CHAPTER 1

1. INTRODUCTION

1.1 Background

1.1.1 Ethnobotany

Ethnobotany, a branch of science that includes the beliefs, tradition, religion and culture of the particular community or area, refers to the study of the relationship between people and plants. The use of plants and their products for different purposes can be traced as far back as the beginning of human civilization. Ethnobotany has contributed significantly to social, economical, cultural and environmental development. However, a higher demand for plant products as a result of global demand has resulted in exploitation of resources, threatening the existence of several important plant species. Because of this, the need for conservation of the remaining plant resource base with sustainable harvesting has been realized.

The term 'ethnobotany' was first used by (Harsberger, 1896) who defined it as the study of plants used by primitive (sic.) and aboriginal people. The science of ethnobotany was broadened by Robbins *et al*. (1916) who suggested that ethnobotany should include the investigation and evaluation of the knowledge of all phases of life amongst indigenous societies and of the effects of the vegetal upon the life customs, beliefs and history of these indigenous peoples. The interactions between plants and people have been established along with the evolution of human beings (Martin, 1995). Martin defined ethnobotany as the relationship of the people with the surrounding environments. Ethnobotanical research is concerned with the use of plants by the local people in their daily life. It is well known that plants have been used as medicine, food, fodder, fence, fuelwood, rituals, religious, and other purposes since ancient times.

1.1.2 Use of Plants as Medicine

Traditional medicine is widespread throughout the world. It comprises those practices based on beliefs that were in existence often for hundreds of years before the development and spread of modern medicine and which are still in use today. These days, according to the World Health Organization (WHO, 2000) as many as 80 % of the world's population depend on traditional medicine for their primary healthcare. Modern health services and other organized systems of traditional medicine have not been provided to the greater part of Nepal where the largest number of people live. There is a shortage of skilled labor and appropriate facilities.

In many areas of rural Nepal, medicinal knowledge and practice are not directly related to any of the formal medical systems, but have been passed down entirely through the oral tradition and personal experience (Bhattarai, 1998). The total population of Nepal is 23.1 million (CBS, 2004), and about 80 % of the Nepali people reside in rural areas where access to government health care facilities is lacking. It is estimated that there is one physician for 30,000 people whereas there is one healer for fewer than 100 people in Nepal (Gillam, 1989).

Plant resources of Nepal, including medicinal plants and the associated indigenous knowledge about their uses are disappearing at an alarmingly rapid rate. The cause of this disappearance is multifactorial, including habitat loss, forest destruction, degradation and over-exploitation of forest resources, population growth and poverty, illegal trade, etc. Literature dealing with use of plants, plant products and traditional medicinal practice is still meager (Chaudhary, 1998; Bhattarai and Maharjan, 2004; Karki and Nagpal, 2004).

1.1.3 Other Uses of Medicinal Plants

Plants are used for many purposes other than medicine as discussed above. Plants are used as food, fodder, for fencing, as fuelwood, for ritual and religious purpose, as dyes, household articles, construction materials and decoration materials amongst others.

Wild plants used in local cuisines are of considerable interest to both scientists and local governmental committees, because of the potential source of these local products as novel nutraceuticals (Pieroni *et al*., 2005). Plant diversity supplies the world's food. Wild food plants play a significant role in the livelihoods of rural communities in many developing countries (Johns and Kokwaro, 1991; Leakey and Newton, 1994), and the use of wild edible plants in Nepal is no different. Even in today's agricultural based societies, people gather wild plants for food. Wild plants, through the process of domestication, became the reservoir of new crop species. Moreover, wild food plants are now a valuable source of genes needed to improve the world's crops (Walters and Hamilton, 1993; Chaudhary, 1998).

Approximately 75,000 species of plants world-wide are believed to be edible (Walters and Hamilton, 1993). It has been estimated that about 3,000 species of plants have been used as food by human beings throughout history and that about 200 have been domesticated as food crops (Simpson and Ogorzaly, 1995). Food production is a concern as the world's population rises, perhaps by 3.7 billion in next 30-40 years. Currently 20 % of the population of the developing world is affected by malnutrition (WHO, 2000), and undernourished people in Nepal are lacking on average 260 kcal per person per day

(FAO, 2000). Sustainable consumption of non-cultivated edible plants could, to an extent, fulfill this requirement.

1.1.4 Bioassay Tests

Plants have been a rich source of medicine because they produce many biologically active molecules, most of which likely evolved as chemical defences against predation or interaction. Most plant species possess one or more medicinal property *viz*, antibacterial, antifungal, antiviral, anthelmintic, anticancer, sedative, laxative, diuretic and others (Taylor *et al*., 1996a, 2002; Taylor and Towers, 1998). Many studies have investigated the uses of medicinal plants in Nepal (Bhattarai, 1992, 1993a; Lama *et al*., 2001; Manandhar, 2002), however only a few species have been screened for biological activity (Bhakuni *et al*., 1969; Taylor *et al*., 1995, 1996a, 1996b, 1996c, 2002; Taylor and Towers, 1998; Parajuli *et al*., 2001; Rajbhandari *et al*., 2007).

Ethnobotanical information has led to the discovery of approximately 120 plants derived drugs, from only 95 species of flowering plants, which account for about 25 % of all drugs prescribed in North America every year (Cox and Balick, 1994). Also, less than 0.5 % of all flowering plant species have ever been studied for potential pharmaceutical activity (Balick and Cox, 1996). Recently, several useful plant-derived drugs have been discovered as a result of scientific follow-up of well known plants used in traditional medicine. Several of today's major diseases such as cancer are being treated with products derived from biodiversity. Thus, modern medicine has also benefited from medicinal plants that were originally used as herbal remedies. Therefore, medicinal plants used in traditional therapy could be a fruitful source for the discovery of many useful drugs.

1.1.5 Biologically Active Constituents

An antibacterial agent is a chemical substance that either kills microorganisms or prevents their growth. According to Tripathi (1995), antimicrobial agents can be synthetic as well as naturally obtained drugs that attenuate microorganisms. The antibacterial activities of plant extracts are studied by observing the inhibition zone (the zone of clearing around the extract on the bacterial lawn).

The action of an antibacterial compound upon microorganism may be either *bacteriostatic* i.e., inhibiting growth and reproduction or *bactericidal* i.e., actually killing the organism. The mechanism of action may be through an alteration of a vital process in the metabolism of this organism by interference with some specific enzyme systems or with the utilization of the certain metabolites. The most significant actions are the

disturbance of cell wall synthesis and the inhibition of protein biosynthesis (Hugo and Russel, 1985).

1.1.6 Indigenous Knowledge and Conservation and Management of Useful Plant Resources

Biological resources and the traditional knowledge of their use by ethnic communities are being eroded at an alarming rate in Nepal. Maintenance of a sustainable future for these biological resources is very urgent. A large number of communities' user groups, governmental and non-governmental organizations as well as herbal industries are concerned about the impact of disappearance of medicinal plants.

In Nepal it is recognized to value and identify important plant areas (IPAs), priority sites of medicinal plants, and priority species for conservation action. Assessment of indigenous knowledge regarding conservation of plant resources has been essential to understand the conservation approach undertaken by the local communities (NTNC, 2007) and local community involvement as a major stakeholder is essential for effective conservation of prioritized medicinal plants at IPAs (Bhattarai *et al*., 2007b; Hamilton and Radford, 2007). It has also been argued that local people are social and political actors whose involvement is required in biodiversity conservation and management (Chaudhary, 1998; Bajrachraya *et al*., 2006; NTNC, 2007; Bajrachraya and Dahal, 2008).

The potential of local institutions to become involved in conservation and management of common property natural resources is widely acknowledged, not least in Nepal which has one of the world's most progressive forest policies in terms of forest user group participation. High altitude medicinal plants are not adequately included in forest management plans, meaning that formal management responsibilities lie with central authorities (HMGN, 2002).

1.1.7 Prioritization and Trade of Important Plant Species

There are between 35,000 and 70,000 plant species which have been used for medicinal purposes in the world (Farnsworth and Soejarto, 1991). Approximately 6,500 species are used in Asia as home remedies (Karki and Williams, 1999). In Nepal, at least 1,000 species of plants are used in traditional medicinal practice (Chaudhary, 1998). Currently approximately 100 species are exploited for commercial uses in Nepal; followed by 540 species in India; 400 in Pakistan; 300 in Bhutan and 250 in Bangladesh. In order to effectively utilize human and financial resources available, a small number of species (perhaps 25-30) need to be selected for an intensive research and focus on sustainable development. These species, if properly and historically examined and used to obtain all

the possible benefits, including biological, medical, ecological and economic, could then be the base of a large effort to improve and sustain a vibrant and socio-economically sound medicinal plants sector (Karki and Williams, 1999).

Experts working in the areas of medicinal plants estimate that about 700 to 1,700 species of MAPs occur in Nepal and out of these, over 100 species are widely traded and exported (Ghimire, 2008; Tiwari *et al*. 2004; Shrestha *et al*., 2000) to different parts of Nepal and abroad. The volume of trade in plants across the Himalaya is enormous, estimated at tens of thousands of tons yearly, composed of hundreds of species and products (Edwards, 1996). As in other Himalayan countries, the state of medicinal plants resources in Nepal is poorly known (HMGN, 2002). Regulation of harvest and trade takes place according to the Forest Act (MFSC, 1993) and Forest Regulations (MFSC, 1995), but compliance with these acts and enforcement has not been effective to date (Nagpal and Karki, 2004; Rawal, 2004; Olsen and Bhattarai, 2000; Olsen, 1998).

Nepal is a major supplier of important Himalayan medicinal plants (Edwards, 1996; Olsen and Larsen, 2003) and study found that more than 90% of traded medicinal plants harvested in Nepal go to India (Olsen, 1998). Today, in Nepal, the main focus within the non-wood forest products sector is on commercial medicinal and aromatic products (Aryal, 1993; Sharma, 1995; Edwards, 1996).

1.2 Hypothesis

1.2.1 Importance of research area

Exploration of ethnobotanical knowledge has gained importance in the remote Himalayan regions of Nepal where modern medicine is lacking. Research has shown that Manang and Mustang districts are important areas for useful medicinal plant resources (Manandhar, 1987; Pohle, 1990; Ghimire *et al*., 1999; NTNC, 2006; Bhattarai *et al*., 2006b; Shrestha *et al*., 1996; Bista and Bista, 2005; Brohl, 2006; Kunwar *et al*., 2006) and neither district has been explored adequately. Manang and Mustang districts were chosen for this ethnomedicinal research for the following reasons (taken from Cox and Balick, 1994):

i. The study area is rich in diversity of useful species (Manandhar, 1987; Pohle, 1990; Bista and Bista, 2005; Chhetri *et al*., 2006);

ii. The society (communities) possess rich traditional knowledge (i.e. cultural diversity) (Pohle, 1990; Bista, 2004; Bista and Bista, 2005); and

iii. There is a culture of tradition in which healers or knowledgeable persons transmit their traditional knowledge from generation to generation, usually through apprentices (Pohle, 1990; Bista and Bista, 2005);

Taking into consideration the case of ethnobotanical research and above points, several questions arise;

1.2.2 Research Questions

(a) How are plant resources being used by the local communities in primary health care and daily life?

(b) Do plant resources used by the local communities possess antibacterial activity in test (bacterial) organisms under *in vitro* conditions? Do plants used to treat illnesses likely caused by bacterial pathogens display antibacterial activity against these same or similar pathogenic bacteria in *in vitro* testing?

(c) Are the indigenous people involved in conservation activities?

(d) How is the knowledge of indigenous peoples transmitted, conserved and utilized?

(e) Are there plant resources being traded?

1.3 Objectives

The general objective of this research is to document the ethnomedicinal knowledge of the *Manangi* and *Mustangi*[1] people and begin to scientifically validate their traditional knowledge in the laboratory. The specific objectives are as follows:

(i) Ethnomedicinal study: To document plant resources used by the local community in traditional medicinal practice as well as other plant resources of daily use. During the ethnobotanical study, healers will also be asked about the transfer of the knowledge to the next generation.

(ii) Bioassay: (a) To assess the *in vitro* antibacterial activity of the selected ethnomedicinal plants. (b) To assess the Minimum Inhibitory Concentration (MIC) of some selected ethnomedicinal plants.

To accomplish this, ethnomedicinal plant species used to treat different kinds of ailments that may be of bacterial origin, for example cough, tonsillitis, fever, boils, respiratory infections, urinary infections etc., will be collected from the study area and tested in the laboratory using relevant bacteria.

[1]*Manangi* and *Mustangi*: The names used by the people of Manang and Mustang to describe themselves. People from Manang and Mustang are called *Manangi* and *Mustangi* respectively.

