaniques des plants utilises dans la Pharmacopee traditional a la reunion. Agenec de cooperation culturulle et technique, Paris.
Lavergne R. (2001). Tisaneurs et plants medicinales indigenes de la reunion. Saint de la reunion, Orphie.
Maheshwari JK, Singh JP. (1984). Contribution to the ethnobotany of Bhoxa tribe of Bijnor and Pauri Garhwal districts, U.P. *Journal of Economic Taxonomy and Botany* 5, 251–259.
Majumdar R, Bharoli BK. (1997). Medicinal plants from Chandel, Churachanpur, Ukhrul forest areas of Manipur state, part-1. *Bulletin of Medico-Ethnobotanical Research* 18, 35–42.
Manandhar NP. (1987a). An ethnobotanical profile of Manang Valley, Nepal. *Journal of Economic and Taxonomic Botany* 10, 207–213.
Manandhar NP. (1991). Medicinal plant-lore of Tamang tribe of Kabhrepalanchok District, Nepal. *Economic Botany* 45, 58–71.
Manandhar NP. (1992). Folklore medicine of Dhading District, Nepal. *Fitoterapia* 63, 163–177.
Manandhar NP. (1993). Ethnobotanical note on folk-lore remedies of Baglung district, Nepal. *Contributions to Nepalese studies* 20, 183-196.
Manadhar NP. (2002). Plants and people of Nepal. Timber Press Inc., Portland, Oregon.
Mao AA. (1993). A preliminary report on the folklore botany of Mao Naga of Manipur. *Journal of Ethnobotany* 5, 143-147.
Mao AA. (2003). Some symbolic and superstitious botanical folklore about Mao Naga tribe of Manipur (India). In J.K. Maheswari (Ed.) Ethnobotany and Medicinal Plants of Indian Subcontinent, Scientific publ., New Delhi, 625-628.
Mao AA, Hynniewta TM, Sanjappa M. (2009). Plant wealth of Northeast India with reference to ethnobotany. *Indian journal of Traditional Knowledge* 8, 96-103.
Mayer N, Muttermeier RA, Muttermeier CA, da Fornseca GAB, Kent J. (2000). Biodiversity hotspots for conservation Priorities. *Nature* 403, 853-858.
Mittermeier RA, Gil PR, Hoffmann M, Pilgrim J, Brooks T, Mittermeier CG, Lamoreux J, da Fonseca GAB. (2004). Hotspots revisited. Earth's biologically richest and most endangered terrestrial ecoregions. Cemex Books on Nature series, USA, 497.
Namsa ND, Mandal M, Tangjang S, Mandal SC. (2011). Ethnobotany of the Monpa ethnic group in Arunachal Pradesh, India. *Journal of Ethnobiology and Ethnomedicine* 7, 31.
Newton SM, Lau C, Gurcha SS, Besra GS, Wright CW. (2002). The evaluation of forty-three plant species for in vitro antimycobacterial activities: isolation of active constituents from *Psoralea corylifolia* and *Sanguinariacanadensis*. *Journal of Ethnopharmacology* 79, 57–67.

Philips O, Gentry AH, Revnel C, Wilki P, Gavez-Durand CB. (1994). Quantitative ethnobotany and Amazonian conservation. *Conservation Biology* 8, 225-248.

Rastogi RP, Mehrotra BN. (1999). Compendium of Indian medicinal plants: vol.2, CDRI publication, New Delhi, 609-610.

Ripu M, Kunwar RM, Shrestha KP, Bussmann RW. (2010). Traditional herbal medicine in Far-west Nepal:a pharmacological appraisal. *Journal of Ethnobiology and Ethnomedicine* 6, 35.

Shrestha PM, Dhillion SS. (2003). Medicinal plant diversity and use in the highlands of Dolakha district, Nepal. *Journal of Ethnopharmacology* 86, 81-96.

Singh MP, Malla SB, Rajbhandari SB, Manandhar A. (1979). Medicinal plants of Nepal: retrospects and prospects. *Economic Botany* 33, 185–193.

Singh NP, Chauhan AS, Mondal MS. (2000). Flora of Manipur, Vol. 1, Botanical Survey of India, Calcutta, India.

Singh PK, Singh NI, Singh LJ. (1988). Ethnobotanical studies on wild edible plants in the markets of Manipur II. *Journal of Economic Taxonomic Botany* 12, 113-119.

Sinha SC. (1996). Medicinal plants of Manipur published by Manipur Association for science & society (MASS), Imphal.

Pfoze NL, Chiezou DN. (2006). *Dicentra scandens* (D. Don) Walp. A highly potent ethnomedicinal plant against, malaria, high blood pressure and diabetes. *Indian Journal of Traditional Knowledge* 52, 268-270.

Pieroni A. (2000). Medicinal plants and food medicines in the folk traditions of the upper Lucca Province, Italy. *Journal of Ethnopharmacology* 70, 235-273.