(iii) Indigenous knowledge and conservation: To assess the indigenous knowledge regarding conservation of medicinal plant resources in order to understand the approach to conservation used by local communities.

(iv) Trade pattern of important plant species: To explore the trade pattern of important plants, in particular those used for medicinal purposes. This will help to better understand the pattern of exploitation.

1.4 Justification

The reasons for undertaking this research are the following:

(a) Manang and Mustang districts are considered to be important areas for medicinal plant diversity (Manandhar, 1987; Pohle, 1990; Ghimire *et al*., 1999; NTNC, 2006; Bhattarai *et al*., 2006b) but neither of the districts has been explored adequately, and in particular there is little work regarding medicinal plants exploration (Manandhar, 1987; Pohle, 1990; Shrestha *et al*., 1996; Bista and Bista, 2005; Brohl, 2006; Kunwar *et al*., 2006). Documentation of ethnobotanical knowledge has gained importance in these remote trans-Himalayan regions of Nepal (Lama *et al*., 2001; Bhattarai *et al*., 2006b), where modern medicine and the infrastructure for modern medicine are lacking. Manang and Mustang have also been considered to be one of the important areas in Nepal for ecotourism, which relies upon biodiversity conservation (NTNC, 2006, 2008a, 2008b).

(b) In Nepal infectious diseases are common among people living in rural areas and are treated in the remote villages by traditional healers and *amchis* (Tibetan doctors). People in the rural areas use traditional remedies for cultural and social reasons.

(c) Exploitation of natural resources causes rapid disappearances of local ecosystems, resulting in loss of the knowledge of local people about plant resources and their use. Documentation of traditional knowledge in these biodiversity rich areas (Bajrachraya *et al*., 2006) is very important.

(d) Many studies have been done to investigate the traditional uses of medicinal plants. However, only few studies have followed up on these ethnobotanical investigations with laboratory work to verify the actual antimicrobial property of these plants (Taylor *et al*., 1995, 1996a, 1996b; 1996c, 2002, Taylor and Towers, 1998, Parajuli *et al*., 2001).

(e) The scientific exploration of traditional knowledge of medicinal plants may helps in the discovery of new medicine, which could be sold and possibly exported. In this

way, plant screening research has the potential to provide economic benefit nationwide along with biodiversity conservation. There is also a precedent that the documentation of traditional plant use decreases the chance of foreign interests patenting this herbal knowledge for profit (Shiva, 1997; Marshall and Bagla, 1997; Mooney, 2000).

(f) Analysis of the trade pattern of exploitation of important plants, in particular those used for medicinal purpose, will be helpful for the future conservation and management of the study area.

(g) Cultivation of highly valued medicinal plants documented from this study may be possible by the local people. These products could then be sold in the market which would increase the economic status of the local communities.

1.5 Limitations

Some limitations in the research occurred due to harsh climatic conditions during the study periods which are listed below:

(a) Collection of ethnobotanical information and sample collection in both the districts (Manang and Mustang) covered more than 80 % of the districts area; however some areas could not be visited because of time constraints.

(b) Antibacterial testing was possible only for selected medicinal plant species because of budget constraints and time limitations.

1.6 Description of the Study Area

1.6.1 Annapurna Conservation Area

The study areas (Manang and Mustang districts) are located in the Annapurna Conservation Area (ACA), which was the first location declared to be a conservation area in Nepal. This is the largest protected area covering 7,629 sq. km in Nepal that involves the local communities directly in conservation. It is located in hills and mountains of west-central, Nepal and the area is bordered to the north by the dry alpine deserts of Dolpa and Tibet (Plate I), to the west by the Dhaulagiri Himal and the Kaligandaki valley, to the east by the Marsyangdi Valley and to the south by the valleys and foothills surrounding the city of Pokhara (Bajrachraya *et al*., 2006). The National Trust for Nature Conservation (NTNC[2]) is responsible for the management of ACA. The main aim of the Trust is to involve the local communities in conservation planning and management, as

[2] NTNC: Previously King Mahendra Trust for Nature Conservation (KMTNC), a Nepali non-governmental organization charged with the responsibility for the management of Annapurna Conservation Area (ACA) with the establishment of Annapurna conservation Area Project in 1986.

well as encourage the local communities to continue their traditional land use practices (KMTNC, 1997a, 1997b, 1999, 2005). Annapurna Conservation Area Project (ACAP) is divided into seven Unit Conservation Offices (UCOs), namely Jomsom, Manang, Bhujung, Sikles, Ghandruk, Lomanthang and Lwang.

The Annapurna Conservation Area (ACA) is inhabited by approximately 120,000 people belonging to at least five ethnic groups and they are highly dependent on natural resources (Bajracharya *et al*., 2006). There is a limited data of the surveys of biodiversity to date, but 474 bird species including 38 species of birds at risk in Nepal and six species of Himalayan pheasants found in Nepal; 3430 species of flora; 2 species of fish; 56 species of reptiles and amphibians; and more than 101 species of mammals have so far been recorded (BPP, 1995 No. 6 & 13; KMTNC, 2005; DNPWC, 2000; Bhuju *et al*., 2007). This area has been considered a shelter for several rare and endangered species including Tibetan argali, musk deer, snow-leopard, Tibetan wolf and 38 species of birds-at-risk (KMTNC, 1997a, 2001-2002; Inskipp and Inskipp, 2001; Bajrachraya *et al*., 2006). Local communities' participation is important in environment conservation, so ACAP integrates local community in all stages of development and this approach has established ACAP as a model project within the Asia. The entire ACA region is one of the most popular mountain tourist destinations of the world where yearly around 60 % of the total trekkers coming to Nepal visit this region (KMTNC, 2001-2002; NTNC, 2006; Bajrachraya and Dahal, 2008).

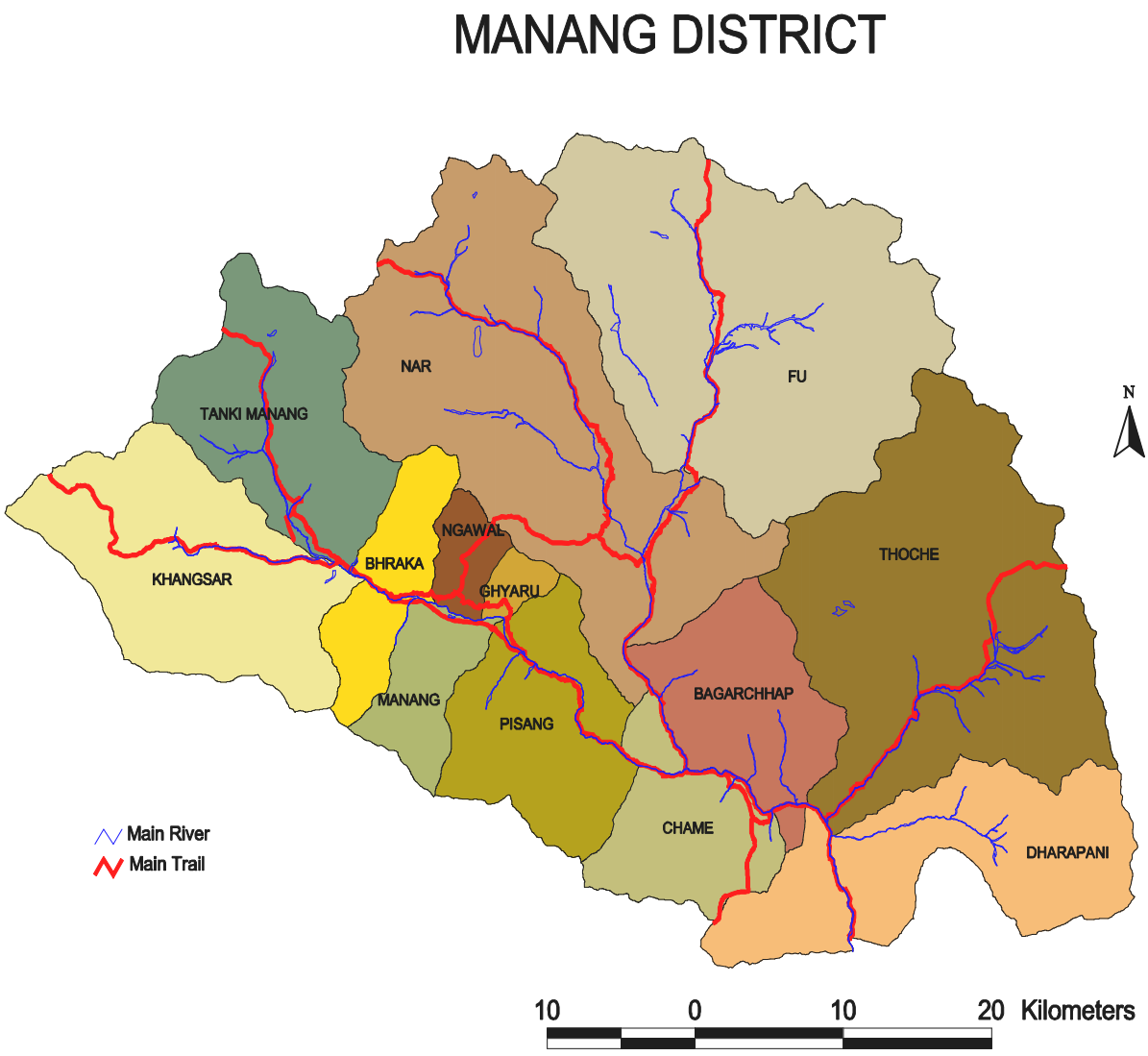
1.6.2 Location

Manang district lies in the trans-Himalayan region between the Himalayan range and the Tibetan Plateau and is surrounded by the Lamjung, Kaski, Gorkha, Mustang, and Myagdi districts. Northern part of Manang shares a border with China. Manang district is divided into three physical regions: Gyasumdo in the southeast, Nyeshang in the west and Nar/Phoo in the north (Pohle, 1990; Rogers, 2004; Aase and Vetaas, 2007). People of Tibetan and Gurung origins live in the area and call themselves *Manangba* (vanSpengen, 1987) or *Manangi* (Chaudhary *et al*., 2007). In this research the term *Manangi* is used to explain the people of Manang including those who migrated as permanent residence in the city. Approximately 5,000 *Manangi* have more or less permanent residence in the capital city of Kathmandu, while some 4,000 still reside in the Manang valley (Aase and Chaudhary, 2007; Aase and Vetaas, 2007).

Mustang district is located in the Mid-Western Development Region of Nepal and is bounded on the south by Myagdi, on the west by Dolpa and on the east by Manang district. Its northern border is contiguous with the Tibetan Autonomous Region of the

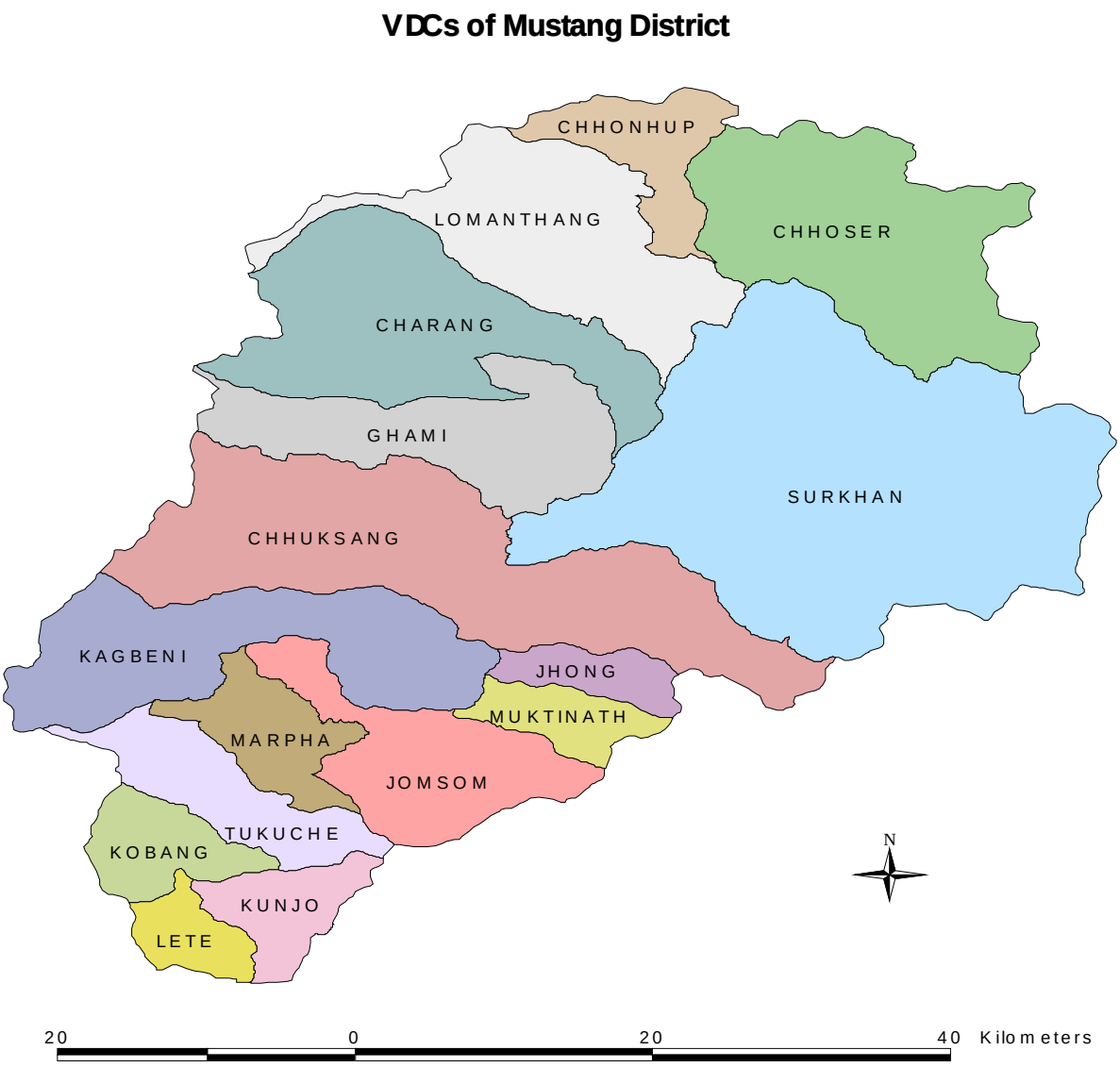
Peoples Republic of China. ACAP's coverage within Mustang district is divided into two regions, i.e., upper and lower Mustang. Lower Mustang part of the Annapurna Conservation Area consists of southern half of the Mustang district. Since 1992, ACAP is managing the upper Mustang area consisting of the northern half of the Mustang district rising above 2,500 m (amsl) in the rain shadow areas of Dhaulagiri and Annapurna Himal. This area is blended with unique culture-mostly Tibetan Buddhist. Due to the unique nature, ancient traditions and distinctive culture of the site, this area is under consideration for nomination as a World Heritage Site (KMTNC, 2002, 2004).

In Manang, the following villages and their surroundings were visited: Tal (1680 m), Dharapani (1860 m), Danaque (2100 m), Bagarchap (2140 m), Timang (2250 m), Chame (2620 m), Koto (2640 m), Bhratang (27400 m), Dhukurpokhari (2860 m), Pisang (2950 m), Hongde (3280 m), Munji (3300 m), Ghyaru (3450 m), Ngawal (3430 m), Bhraka (3320 m), Manang (3440 m), TankiManang (3560 m), Khangsar (3620 m), Nar (4110 m), Phoo (4080 m) and also stopping-places such as Tilicho Lake (5100 m), Kecho Lake (4680 m), Yakshed (4720 m), Goatshed (4310 m), Gangapurna Lake (3420 m), and Milireppa Cave (3520 m) (see Map 1). Twelve field visits were made during the years 2002-2007, for the collection of ethnobotanical information.



Map 1: Manang district, Nepal, site of 12 ethnobotanical field visits from 2002-2007.

In Mustang, the following villages and their surroundings were visited: Ghasa (2010 m), Lete (2480 m), Sekung Taal (2620 m), Larjung (2550 m), Kalopani (2510 m), Tukuche (2950 m), Kobang (2640 m), Kokhethanti (2520 m), Marpha (2670 m), Jomsom (2720 m), Thini (2800 m), Kagbeni (2810 m), Eklebhatti (2740 m), Jharkot (3270 m), Mukthinath (3300 m), Chhuksang (2940 m), Chele (3050 m), Samar (3660 m), Syangboche (3820 m), Ghemi (3490 m), Dhakmar (3535 m), Ghiling (3510 m), Tamagaon (3480 m), Jhaite (3570 m), Bhena (3690 m), Tsarang (3620 m) and Lomanthang (3720 m) (see Map 2). Three field visits were made to Mustang during the years 2005-2007 for the collection of ethnobotanical information.



Map 2: Mustang District, Nepal, site of three ethnobotanical field visits from 2005-2007.

1.6.3 Physiography and Climate

The upper Manang valley lies in Northwest side of Manang district in central Nepal. The U shaped inner valley extends east to west and is situated between 28^0 37' 56" to 28^0 39' 55" N latitudes and 83^0 59' 83" to 84^0 07' 97" E longitudes with the elevation ranges from 2900 m to 4600 m (amsl). Manang district is surrounded by Annapurna range from the south, Manaslu from the east, Peri, Himlung and Choya from the north and Damodar and Muktinath from the west. The territory of the district is not only surrounded by high mountains but also more than two thirds of the total surface area of approximately 2200 sq. km is occupied by high mountains (Pohle, 1990). Marsyangdi river, Nar khola, and Dudh khola drains the district towards south.

Mustang, one of the districts of Dhaulagiri Zone lies in the northern side of the Himalayan ranges bordering to Tibetan autonomous region of the Peoples Republic of China. Geographically it lies between 28^0 36' 36" to 29^0 $0^{'}$ $19^{"}$ N latitudes and 83^0 $28^{'}$ $3^{"}$ to 84^0 0' 8'' E longitudes. Upper Mustang Biodiversity Conservation Project (UMBCP) area is located around 28^0 $47^{'}$ $39^{"}$ N to 29^0 $19^{'}$ $54^{"}$ N latitudes and 83^0 $28^{'}$ $56^{"}$ E to 84^0 $15^{'}$ $16^{"}$ E longitudes and covers 2,567 sq. km area of the northern Mustang.

These areas are characterized by the high altitude, cold climate, semi-desert environment and rain shadow of Dhaulagiri and Annapurna Himal (KMTNC, 2001-2002), and receive little of the monsoon rain (Vetaas, 2007). Upper Manang and upper Mustang valleys were formed by glaciers. The climate is influenced by variations in altitude and the rain shadow cast by the Annapurna and Dhaulagri massifs.

The meterological station serving Mustang and Manang areas is located in Jomsom. Data from this station show that this area is one of the driest in Nepal in terms of precipitation and humidity, where the average rainfall is 320 mm per annum (KMTNC, 2002; NTNC 2006). The dry conditions result in crops taking a long time to mature (Chhetri, 2006). Average maximum and minimum temperatures were recorded from Jomsom meterological station as 7.9^0C/-1.75^0C in winter and 22.6^0C/14.15^0C in summer during 1995 (Anonymous, 1999). Snow covers the valley during winter.

1.6.4 Land Use and Vegetation

The total area of Manang district is 2246 sq. km. Land use statistics suggests only 279 hectare of land is under agriculture, which includes cultivated fields and grasslands (JAFTA, 2000). Approximately 83.56 % of the total area of Manang district is covered by trans- Himalaya and High Mountain. Forest and shrubs cover only 4.58 %, pasture covers 10.92 % and cultivated land and water bodies cover 0.65 % and 0.29 % respectively (Shrestha *et al*., 1996). Settlements of the human population and cultivation were along the valleys of Gyasumdo (lower Manang); Nyeshang (upper Manang) and Nar-Phoo (northern Manang). Most of the agriculture fields are found in the south exposed slopes or at the bottom of the 'U' shaped valley.

The total area of the Mustang district has 3639.58 sq. km of land and out of that 54.67 sq. km (1.5 %) of land is considered to be suitable for agriculture purpose. The total cultivated land in upper Mustang is estimated at 54.76 sq. km. Theoretically, there is an extra 14.37 sq. km (36 %) of land available; however due to the scattered nature of these lands, it has become difficult to put them into production (Chhetri, 2006). The land base

comprises forest (3.4 %), agriculture land (1.5 %), snow cover (8.4 %), rock (40 %), pasture (41 %) and others (6.4 %) (DADO, 1998).

The vegetation of upper Manang and upper Mustang is dominated by *Pinus wallichiana*, which is distributed on both north and south aspects of the valley. Above 3,000 m, in the north facing slopes forests of *P. wallichiana*, *Betula utilis* and *Abies spectabilis* are found whereas some forests of *P. wallichiana* occur on the dry south facing slopes (Ohba *et al*., 2008; Panthi *et al*., 2007). Shrubs of *Rosa sericea*, *Rosa macrophylla*, *Juniperus* species, *Caragana* species etc, are dominant. *Juniperus communis* mixed with *Juniperus indica* are abundant in lower belt up to 3,500 m (amsl) and above this *Abies spectabilis* and *Betula utilis* are common. *Juniperus indica* and *Rosa sericea* with other shrubs are mostly found on dry south facing slopes. The most predominant ground herb species of upper Manang and upper Mustang consist of scattered patches of *Primula* species, *Saxifraga* species, *Androsace* species, *Anaphalis* species, *Tanacetum* species, *Thymus linearis*, etc. These days in upper Mustang plantations of *Populus ciliata* and *Salix babylonica* are widespread. Natural as well as cultivated growth of forest plant species is slow due to low temperatures and inadequate moisture (Walder, 2000).

1.6.5 Population and Economy

The total population of Manang district is 9,587 (according to 2001 census) living in 1,776 households with the crude population density 4.3 person/sq. km (CBS, 2004). The inhabitants fall under the Gurung community, with a few exceptions of Brahmin and Chhettri. Although the real ethnic history of the *Manangi* is not known, they probably came from Tibet (Gurung, 1980; vanSpengen, 1987).

According to the 2001 census, population of the Mustang district is 14,981 including speakers of Thakali, Nepali, and Gurung languages (CBS, 2004). Upper Mustang population density is sparse (around 6,000) clustered in some 20 small and large settlements. Lower Mustang part of the Annapurna Conservation Area consists of southern half of the Mustang district and has nine Village Development Committees (VDC), 39 settlements, 2,070 households (HHs) and a population of 9,130 (KMTNC, 2002; CBS, 2004).

The majority of the population in Manang and Mustang follow Buddhism (75 %) and the rest (25 %) follows Hinduism (CBS, 2004). The main occupation of upper *Manangi* and *Mustangi* is pastoral agriculture and they also generate income from animal husbandry, agriculture, trade of medicinal plants and tourist oriented businesses. The number of livestock in Mustang is the highest (20.19 livestock per farm household) and Manang is

second highest (20.05 livestock per farm household) among all districts of Nepal (ICIMOD, 2003). Major livestock are *chauri* (*nak*), yaks, horses, mules, goats and sheep. Livestock farming in the region is a popular activity due to minimal opportunities from other activities and also primarily because of high pasture land available in the region (KMTNC, 2001-2002). *Manangi* and *Mustangi* have established themselves as a trading community in Nepal and abroad from time to time taking advantage of their status from the governmental designation as a privileged group since 1784 C.E. (Gurung, 1980). At first their trading was limited to inside Nepal and India and slowly extended worldwide through South East Asia (vanSpengen, 1987). Agriculture production from seasonal cultivation of millet, buckwheat, oat, barley, wheat, potato, peas and mustard are important. Agriculture and tourism are important but have less significance to the regional economy.

1.7 People of Manang and Mustang

Several ethnic groups including Gurungs, Thakalis, Sherpas, etc., inhabit Manang and Mustang districts. In Mustang, even today the majority of the people speak the Sherpa language (29.07 %), followed by Thakali (13.38 %), Gurung (9.45 %), and Lepcha (5.20 %). However, in Manang, the majority of the people speak Gurung (75 %), followed by Nepali (9 %), Tamang (8 %), Tibetan (7 %), and Newari (1 %) (CBS, 2004).

1.7.1 The *Manangi* People

The people of upper Manang (Nyeshang) used to consider themselves to be Ghale Gurung but later it was said they were converted into Lamas. Despite their proclamation that they are Gurungs, the southern Gurungs do not accept this. Their language is very different from any other Tibetan dialect. It might be a Gurung dialect as they insist, but conclusive studies on these ethno-linguistic matters have not been made (Bista, 2004). The Manang settlement area is also known as Nyeshang. For this reason, they are also called the inhabitants of Nyeshang but people of other districts generally call themselves *Manangi,* which is the reason I have chosen to use this terminology throughout my research. Though the language, life style, food habits, costume, culture, etc, of *Manangi* resemble those of Tibetans, they do not like to establish matrimonial relationships with Tibetans. With regards to body structure, the *Manangi* resemble the Gurung and also Tibetans in many respects (Bista, 2004).