Puyvelde LV, Ntawukiliyayo JD, Portaels F, Hakizamungu E. (1994). In vitro inhibition of mycobacteria by Rwandese medicinal plants. *Phytotherapy Research* 8, 65–69.

Rethy P, Singh B, Kagyung R, Gajurel PR. (2010). Ethnobotanical studies of Dehang-Debang biosphere reserve of Arunachal Pradesh with special reference to *Memba* tribe. *Indian journal of Traditional Knowledge* 9, 61-67.

Rosangkima G, Prasad SB. (2004). Antitumour activity of some plants from Meghalaya and Mizoram against murine ascites Dalton's Lymphoma. *Indian Journal of Experimental Biology* 42, 981-988.

Saha J, Sarkar PK, Chattopadhyay S. (2011). A survey of ethnomedicinal plants of Darjeeling hills for their antimicrobial and antioxidant activities. *Indian Journal of Natural Products and Resources*, 2(4): 479-492.

Sajem AL, Gosai K. (2006). Traditional use of medicinal plants by the Jaintia tribes in North Cachar Hills district of Assam, Northeast India. *Journal of Ethnobiology and Ethnomedicine* 2, 33.

Sajem AL, Gosai K. (2010). Ethnobotanical investigation among the Lushai tribes in North Cachar Hills district of Assam, Northeast India. *Indian journal of Traditional Knowledge* 9, 108-113.

Shah NC, Joshi MC. (1971). An ethnobotanical study of Kumaon region of India. *Economic Botany* 25, 414–422.

Sharma HK, Chhangte L, Dolui AK. (2001). Traditional medicinal plants in Mizoram, India. *Fitoterapia* 72, 146–161.

Shrestha PM, Dhillion SS. (2003). Medicinal plant diversity and use in the highlands of Dolakha district, Nepal. *Journal of Ethnopharmacology* 86, 81–96.

Soe K, Myo Ngwe T. (2004). Medicinal plants of Myanmar. Myanmar Forest Resource Environment Development and Conservation Association, Myanmar, pp 255.

Srivastava RC. (2009). Traditional knowledge of Adi tribe of Arunachal Pradesh on plants. *Indian journal of Traditional Knowledge* 8, 146-153.

Syiem D, Syngai C, Kharbuli B, Kayang H, Khongwir BS. (2003). Anti-tumor activity of crude root extract of *Potentilla fulgens*. *Indian Drugs* 40, 124-125.

Syiem D, Syngai C, Khup PZ, Khongwir BS, Kharbuli B, Kayang H. (2002). Hypoglycemic effects of *Potentilla fulgens* L. in normal and alloxan-induced diabetic mice. *Journal of Ethnopharmacology* 83, 55-61.

Taylor RSL, Manandhar NP, Towers GHN. (1995). Screeninig of selected medicinal plants of Nepal for antimicrobial activities. *Journal of Ethnopharmacology* 46, 153–159.

Teklehaymanot T, Giday M. (2007). Ethnobotanical study of medicinal plants used by people in Zegie Peninsula, Northwestern Ethiopia. *Journal of Ethnobiology and Ethnomedicine* 3, 12.

Tene V, Malagon O, Finzi PV, Vidari G, Armijos C, Zaragoza T. (2007). An ethnobotanical survey of medicinal plants used in Loja and Zamora-Chinchipe, Ecuador. *Journal of Ethnopharmacology* 111, 63–81.

Tona L, Kambu K, Ngimbi N, Cimanga K, Vlietinck AJ. (1998). Antiamoebic and phytochemical screening of some Congolese medicinal plants. *Journal of Ethnopharmacology* 61, 57-65.

Tushar, Basak S, Sarma GC, Rangan L. (2010). Ethnomedical uses of Zingiberaceous plants of Northeast India. *Journal of Ethnopharmacology* 132, 286-296.

Ugulu I, Baslar S, Yorek N, Dogan Y. (2009). The investigation and quantitative ethnobotanical evaluation of medicinal plants used around Izmir province, Turkey. *Journal of Medicinal Plants Research* 3, 345-367.

Uniyal SK, Singh KN, Jamwal P, Lal B. (2006). Traditional use of medicinal plants among the tribal communities of Chhota Bhangal, Western Himalaya. *Journal of Ethnobiology and Ethnomedicine* 2, 14.

Uprety Y, Asselin H, Boon EK, Yadav S, Shrestha KK. (2010). Indigenous use and bio-efficacy of medicinal plants in the Rasuwa District, Central Nepal. *Journal of Ethnobiology and Ethnomedicine* 6, 3.

Warrier PK, Nambiar VPK, Ramankutty C. 1993. Indian Medicinal Plants, vol.1–5.Orient Longman Ltd., Madras.

Wealth of India. Publications and Information Directorate, CSIR, New Delhi, 1976, 11: 21-22.

Yumkham SD, Singh PK. (2011). Less known ferns and fern-allies of Manipur with ethnobotanic uses. *Indian journal of Traditional Knowledge* 10, 287-291