The eastern part of the district is inhibited by Gurungs and other Himalayan people (Bista, 2004). Culturally the Gurungs are very close to the Tibetan (Harrison and Macfarlane, 1993; Manandhar, 2002).

1.7.2 The *Mustangi* People

The development district of Mustang consists of Lo, Baragaun, Panchgaun, and Thakkhola. The people living in Lo are called Lopa and their capital town is known as Manthang, but people residing outside Mustang refer to it as Mustang. The Lo people can be divided into three different social classes. The Kutak is the highest, also referred to as Bista (the Rajas family and the nobles). The population is small and was concentrated in Manthang but today may be scattered among the other villages of Lo. The Shelva are the second group of Lopa, and make up the majority of the population and the Righin are the third group, and are seen as the lowest in ritual status (Bista, 2004).

Five villages of Panchgaun, namely Jomsom-Thini, Syang, Marpha, Chivang, and Chherok lie between Tukche and Kagbeni. The people from these 5 villages are known as Panchgaunle, but they prefer to call themselves Thakalies, and speak variety of the Thakali dialect. Although they look like Thakali people and have adopted much of the Thakalis' culture, they are thought not to be true Thakalies (Bista, 2004). These people who call themselves Thakali come from Thak Khola which lies in the Mustang district of Dhaulagri zone. The traditional area of the is known as Thak-Sat-Sae, or 'seven hundred thak', which is divided into 13 village units but by now they have greatly increased in number and have spread in area. The Thak Khola people depend on the salt trade for their livelihood (Bista, 2004).

Baragaunle people live in Baragaun - the area between Lo (Mustang) in the north and Panchgaun and Thak in the south. They physically and lingustically resemble the Lo people. They are called Baragaunle because the previous term used to describe them - 'Bhote' - offends them, as it does many other Himalayan people. However they would prefer to be called Gurung (Bista, 2004).

1.8 Tibetan Medicine and Traditional Tibetan Doctors (The *Amchi*)

Tibetan medicine has been practiced for centuries in Tibet and in the Himalayas. According to the Tibetan view, the knowledge about medicine was passed on by Buddha himself and this has been taken as a historic medical system. *Amchis* are the Tibetan medicinal practitioners and the term *amchi* is Tibetan, not Gurung, Nepali nor Thakali.

The seventh and eighth centuries were important periods for the development of *amchi* medicine. During these periods, Tibetan script was developed first and then *amchi* medicinal traditions were brought into Tibet. The Sanskrit text '*Astangahriha Samhita*' was translated into Tibetan when King Songtsen Gampo of Tibet married Queen Bhrikuti from Nepal. Later on, this (Sanskrit) text was incorporated into four Tantras (*Rgyud bzhi*).

Rgyud bzhi, the book of the four medical Tantras, remains the fundamental medical text even today. The *rgyud bzhi* is comprised of four Tantras - the Root Tantra (T. *rtsa rgyud*), the Explanatory Tantra (T. *bshad rgyud*), the Quintessential oral instruction Tantra (T. *smenngags rgyud*), and the Last Tantra (T. *phyima rgyud*). Medicine preparations are based on three groups of ingredients, i.e., plants, minerals and animals (from precious stones, root and fruits of trees, soil, minerals, ingredients derived from animal products) (Kletter and Krieckbaum, 2001; Bista and Bista, 2005).

The Tibetan doctor (*amchi*) diagnoses diseases of the patient mainly by pulse reading, questioning the patient about his or her symptoms, his or her way of living, diet and behavior. If the case is complicated, they send the patient to Kathmandu or Pokhara for further medical analysis which cannot be done in the remote areas. Pulse reading has been taken as the very important tool of diagnosis of diseases, but it requires a lot of experience. Only the experienced Tibetan doctors (*amchis*) know how to differentiate between the different pulse quantities and are capable of interpreting them properly (Kletter and Kriechbaum, 2001).

In the remotest trans-Himalayan regions of Nepal, including Manang and Mustang, the *amchi* system of medicine and local medicinal plants have been playing a pivotal role in primary health care. The *amchis* have a keen interest in promoting and conserving medicinal plants along with traditional medical practices. Health posts, hospitals, experienced medical doctors with modern infrastructure are difficult to operate in these remote areas of Manang and Mustang. In place of this modern health post, medical doctors and other infrastructure, *amchi* medicine and their traditional health care system supports the health of the local people. Local people and *amchi* have been considered as a main promoter of the appropriate health care in the remote regions of the Himalayas where traditional medicinal practice has been passed down from generation to generations (Lama *et al*., 2001).

In Nepal, there are nearly 150 senior *amchis* producing medicine in their houses or monasteries and treating sick people (Lama *et al*., 2001). The following organizations: Kunphen Medical, Himalayan Medicine Industry, Shelkar Tibetan Medical Clinic, Sechen Clinic, Kailash Medical and Astro Society, Lo Kunphen Traditional Herbal Clinic and School, Ganchen Menkhang, Dho-Tarap, Traditional Clinic and Medical School and School in Swayambhu are actively working in the cities and rural areas and running clinics for traditional health care (Bista and Bista, 2005; Lama *et al*., 2001). The

Himalayan *Amchi* Associations (HAA)[3] have been collaborating with national and international organizations and provide financial support to run the *amchi* school of Mustang.

Studies regarding the bioprospecting research in these two districts are meager (Manandhar, 1987; Pohle, 1990; Ghimire *et al*., 1999; Bhattarai, 2003; Bista and Bista, 2005; Brohl, 2006; Kunwar *et al*., 2006). Therefore this long-term bioprospecting research will be one of the important documentation of the trans-Himalayan region of Nepal (Manang and Mustang District). This study will be helpful to the scientific community for detailed future bioprospecting research. Future research in Manang and Mustang may benefit from the involvement of the local communities and the local resources, which in turn may gain benefit from future studies.

[3] HAA: HAA is an association of *amchis*. This association has been working towards the conservation of *amchi* medicine and traditional medicinal practices since its establishment in 1998.

CHAPTER 2

2. ETHNOMEDICINAL STUDY

2.1 Introduction

2.1.1 Ethnobotanical Research in Nepal

Scientists in Nepal are deeply distressed over the losses of Nepal's biodiversity and indigenous knowledge of the communities and have pledged themselves to find a way to arrest this destruction (Chaudhary, 1998; HMGN, 2002). Bioprospecting is seen as possible a way to conserve and use the country's biodiversity. Bioprospectors search for new or useful species, or natural products/compounds by screening the country's species for interesting or novel uses. Ethnobotanical study can be the first step in bioprospecting, as plants have already been through a 'primary screening' by the local users, who already know their uses.

An urgent need, today, is to begin a pilot bioprospecting program in Nepal in collaboration with institutions abroad and in country to ensure long-term conservation of biodiversity which can serve as an *in situ* genetic and biochemical storehouse. This present research hopes to add to the previously documented knowledge in order to move this research forward. In this chapter ethnobotanical knowledge of the local people of Manang and Mustang districts has been discussed in detailed.

Most of the ethnobotanical work in Nepal has been conducted in the field of medicinal plants (Manandhar, 1985, 1986, 1989a, 1989b, 2002; Bhattarai, N.K., 1993b, 1998; Bhattarai, M., 2002; Karki and Williams, 1999; Lama *et al*., 2001). Studies regarding the ritual and religious significance of Nepali plants are meager (Bhattarai, 1989; Majpuria and Majpuria, 1978; Majpuria, 1985; Majpuria and Joshi, 1989). Wild edible plants of Nepal have been documented as well (Shrestha, 1978; Regmi, 1979; Bajrachraya, 1980a, 1980b, 1981a, 1981b, 1985; Bajrachraya *et al*., 1982; Kattel, 1982; Shrestha, 1983; Manandhar, 1995, 1997; Amatya, 1999; Maskey and Shah, 1982; Panday, 2003; Joshi, 2004; and Shrestha and Dhillion, 2006).

2.1.2 Use of Plants as Medicine

Medicinal plants are an important resource of Nepal. Medicinal plants continue to play an important role in traditional health care, medicinal practices as well as in supplying household income for the people in rural areas such as Manang and Mustang. People living in rural areas of Nepal collect medicinal plants for primary health care and harvest medicinal plants for income as well as trade, which also include those species possessing

high commercial value. This present research documents important medicinal plants of Manang and Mustang which are often used by the Gurung, Thakali and other communities for primary healthcare.

In Manang and Mustang districts herbal medicine preparations are used to treat a variety of different ailments, from cough and cold, to respiratory diseases to indigestion (dyspepsia). Access to health care is often a problem in remote districts of Nepal and Manang and Mustang districts are no exception. The only means of trustworthy transport in the districts are chartered helicopters and to travel by foot, which takes two-three days to reach to the districts headquarters, from the road-head town[4]. Because of the specific geographical features of Manang and Mustang districts and the lack of government health facilities in the districts, the people are largely dependent on the indigenous health care system. Local herbs and other plant resources found in that area are the principal source of medicine and are prescribed by traditional healers as medicines. This is often the only source of primary health care in the districts of Manang and Mustang.

2.2 Review of the Literature

Ethnobotanical literature is mostly focused on medicinal plants in Nepal. The publication of 'Chandra Nighantu' or 'Bir Nighantu' a hand written herbal encyclopaedia with 750 colored plates of plants and in medicinal uses in eight volumes was compiled at the end of 19th and the beginning of 20th centuries (Malla and Shakya, 1999). Similarly Francis Buchanan (a Scottish medical doctor) recorded useful plants of Nepal in his first botanical exploration of Nepal in 1802-1803, which was later followed by Nathaniel Wallich in 1820-1821 (Rajbhandary, 2001).

Banerji's (1955) publication on medicinal and food plants was followed by B.D. Pande (1964); R.R. Pande (1964); K. Devkota (1968); and Malla and Shakya (1986) on medicinal plants. During the year 1971-1975 about 14 works were conducted in ethnobotany basically in medicinal plants, general uses of plant resources.

Studies on ethnobotanical research in Manang and Mustang have been done by a few researchers (Manandhar, 1987; Pohle, 1990; Ghimire *et al*., 1999; Kunwar *et al*., 2006; Bista and Bista, 2005; Brohl, 2006; Bhattarai, 2003; Bhattarai and Chaudhary, 2005, 2006; Bhattarai *et al*., 2006a, 2006b; 2007a, 2007b). The specific geographical features of Manang and Mustang districts combined with a lack of manufactured commodities have resulted in continued reliance of the locals on indigenous knowledge for the fulfillment of daily needs. This makes it a very interesting site for ethnobotanical research. Only a few

[4] Road construction to link the headquarters of Manang and Mustang is a priority of Governments of Nepal (NTNC, 2008b).

studies (Ghimire *et al*., 1999; Brohl, 2006; Kunwar *et al*., 2006; Pohle 1990; Manandhar, 1987, etc), have been done to document knowledge about medicinal uses of plants in Manang and Mustang districts.

Extensive ethnobotanical work was conducted in different parts of the country after 1980 C.E. focusing mainly on specific ethnic groups, geographical areas and diseases. Manandhar (1987) documented 81 species of plants under 75 genera and 32 families. These plants were used by the inhabitants of five villages of Manang valley: Manang tanki, Manang bhot, Tanje, Braga and Munje. The data has been gathered from healers and knowledgeable villagers. In continuing the ethnobotanical research, Manandhar (1998), published a study of native phytotherapy among the Raute ethnic group of Dadeldhura district, Nepal. Among 47 plant species recorded, eight plant species including *Calotropis gigantea, Ageratum houstonianum, Jatropha curcas* were used in treating cuts and wounds; ten plant species including *Justicia adhatoda, Terminalia bellirica* in treating fever; six species including *Jatropha curcas, Woodfordia fruticosa* in treating boils; and *Floscopa scandens* in treating coughs and colds.

Joshi and Edington (1990) documented the use of medicinal plants by two village Communities (Chaubas in the Shivapuri watershed Wildlife Reserve area and Syabru in the Langtang National Park) in the Central Development Region of Nepal. It was recorded that 66 plant species were being used for medicinal purposes. Some medicinal plants were also used as insecticides or pesticides. It was recognized in the villages that the use of these latter species as human food or animal fodder was limited by the presence of toxic constituents. Similarly, a total of 48 plant species used by the local communities of the Kali Gandaki watershed area, Nepal was enumerated by Joshi and Joshi (2000). Three plant species including *Magnifera indica, Justicia procumbens* were used for fever; seven plant species including C*entella asiatica, Mimosa rubicaulis* for cuts and wounds; *Cyperus rotundus* was used for boils; three species *Ocimum basilicum, Asparagus filicinus, Plantago major* were used for urinary disorders; and two species *Taraxacum officinale, Datura stramonium* are used for asthma.

Joshi (2000) reported 31 species of medicinal plants from hilly villages of the central development region, Nepal. Six plant species including S*elaginella biformis, Maesa macrophylla, Eupatorium adenophorum* were used in treating cuts and wounds; three species, *Swertia chirayita, Taraxacum officinale* and *Sonchus arvensis* were used for fever; three species including Z*anthoxylum armatum, Sonchus arvensis* were used for cough and cold; and *Maesa macrophylla* for tonsillitis. In addition to the above research, altogether 286 medicinal and aromatic plants were recorded with its scientific names,

synonym, common name, family, description, distribution, parts used, important biochemical constituents and usage (Joshi and Joshi, 2001). Moreover, 67 photographs of different plant species were also given along with the sketches of 28 species.

Pohle (1990) gave descriptive information on the useful plants of Manang district. In this study 239 plant species were reported. Among 239 plant species, 8 plant species including *Neopicrorhiza scrophulariiflora, Aconitum violaceum* were used to treat fever; eight plant species including *Melothria mucronata, Hypecoum leptocarpum, Pterocephalus hookeri* for cough and cold; four plant species including *Cissampelos pareira, Gonostegia hirta* for boils; two species including *Malva verticillata* for urinary problems; and eight species including *Juniperus communis, Pinus wallichiana, Myricaria rosea* for respiratory diseases.

Bhattarai (1992) gave information of the three districts of Karnali zone *viz*. Jumla, Mugu and Kalikot. Altogether 62 plant species were reported for the treatment of wide rage of ailments. In continuation of the research, Bhattarai (1993a) documented information on 50 empirically accepted and frequently used prescription involving 42 plant species from 39 genera and 30 families with additives along with details on uses and parts used. Similarly, Bhattarai (1997) studied the traditional herbal medicines used to treat wounds and injuries in Nepal and documented a total of 42 plant species including *Anaphalis triplinervis, Artemisia dubia, Cannabis sativa, Cynoglossum zeylanicum, Dactylorhiza hatagirea, Gnaphalium affine, Mentha longifolia, Neopicrorhiza scrophulariiflora* used for cut and wounds.

Bhattarai (2002) gave the descriptive information on some aspects of general pharmaceutical practice employed by the traditional healers from nine districts (Kathmandu, Lalitpur, Bhaktapur, Kavrepalanchok, Sindhupalchok, Rasuwa, Nuwakot, Dhading and Makwanpur) of central Nepal. The findings have been critically discussed mainly in relation to modern pharmaceutical and medicinal practices. The importance of traditional healers to healthcare system among the rural population in the country has also been emphasized. Bhattarai (2003) enumerated 81 medicinal plant species belonging to 37 families under 66 genera from Manang district, central Nepal. Among 81 plant species recorded, 58 plant species have medicinal properties.

Karna (1997) made a detailed account of 50 species of medicinal plants and traditional medicinal practice in Chapagaun VDC of Lalitpur District, central Nepal. Among them, five species including *Cynoglossum zeylanicum, Oxalis corniculata* were used to treat boils; six plant species including *Pinus wallichiana, Rhus javanica* to treat cuts and wounds; *Myrica esculenta* to treat cough and cold; three plant species including *Berberis*

aristata, Cuscuta reflexa to treat jaundice; and two species *Rubus ellipticus* and *Justicia adhatoda* to treat fever.

Ghimire *et al*. (1999) studied the ecology of some high altitude medicinal and aromatic plants in the Gyasumdo valley, Manang Nepal. Distribution pattern, population density, regeneration status and biomass production of five most important high altitude and aromatic plants (*Aconitum orochryseum, Dactylorhiza hatagirea, Nardostachys grandiflora, Neopicrorhiza scrophulariiflora* and *Rheum australe*) were assessed in three different natural sites of the Gysumdo valley. The results showed that the density, regeneration, and biomass was comparatively higher in Ponger lake site for *N. grandiflora,* and *N. scrophulariiflora* compared to other medicinal plants.

Nepal (1999) studied the ethnobotany of the Rai and the Sherpa Communities in the Makalu-Barun region, eastern Nepal. Among 142 plant species, nine plant species including *Pteris biaurita, Tectaria coadunata, Clinopodium umbrosum* were used for cuts and wounds; six species including *Diplazium maximum, Hemiphragma heterophyllum* for cough and colds; two species including *Botrychium daucifolium, Mimosa pudica* for urinary problems; two species including *Acorus calamus* for respiratory diseases; and six plant species including *Swertia chirayita, Rubia manjith* for fever.

In an IUCN-Nepal publication, 150 medicinal plant species are described with their botanical name, Nepali name, short taxonomic description and uses (IUCN-Nepal, 2000). Accordingly, 26 plant species including *Justicia adhatoda, Aconitum bisma* were used to treat cuts and wounds; 24 plant species including *Berberis aristata, Myrica esculenta, Cyperus rotundus* to treat fever; and 15 plant species including *Selinum tenuifolium, Hygrophila auriculata, Vitex negundo, Piper longum* to treat cough and cold.

Lama *et al*. (2001) explored the medicinal plants of Dolpo. In that study, 102 plant species were recorded; among them, 51 plant species including *Aconitum naviculare, Anaphalis triplinervis, Cicerbita macrorhiza* were used to treat fever; 28 plant species including *Neopicrorhiza scrophulariiflora, Aconitum spicatum, Anemone rivularis, Caragana gerardiana* were used to treat cough and cold; 22 plant species including *Lancea tibetica, Aconitum spicatum, Dactylorhiza hatagirea* were used for cuts and wounds; 21 plant species including *Rumex nepalensis, Rubus foliolosus* were used to treat respiratory diseases; and four plant species including *Rhodiola himalensis, Cypripedium himalaicum* were used to treat urinary diseases.

Niraula (2001) documented 63 medicinal plants in and around Tinjure Hill (Tehrathum and Sankhuwasabha Districts), east Nepal. Among them, seven species including

Artemisia indica, *Centella asiatica* were used for cuts and wounds; six plant species including *Aconitum ferox, Citrus reticulata* for fever; seven plant species including *Clematis buchananiana, Piper longum* for cough and cold; and one plant species *Mimosa pudica* for urinary diseases.

Sherpa (2001) studied the ethnobotany of the Walung people of Walangchunggola, Kanchenjunga conservation area, east Nepal. Out of 69 plant species described, 21 plant species were used for the primary health care.

Bista and Bista (2005) explored 51 high altitude medicinal plant species from Mustang district of Nepal and provided its vernacular names, botanical name, diagnostic characteristics, habitat, harvesting seasons, methods of preparations, part used, taste/energy, use/treatment, mode of use for each plant species.

Kunwar *et al*. (2006) examined the ethnobotany and traditional use of plants from Dolpa, Humla, Jumla and Mustang districts of Nepal. Altogether 107, 59, 44 and 166 species of ethnomedicinal importance were documented from Dolpa, Humla, Jumla and Mustang district respectively. Of these, 84 common species, used at least in two districts were selected to enumerate their ethnomedicinal properties. Similarly 25 species of medicinal plants were documented with their scientific name, family name, English name, vernacular name, general introduction, distribution and habitat, flowering and fruiting, inventory (inventory of sustainable harvest amount), harvesting, store and value addition, parts used, indigenous use, scientific use, chemical constituents, calendar, marketing information (Kunwar, 2006). Among 25 species documented, *Cordyceps sinensis*, *Dactylorhiza hatagirea*, *Morchella conica*, *Nardostachys grandiflora*, *Neopicrorhiza scrophulariiflora*, *Valeriana jatamansii* and *Zanthoxylum armatum* were considered important medicinal plant species of Manang and Mustang.

Rajbhandary and Ranjitkar (2006) provided detail information on 30 commercially important and highly traded herbal drugs, along with historical development of pharmacognosy and its importance in present context. Trade control and provision of rules and regulation for medicinal plants in Nepal and their conservation have been well elaborated.

Chetri *et al*. (2006) emumerated 438 species of vascular plamts belonging to 91 families. Here, several plant species including *C. sinensis*, *D. hatagirea*, *N. grandiflora*, *N. scrophulariiflora*, *V. jatamansii*, etc were documented to be used in traditional medicine.

2.3 Materials and Methods

Ethnobotanical information was collected from the field by the extensive field visits during the year 2002-2007. During each visit ethnobotanical interview was conducted with the local people for the collection of detailed information.

2.3.1 Field Visits

In this study, detailed information was gathered from different field trips conducted in various seasons during the year from 2002 to 2007. A total of 12 field visits to Manang (2002-2007) and three field visits to Mustang (2006-2007) were conducted for the collection of detailed ethnobotanical information.

2.3.2 Ethnobotanical Interviews

The main aim of the study was to document the traditional knowledge on the use of plant species by the local people from the study area. During interviews a detailed standard set of information was collected on each plant species. The information was mainly focused on detailed uses (miscellaneous) including: date of collection, plant local names, ethnic group, age, sex, occupation of interviewee, mode of preparation, dose, administration, storage, any side effect of the plant species on use, etc.

Selection of Interviewees

Upon reaching a village for the first time, the village elders were approached and the research project explained. The elders gave advice regarding the people who would be the best sources of information. I then met with the local people who were said to be the most knowledgeable, and explained the research to gain their informed consent. These interviewees often suggested other people who would also be able to contribute to the project and so each time I returned to the area, the number of people to interview increased. Beginning in 2004, traditional Tibetan doctors (*amchis*) were also interviewed.

I spoke with more than 300 people during the six years of research. Most people were interviewed several times during different seasons. In order to insure a sample that included people from all aspects of *Manangi* and *Mustangi* society, I attempted to interview both men and women of a variety of ages and from different socieoeconomic and ethnic groups. As the knowledge of edible plants is often passed down from parents and grandparents, I did not restrict my interviewees to people working in a specific capacity (for example, farmers). Interviewees worked as medicinal plant traders, farmers, hotel or shop owners or managers, footpath traders, *amchi*, those who worked at home, and village elders. Also I included 50 more affluent road-head traders and rich *Manangi*

and *Mustangi* who have now settled permanently in the larger cities of Nepal such as Narayanghat, Kathmandu and Pokhara. If participants were selected by this directed, convenience sampling rather than by referral by the village elders, their knowledge on plant species was first assessed based on information I had previously gathered.

Method of Interviews

Local people were asked about their knowledge of plant use, including uses of plants for medicine. Other uses of medicinal plants such as vegetables, fruits, juice, food, ritual-religious, *achar* and miscellaneous were also documented.

The information contained in this research was gathered by direct observation of locals in the fields and forests, and through semi-structured interviews. At first, interviews were conducted using the 'specimen display' method. After collecting plant specimens for research, I showed these fresh specimens to the locals in order to elicit any information. The same plant specimens were shown to different people to confirm the accuracy of the results. When convenient to the locals, they were asked to accompany the researchers for a forest walk, allowing for both plant collection and detailed information gathering.

Consent for the research project was obtained in writing from the Annapurna Conservation Area Project, Pokhara, and verbally from each villager before they were interviewed. The project was approved by the Central Department of Botany Research Committee of Tribhuvan University. Villagers, healers and *amchis* who were interviewed, contributed their knowledge, and agreed to have their names published are listed in appendix IV. Many people interviewed wishes to remain anonymous. The completed manuscript will be returned to the villages, and copies given to key people who collaborated on the research.

2.3.3 Collection of Voucher Specimens

The reported plant species during the research periods were collected for the herbarium preparation. The collected plant species were placed in front of the local people to confirm their identity in terms of vernacular names, uses and other information. The Voucher Herbarium Specimens were prepared following the standard technique (Lawrence, 1967; Bridson and Forman, 1992). The plants were dried carefully and pressed before mounting on the herbarium sheet. After mounting the plant species on the herbarium sheet, they were identified with the helps of standard literatures (Polunin and Stainton, 1984; Stainton, 1988; Grierson and Long, 1983-2001; and Noltie, 1994) and nomenclature of the identified species follows APG (2003), Hara and Williams (1979), Hara *et al*. (1978, 1982), Press *et al*. (2000), and Ohba *et al*. (2008).

Further, the specimens were cross-checked with herbarium deposited at the National Herbarium and Plant Laboratories (KATH), Godawari, Nepal and Herbarium of the Tribhuvan University Central Herbarium (TUCH). Some of the herbarium specimens were identified by Dr. Ram Prasad Chaudhary using resources of the Royal Botanic Garden (E), Edinburgh, United Kingdom during his visits in 2007. Some of the information regarding altitude, locality, flower color, local name, uses etc was noted on the herbarium sheets. The Voucher Specimens will be submitted to Tribhuvan University Central Herbarium (TUCH) after completion of this doctoral research.

2.4 Results and Discussion

Altogether, 157 ethnomedicinal plants species belonging to 56 families and 114 genera are reported from the study area (see appendix V and plates III, IV, V). The largest number of species were noted from the family Asteraceae (21 species), followed by Ranunculaceae (13 species), and other species that can be seen in figure 1. Not shown in figure 1 are the seven families, including Araceae, Pinaceae, Valerinaceae, etc., that were represented by only two plant species, and the twenty nine families, that were represented by one plant species each.

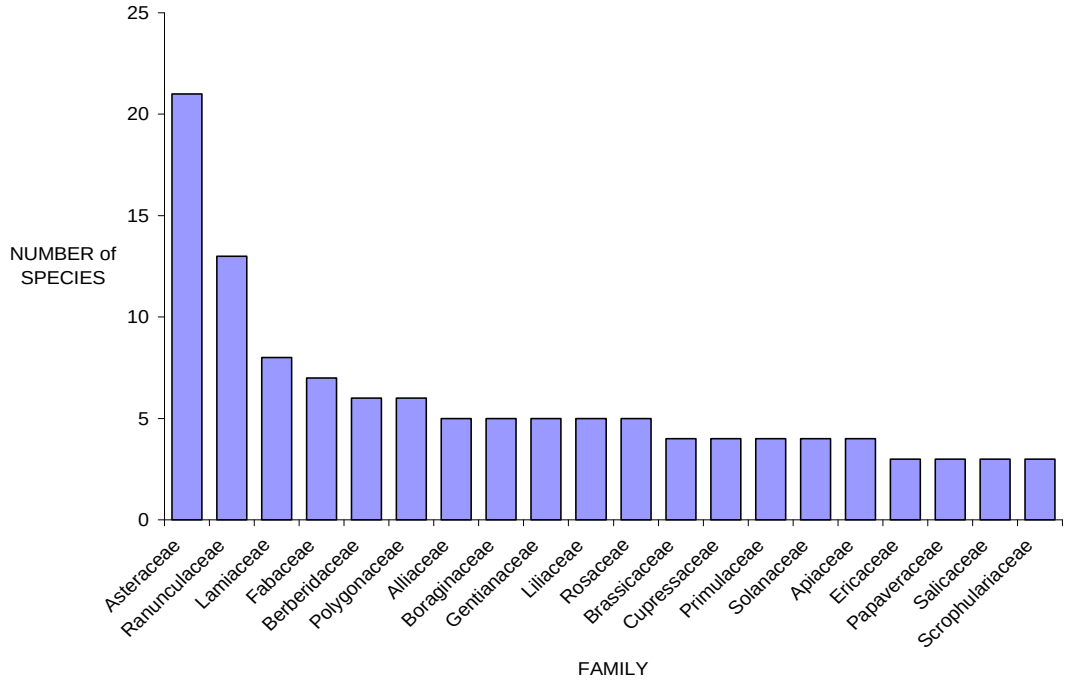


Figure 1: Number of medicinally used species belonging to the 20 most frequent families. Families having only 1-2 species of plants used medicinally in Mustang and Manag are not shown on this figure, but may be seen in Appendix V

Of the 157 medicinal plants recorded, 88 plants were also used for uses other than medicine in Manang and Mustang. A total of 42 medicinally used plant species were also

used for food, followed by 42 species in miscellaneous purposes (for fodder, fertilizer, as construction materials, decoration materials, dye and soap, household articles, manure, paper, recreational drug, tea substitute and others). Similarly, 32 medicinal plants were also used for fence and fuelwood and 29 medicinal useful species for ritual and religious purposes. These can be seen listed by use in appendix VIII and below in figure 2.

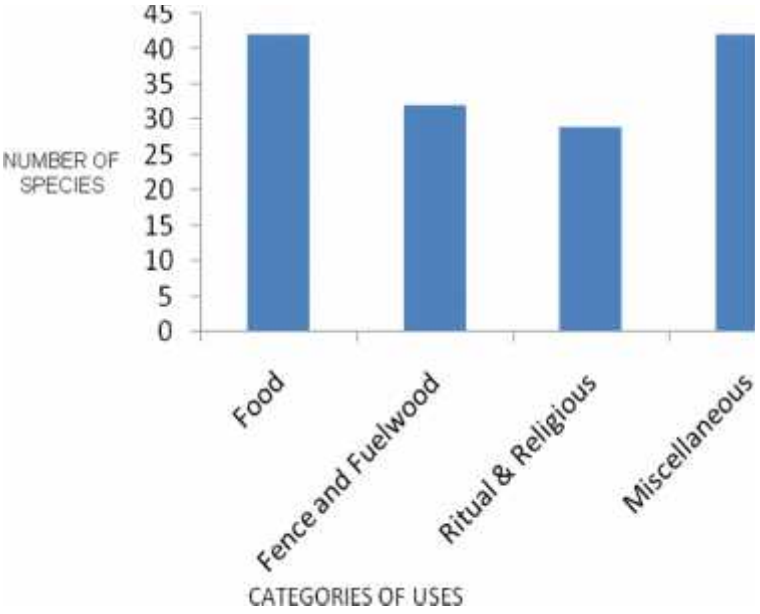


Figure 2: Number of medicinally used species used for multiple categories of uses in Mustang and Manang.

Some of the multiple uses of medicinal plants documented during the research are interesting. As for example, *Allium* species are known to everyone and used by the local people in various food items. In Manang *Allium fasciculatum*, a local favourite, is collected in large amounts in *nanglo* (bamboo baskets) to be eaten fresh in vegetable items and dried and stored for the colder seasons and are also used to make *achar*. Dried as well as fresh plants can be cooked or sometimes prepared raw. During my field visits, I found the popular *achar* made from *Allium prattii* to be very tasty (for detail see appendix V and Bhattarai *et al*. 2009). The most important species for trade in major cities in Nepal and India are *A. oreoprasum* and *A. wallichii* (plate VII), and often exchanged for money or crops such as wheat and buckwheat.

Root tubers and leaves of *Arisaema flavum* and *Arisaema jacquemontii* are said to be very poisonous which contains crystals of calcium oxalate in large quantities but are most often used by the *amchi* of Manang and Mustang in their traditional medicine to treat skin diseases, wart, edema, wounds on skin and in the vagina (‘*Bhringhee*’), sinusitis, bone

spurs, etc. In addition, both of the species also play a significant role in meeting the vegetable requirements of the remote villages of Nar and Phoo of Manang and some remote villages of upper Mustang. The local people of Manang and Mustang have developed a traditional way to use these poisonous plants for food. Laboratory research is also needed to see if this traditional processing technique liberates nutrients that otherwise would not be bio-accessible (for detail about the use and processing techniques see appendix V and Bhattarai *et al*. 2009).

It is also important to mention that *Hippophae salicifolia* and *Hippophae tibetana* are used to treat cough, cold, chest pain, stomachache, diarrhoea, dysentery, worms, rheumatism, gastritis, diuretic, tonic, fatigue, to treat worms, etc, (see appendix V, plate III), and are the most popular fruits in Manang and Mustang. The fruits are widely used locally and as a tasty drink for tourists. The fruits of *Hippophae* species have a high market value in Kathmandu and Pokhara and are used to make Seabuckthorn juice. Even though the market price of these fruits has been increasing steadily, the local consumption has not yet decreased. Further bioprospecting research on *Hippophae salicifolia*, and *Hippophae tibetana c*ould help with the conservation and management of these local resources as well perhaps benefit the local people economically.

Juniperus species are commonly used for medicine in the study area. It is used to relieve respiratory complaints, chest pains, lung infection, bronchitis, kidney diseases, cough, cold, tonsillitis, headache, malarial fever, neck pain, to reduce blood pressure, scabies, wounds, etc. Besides its medicinal value, *J. indica* was used popularly for incense, fence and fuelwood, and other purposes in almost every house in Manang and Mustang (Bhattarai *et al*., 2008). When asked what they used for incense, the villagers almost always answered *J. indica*, because it is easily available and highly valued as a religious plant (appendix V, plate III). Although, *Berberis aristata*, *Berberis angulosa*, *Berberis ceratophylla*¸ *Berberis lycium*, were used in medicine for cough, cold, fever, dysentery, jaundice, eye pain, kidney diseases, bile disorders, edema (swelling of the body), eyes diseases, to increase 'blood filtration' and 'blood circulation', diarrhea, dysentery, fever, etc, but also commonly used for fencing, fruits (appendix V).

The results of the present study are presented in Appendix V with alphabetical arrangement of plant scientific name (in italics) followed by family name (in capital letters), voucher number, local names (Gurung/Thakali/*amchi*/Nepali) and detailed uses (mode of preparation doses and administration of medicine). Therefore, the exhaustive study of medicinal plants within the Manang and Mustang reflects its rich diversity and history of medicinal plant use.

Manang and Mustang districts house endemic species of plants, endangered animals, birds, unique nature and ancient traditions (Bhuju *et al*., 2007; NTNC, 2007, 2008a,

2008b). This local biodiversity have been supporting the daily needs of the indigenous people for centuries. For these reasons this area has also been considered an important area of Nepal for ecotourism.

Documentation of Ethnomedicinal Knowledge

Documentation of ethnobotanical knowledge has gained importance in the remote trans-Himalayan region of Nepal (Manandhar, 1987, 2002; Pohle 1990; Lama *et al*., 2001; Bista and Bista, 2005; Bhattarai *et al*., 2006b), where modern medicine and infrastructure for modern medicine are lacking. Infectious disease is common among people living in rural areas and illness is often treated in the village by *amchi*. Manang and Mustang are considered important areas for medicinal plant diversity but have not yet explored thoroughly (Manandhar, 1987; Pohle 1990; Bista and Bista, 2005; Brohl, 2006; KMTNC, 2004).

For centuries people living in rural areas of Nepal have been using traditional remedies because of their cultural and social reasons and beliefs. *Manangi* and *Mustangi* do not have easy access to most of the modern facilities of health posts, doctors, or allopathic medicines. Perhaps because of the lack of these facilities, inaccessibility and expenses to reach the modern facilities, indigenous people feel comfortable using *amchi* medicine. Also, this type of medicine has been available for centuries, so is culturally appropriate and trusted. *Amchi* prepared medicine, made from local medicinal plants is quite popular in these remote areas of Nepal.

When looking at publications concerning only plants used traditionally as medicines in Manang, Manandhar (1987) documented 81 species of plants specifically from Manang. This research added 45 new ethnomedicinal plants for Manang from the present study in Manang. Twenty-three plant species including *Cicerbita macrorhiza*, *Cynoglossum zeylanicum*, *Rhododendron lepidotum*, *Rosa macrophylla*, *Rosa sericea*, *Rubus foliolosus*, *Rumex nepalensis*, etc., were common ethnomedicinal plants in the above and the present results of Manang, however, additional uses were also noted in the present results.

Pohle (1990) documented 239 species of plants used traditionally in Manang, of which 66 species of plants were used ethnomedicinally. Compared with Pohle (1990), the present results from Manang added 60 new species of plants which were used ethnomedicinally in the same area. Thirty-one plant species were found to have the same ethnomedicinal uses as documented by Pohle, but the present investigation discovered more uses of those same plants. The present results of medicinal plants of Manang revealed 45 plant species

whose medicinal uses were not previously documented by either Manandhar (1987) or Pohle (1990).

For Mustang, Bista and Bista (2005) documented selected 51 plant species used as *amchi* medicines. This present research added 96 new ethnomedicinal plants of Mustang. Twenty-four plant species including *Aconitum naviculare*, *Anemone rivularis*, *Arnebia benthamii*, *Dactylorhiza hatagirea*, *Rosa sericea*, etc., were common ethnomedicinal plants in the above and the present results; however, additional uses were also noted in the present results. Compared with Borhl (2006), the present results of Mustang added 105 new species of plants which were used ethnomedicinally in the same area. Fifteen plant species including *Ephedra gerardiana*, *Fragaria nubicola*, *Malva verticillata*, *Morina polyphylla*, *Rosa sericea*, *Stellera chamaejasme*, etc., were found to have the same ethnomedicinal uses as documented by Borhl, but the present investigation explored more uses of those same plants. Similarly, compared with Chetri *et al*. (2006), the present results of Mustang added 55 new species of plants which were used ethnomedicinally in the same area. Seventy plant species including *Aconitum naviculare*, *Allium fasciculatum*, *Lilium nepalense*, *Rosa sericea*, etc., were common ethnomedicinal plants in the above and the present results; however, additional uses were also noted in the present results.

These newly added plant species are noted with asterisks (see appendix V). It is hoped that these newly documented plants may be valuable for future research activities. This initial documentation represents an important step of bioprospecting of medicinal plants of Manang. Perhaps further steps in bioprospecting with regards to these medicinal plants will be beneficial for the discovery of new drugs/medicines.

Plant Parts Used

This study found that many different parts of medicinal plant species are used as medicine. The whole plant was most commonly used, and the percentage of medicines using different plant parts can be seen in figure 3 below. It would follow that the most commonly used plant parts have been selected because they contain more active principles in comparison to the least commonly used parts. Leaves, roots, stems and flowers are physically more vulnerable to attack by herbivores or pathogens than the more hardy bark, latex or cones and therefore it is not surprising that they contain more chemical defence compounds in the form of biologically active secondary metabolites.

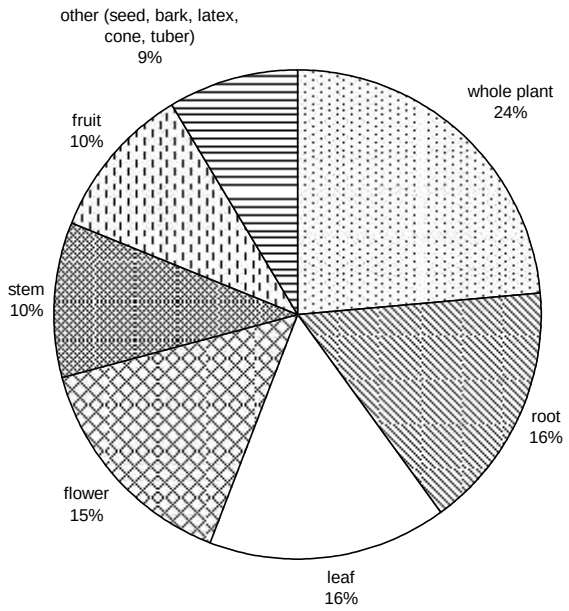


Figure 1: Percentage of medicinally used parts

Forms of Medication and Use of Additives

Medicines are prescribed in different forms including powder, paste, pills, decoction (liquid obtained from boiling of the medicinal plants in solvent) and infusion (plant powder/paste mixed with cold solvent). *Amchi* use the traditional methods in the preparation of medicines. To prepare pills at first they make powder from the specific plant using a grinding stone slab. The use of electric grinders to make powders for other purposes, such as cooking, is common among *Mustangi* and *Manangi* but not for medicinal plants. The *amchi* feel that heat created by the electric grinder may degrade the active chemical constituents of plant powder and, thus the quality of the medicine may decrease. Powder prepared using a stone slab is said not to degrade the quality of the medicine.

The powder is then mixed with water and sufficient amount of additives (honey, jaggery (gur[5]), black sugar cube, etc.). Additives are added according to the need of the specific plant powder to aid with the shape of the prepared pills (rounded, rectangular, etc). The process of boiling continues until no water remains in the mixture. Complete evaporation of the water makes it easy for the *amchi* to form the medicinal mixture into the preferred shape. Only experienced *amchi* knows the quantity of additives used for the individual plant and the preparation of quality *amchi* medicine is very difficult and takes dedicated time.

[5] Gur: Traditional, unrefined, whole sugar (*Saccharum officinarum* L.)

Amchis' traditional method of maintaining the good quality of their herbal medicine is also unique. As for example, for centuries *amchi* have placed herbal medicine in a bag of *Moschus chrysogaster* (muskdeer) skin and tied it twice with thread. Their experiences showed that tying the herbal medicine in *Moschus chrysogaster* (muskdeer) skin allows it to remain effective for one to two years. They believe that *Moschus chrysogaster* (muskdeer) habitat is in the alpine pasture and their food is mostly medicinal herbs.

Similarly, the preparation of medicine from *Cordyceps sinensis* according to *amchi* Tshampa Ngawang Gurung of Jomsom is time consuming and requires much experience. *Cordyceps sinensis* has been used in traditional medicine since centuries as tonic to increase sexual power. Strict rules (i.e. confidential), time and effort are necessary to prepare this expensive tonic. Different confidential medicinal mixtures were used with ghee and the final prepared medicine resembles jam.

In this study, powders and decoctions were found to be used more often in comparison to pills, pastes and infusions. Medicines are prescribed in both ways, as a single drug and in mixed ingredient form. In mixtures, anywhere from several to many valuable medicinal plants are mixed with the other (often local) medicinal plants in standard amounts. The mixture does not change depending on the person but the dose may be changed with age. Only herbal treatments were considered for this research, leaving treatments that use mainly animal and mineral ingredients for possible future research. Out of the 157 plant species, 18 species are used to cure only one disease and the remaining 139 plant species were used to cure more than one disease/disorder.

Use of Solvents

Plant parts were generally prepared as medicine using hot and cold water as the 'solvent', but occasionally remedies were prepared with milk, honey, oil, jaggery, black sugar cube, curd, alcohol and ghee. In Manang, it is interesting and important to mention that medicines are sometimes prepared with ghee (butter from a female Himalayan cow) when a patient has fever. For example *Aconitum naviculare* is used for fever and jaundice. Half a spoonful of powder (made from dried whole plant) is mixed with two spoonfuls of *chauri* ghee (butter from a female yak) and taken two times a day for fever and jaundice until recovery. This is a unique method of treatment of the fever patient. This local tradition was explained as to have started to 'sweeten' the taste of bitter *Aconitum naviculare*. This is interesting as doctors in Nepal often prohibit the use of oil for cooking when the patient has fever. Similar interesting results were also documented from Mustang (see appendix V).

The more common use of water in the preparation of medicine could be due to reduced availability of other infusion materials such as milk, honey, oils, jaggery, curd and ghee in the rural villages, or the good solubility of active components in water. Milk, curd and ghee are expensive to buy if a family does not own the animals. This does not explain the use of milk as a solvent. Water and milk have different chemical properties. Milk, containing fats, will dissolve fat soluble chemicals that water may not. Perhaps some plants are mixed with milk, or curd to dissolve active phytochemicals that are not water soluble.

Collection of Medicinal Plants from Southern Plains (Terai)

Medicinal plant use in Manang and Mustang are not restricted to local plants. The *amchi* import several valuable medicinal plants from the lower regions of the districts including the Terai (southern plains) region for the preparation of medicine. Some of these include *Rouvolfia serpentina*, *Glycerrhiza glabra*, *Asparagus* species, *Acorus calamus*, *Phyllanthus emblica*, *Mallotous philippensis*, *Terminalia bellirica* and *Terminalia chebula*. Many valuable medicinal plants of Terai are known to the *amchis* and many are also mentioned in the Tibetan medical literature.

***Amchis'* Experience in the Collection and Use of Medicinal Plants**

Amchis always collect local medicinal plants themselves. They stress that this is very important because they have the long visual experience to identify Himalayan medicinal plants. They worry that a misnamed or falsely collected sample may be dangerous and cause death of the patient. This is particularly true in the case of *Aconitum orochryseum* and *A. spicatum*. *A. spicatum* is highly poisonous and is difficult to differentiate from *Aconitum orochryseum*. Using the wrong species by mistake can result in death. The medicine from this plant can only be prepared by highly experienced *amchi*. Medicine must be made by *amchi* with other medicinal plants of the Himalaya, so that the poison of that plant is inactivated without inactivating the medicinal properties.

For example, in Mustang, *A. spicatum* whole plant (mainly root) is used to make medicinal pills by the *amchi* to treat: (a) infected wounds; (b) as a tonic to provide relief from general weakness; (c) to counteract the effects of poison, including inappropriate self medication, poison ingested on purpose or accidentally, poisonous animal stings or bites; (d) boils; (f) fever; (g) allergy and (h) edema. It is never used alone and is always mixed with other medicine of the Himalaya. A paste of the root is applied for allergy, boils, cuts, wounds, and edema after mixing with other medicinal plants. Perhaps these other plants remove the poisonous effects of *A. spicatum*. The root is used by *Dhami* or

amchi to tie around the neck of the patients. During this tying ritual, the *amchi* spell ritual '*Mantras*' to wish good luck to the visitors willing to leave his/her home for work.

Amchis may also create confidential mixtures of medicines for a patient. This confidentiality was maintained and no data regarding those mixtures were recorded. When permission was granted, the plants species has been indicated for example (see appendix V) with the confidential nature of the mixture noted. They mentioned that more than one plants in the preparation of medicine is important than a single plant because a combination of two or more plant species increases the efficacy of the medicine.

Although autumn season has been considered the best for collection of root and spring season for stem by *amchi* but important days or months of collection of individual plant species varies greatly and known more to *amchi* because the time of collection of plant parts are very important in containing the active principles.

Range of Treatment of Ailments

Many plant species are used by *amchis* to treat a broad range of ailments, while some plant species are found to treat only one ailment. For example, *Allium oreoprasum*, *Aster diplostephioides*, *Neopicrorhiza scrophulariiflora*, *Rosa sericea* (Bhattarai and Chaudhary, 2005), and *Rumex nepalensis* treat broad range of ailments, while *Caragana gerardiana*, *Descurainia sophia*, *Maharanga bicolor*, *Maharanga emodi*, etc., are used to treat only one ailment. In total, 157 medicinal plants were found to be used to treat 150 ailments. A detailed list of ailments and terminology can be seen in appendix VI and VII.

Rosa sericea is used to treat: cough, cold, enervates periods, fever (any kinds of fever), to lower blood pressure, headache, numbness of limbs, vertigo/dizziness, eyes sight, liver diseases, bile disorders and air/wind diseases. Similarly, *Urtica dioica* is used to cure different kinds of disease which are not cured by other medicines such as, to lower blood pressure, to increase blood, to treat edema and to cure difficulty in passing urine. In Manang and Mustang, *Verbascum thapsus* is taken to dry wounds, as an anthelmintic, for pain in stomach, to cure difficulty in passing urine, excess menstrual bleeding, infectious diseases, edema and burns. Similarly, *Arisaema flavum* and *Arisaema jacquemontii* for sinusitis, skin diseases, when extra bone appears on part of the body, for pregnant women and for blood diseases.

Two species of *Hippophae* are included in this group of important medicinal plants. *Hippophae salicifolia* fruit is used for cough and cold, chest pain, stomachache, diarrhoea, dysentery, worms, rheumatism and gastritis and *Hippophae tibetana* fruit is used as a diuretic, tonic, cough and cold, to treat periods of weakness, and worms. These

two species are used to treat broad range of ailments. It is very important to take immediate steps towards conservation and management aspects of important medicinal plants of Manang and Mustang. Cultivation of these two species in the barren lands helps in conservation and management, while at the same time can improve the economic status of poorer people.

Health in Manang and Mustang

The allopathic health care system in Manang and Mustang districts is rudamentary. Few allopathic medicines are available, with the exception of paracetamol (acetaminophen) and brufen (ibuprofen). For this reason and because of traditional and cultural customs and beliefs, many people rely on local healers or *amchis* for health care. The most commonly treated ailments by the *amchis* in Manang and Mustang include gastritis, cough, cold, edema, stomachache, diarrhoea, dysentery, jaundice, rheumatism and numbness of limbs. *Amchi* believed the cause of these diseases were from: (a) dust; (b) low rainfall, less green vegetation and decreased availability of green vegetables and (c) no fixed time for lunch and dinner.

Approximately 150-300 patients per month visit *amchis* (Gyasto Bista, Tenzing Bista Lama, Karma Sonam Lama, Tshampa Ngawang Gurung) in April and May suffering from air and water born diseases. Local people and foreigners trekking through the district visit *amchis* for the treatment where they are treated free of charge.

Case Histories of Patients Treated by *Amchis*

The *amchis* have great knowledge about the use of medicinal plants and the villagers rely heavily upon them for health care. For example in Manang, not only do the people of Nar and Phoo depend on *amchis* for health care but patients from surrounding villages come to the village of Phoo, the site of a monastery with much respected *amchis*, for treatment. For example, one patient (who agreed to the use of her story as long as her name was not used) from Tilche (of lower Manang village), travelled to the monastery for the treatment of dysfunctional vaginal bleeding. She had sought treatment in several places in Nepal and in India but her condition had not improved. The *amchi* gave a confidential mixture, prepared especially for this patient, continuously for a week. After the treatment the patient recovered and returned to her home.

Many interesting treatments are also performed by the *amchi* Tshampa Ngawang Gurung in Jomsom. As for example, it was said that Mr. Joseph from the United States of America had suffered from rheumatism. Upon reaching Jomsom, he could not stand up properly but after the treatment for a month by *amchi*, he recovered and went back to his

country. The *amchi* claims that patients who have been advised by Gandaki hospital (Pokhara) doctors to have their hands or legs amputated in order to recover were cured by his treatment. These accounts speak of the trust and respect that the people of Mustang districts have for the traditional healers.

Most of the *amchis* learned traditional medicinal practice from their fathers or other elders and often from Dharmashala (India), Darjeeling (India), Lhasa (Tibet) and Kathmandu. Their fathers or elders took them in the pasture and gave deep knowledge about the useful plants which makes them recognized in the top list of *amchi* in Nepal. Due to lack of good health posts with certified doctors, local people prefer to visit *amchi* for the treatment. As for example, in the district health post of Jomsom there is limited medicines, but people have easy access of *amchi* medicine and treatment with full beliefs. Nowadays *Mustangi* and *Manangi* believe that there are no side effects from *amchi* medicine, but they take a long time for complete recovery.

Transmission of *Amchis* Knowledge

The remote village of Phoo, where this *amchi* practices, contains only 28 houses and from these houses, 23 people are now working outside the country after having been trained by the most senior *amchi* (Karma Sonam Lama) (see plate II). In the past centuries, *amchi* knowledge was transmitted based on lineage, but to date five private *amchi* schools have been established in Nepal. Governments of neighbouring countries (China, India, Mongolia, Bhutan) have supported the study of *amchi* medicine through college and university but the government of Nepal has not yet followed and recognized it. In recent years, *amchi* have come to believe that the practice of knowledge transmission has declined due to change in socio-economic causes and conditions in Nepal (Bista and Bista, 2005), but to date *amchi* professionalism remains in different regions of Nepal and are under threat. Since the establishment of Himalayan *amchi* association in 1998, the health and developmental works related to *amchi* are handled by this association.

In Manang and Mustang both women and men come to the monastery to seek training because it is very easy for an *amchi* to leave the country to work after this training is completed. However, the trend of leaving the country after training worries the senior *amchis* (plate II), because till date they identified the shortage of trained *amchi* manpower within the country. Now-a-days senior *amchis* also consider leaving their villages because of lack of modern facilities but are strongly bound to continue their *amchi* tradition to the younger generations. They thought that the traditional knowledge has been transmitted within their generations since centuries and this vast knowledge may disappear when they

left their villages. This can be taken as a good example of dedication of the senior *amchi* towards the conservation of traditional knowledge and practices.

The senior *amchis of* Phoo, Lomanthang and Jomsom (plate II), were also familiar with the very intricate rules for collecting plants for use as medicines, such as time of collection, parts to be collected, and care in the conservation and management aspects of medicinal plants. They feel that it is of utmost important to conserve the traditional healing system and aware the local community about the importance of medicinal plants which will lead them to the conservation and management of medicinal plants in the villages. If this healing system cannot be conserved and utilized, they feel that in time it will have a negative effect on the whole community. Senior *amchis* of Phoo, Lomanthang and Jharkot feel fortunate that their brothers, sons and daughters were learning the traditional healing system from them and are acquiring a deep understanding of the use of medicinal plants. Many plant species of Manang and Mustang districts are used as medicine, and several are very popular and known throughout Nepal.

Amchis are aware of the harsh climatic conditions, green vegetation and their impact on human beings. To preserve the wild plant resources of Manang and Mustang they follow selective and alternative methods of harvesting the wild plants having similar medicinal uses. As far as possible they use all plant parts in medicine. They know that Manang and Mustang are the rain shadow districts and the process of overharvesting of the same species within the same habitat may possibly result in the loss of that species from that habitat which leads more barren land. Because of this, living areas will become unsuitable for human settelments. Therefore this long awarness vision of *amchi* towards the conservation of medicinal plants looks very encouraging.

2.5. Conclusion

Natural forests are a common property resource, accessible to all members of the community in the Annapurna Conservation Area of Manang and Mustang. The present survey concludes that the local populations of Manang and Mustang districts have a fairly extensive and detailed knowledge regarding wild plants and their utility.

With regards to the uses of plants as medicines, this research confirms the vast knowledge of the traditional healers such as *amchis*, local healers and village elders on the subject of plants used for medicinal purposes. Several factors may contribute to the persistence of this knowledge. The lack of modern and government facilities and remote geographical features of Manang and Mustang district, as well as a strong belief in folk medicines continue the preference for traditional healers for their health care. This tradition is strong in the remote villages of Nar, Phoo, Lomanthang, Jharkot, Jomsom, Larjung and Kagbeni

where *amchi* are the only source of primary health care. Generally, most village elders can treat minor diseases themselves, using local medicinal plants. If they cannot treat the illness by themselves, they will seek help from the senior *amchi*. There are other more junior healers and traditional medicinal plant sellers in the village of Manang and Mustang but none more expert than the senior *amchi*.

The senior *amchi* of Phoo and Lomanthang are grateful that their children were interested in learning how to use medicinal plants. It is common in the area to have a lack of flow of indigenous knowledge from elder to younger generation, since the young generation is reluctant to learn about traditional medicinal practices. The younger generations often leave their villages because of the profound economic changes that have come about during the last ten years. Many young families have left Manang and Mustang and established themselves in the cities of Kathmandu or Pokhara.

In the quest to increase earnings, important medicinal plants are now being harvested for profit, which may put some species at risk. For example large amounts of *Cordyceps sinensis*, *Allium wallichii*, *Aconitum orochryseum* etc., were collected each year in the district. The continuation of collecting these species in the same area each year will decrease the population of the species and the locals worry that plants are rarer now and the species disappearing from the same habitat. Indigenous practices and knowledge regarding the sustainable harvest and utilization of plant resources as medicine should be documented and preserved before they disappear.

CHAPTER 3

3. ANTIBACTERIAL STUDY

3.1 Introduction

In Nepal, because of the rapid disappearance of local ecosystems, much of the knowledge of local people about plant resources and their use are disappearing rapidly. This type of destruction may result in loss of traditional knowledge. Plants have long been proved as a rich source of medicine all over the world and recent bioprospecting research shows that nature is still productive source of new medicine (Ballick and Cox, 1996, 1997). Many useful plant derived drugs were discovered as a result of scientific follow-up of well known plants used in traditional medicine. Some of today's major diseases, such as HIV and cancer are being treated with products derived from biodiversity. Modern medicine has also benefited from medicinal plants that were originally used as home herbal remedies. Therefore, medicinal plants used in traditional therapy could be a fruitful source for the discovery of many useful drugs.

In developing countries the availability of modern medicines is limited and traditional medicine derived mostly from plants is used in health care. Although many plants have long been recognized and widely used in Nepalese traditional medicine, most have not been explored scientifically and therefore have not arrived into mainstream medicine (Bhattarai *et al*., 2006b; Rajbhandari *et al*., 2007). Therefore, the research into new drugs must continue and natural products may prove to be a source of safe and affordable medicines.

The screening of plants as a possible source of antibacterial and antiviral drugs has led to the discovery of potent inhibitors of *in vitro* bacterial and viral growth (Ojwang *et al*., 2005). An antibacterial agent is a chemical substance that either kills microorganisms or prevents their growth. According to Tripathi (1995) microbial agents are synthetic as well as naturally obtained drugs that attenuate microorganisms. The action of antibiotics upon microorganism may be either bacteriostatic i.e., inhibiting growth and reproduction or bacteriocidal i.e., actually killing the organism. In general antibiotics appear to alter vital process in the metabolism of this organism by interference with some specific enzyme systems or with the utilization of the certain metabolites. The most significant actions are the disturbance of cell wall synthesis and the inhibition of protein biosynthesis (Hugo and Russel, 1985).

Many studies have investigated the traditional uses of medicinal plants in Nepal (Manandhar, 1985, 1986, 1987, 1989a, 1989b, 1994; Bhattarai, 1993a; Shrestha and

Joshi, 1993), although only a few species have been screened for biological activity (Bhakuni *et al*., 1969; Taylor *et al*., 1995, 1996a, 1996b, 1996c; 2002).

The aim of screening was to correlate the antibacterial activity of the plant extracts to the indigenous uses. This can be seen as the first step in the search for primary health care products that are socially acceptable and scientifically valuable. In Nepal, this is seen as an opportunity for income generation as well as possibly a strong and economically viable reason for biodiversity conservation.

3.2 Literature Review

Little research regarding the screening of ethnomedicinal plants for antimicrobial (antiviral, antifungal and antibacterial) activities has been undertaken in Nepal. Some of the important literatures have been reviewed briefly below.

Shakya (1982) performed preliminary studies on some medicinal plants for their antimicrobial activities. Forty-eight indigenous plants were studied for their antimicrobial activities by disc diffusion method. The test organisms were *Staphylococcus aureus, Agromobacterium tumefaciens, Bacillus subtilis, Salmonella typhi, Escherichia coli, Shigella dysenteriae, Candida albicans, Saccharomyces cerevisiae* and *Cryptococcus neoformans*. Some plant species showed weak and moderate activities on both bacteria and fungi while some extracts showed encouraging activities.

Adhikari and Sharma (1987) studied the antimicrobial activities of some plant extracts. Results obtained from minimum inhibitory concentration of some plant extracts against some fungi and bacteria are presented in this paper. Four different plants *Allium sativum, Artemisia vulgaris, Hydrocotyle asiatica* and *Melia azedarach* were tested against four fungi *Aspergillus fumigatus, Fusarium oxysporium, Candida albicans,* and *Saccharomyces cerevisiae* and four species of bacteria, *Escherichia coli, Pseudomonas aeruginosa, Streptococcus* species and *Staphylococcus aureus*. The extracts of *Melia azedarach* showed best inhibition effect against tested fungi while extracts of *Artemisia vulgaris* were active against bacteria. The extract of *Allium sativum* was found to have moderate activity against both fungi and bacteria.

Rijal (1994) studied some medicinal plants and essential oils for antimicrobial activities. Antibacterial activities of 32 indigenous medicinal plants are studied. Among them extract of the tuber of *Stephania glandulifera,* flower bud of *Sphaeranthus senegalensis* and aerial part of *Chenopodium ambrosioides* oil showed activities in fungal growth. Likewise *Perilla frutescens* oil from leaf extracts showed the strong inhibition activities in fungal growth and weak inhibition activities for bacterial growth.

Taylor *et al*. (1995) studied the *in vitro* screening of selected medicinal plants of Nepal for their antimicrobial activities. Extracts of twenty-one species of plants showed activity against at least two bacterial species, and twenty showed activity against at least two fungi species. Only three species were active against Gram-negative bacteria and none of the extracts were active against *Pseudomonas aeruginosa* or *Candida albicans*.

Taylor *et al*. (1996a) described twenty species of plants belonging to thirteen different families. Fifteen plant extracts showed activity against fungi and bacteria. Only four extracts were active against *Pseudomonas aeruginosa*. None were active against the other Gram-negative bacteria *Escherichia coli, Klebsiella pneumoniae, Enterobacter arogenes, Salmonella typhimurium*. Similarly, Taylor *et al*. (1996b) studied the antiviral activities of medicinal plants of southern Nepal. Altogether 21 species were assayed for activity against three mammalian viruses: herpes simplex virus, Sindbis virus and polio virus. Assayed were performed in UV-A or visible light, as well as dark. Individual species of *Hypericum, Lygodium,* and *Maesa* exhibited impressive antiviral activities, although their selective effects on the three viruses suggested that the antiviral ingredients were different in each extract. In addition, many of the other extracts showed partial inactivation of one or more test viruses.

Taylor and Towers (1998) found antibacterial constituents of *Centipeda minima*, a herb used medicinally to treat cough, sinus infections, colds, headache and blocked nose resulting from coughs and colds in Nepal. Three antibacterial sesquiterpine lactones have been isolated from *C. minima*. The antibacterial constituents, determined through bioactivity guides fractionation are also described. Taylor *et al*. (2002) conducted ethnobotanical research in the proposed Tinjure-Milke-Jaljale Rhododendron conservation area, eastern Nepal. A healthy knowledge of medicinal plants was observed among the inhabitants, and specific remedies were recorded. Of the 27 plants tested, 21 showed activity against *Bacillus subtilis*, 17 against *Staphylococcus aureus*, 12 against *Mycrobacterium phlei* and three against *Pseudomonas aeruginosa*. No plant extracts were active against *Escherichia coli*. This paper discussed activities of 10 plants in detail.

Shrestha and Sharma (1998) observed the antimicrobial activities of some essential oil *viz. Mentha arvensis, Acorus calamus, Zanthoxylum oxyphyllum* and turpentine oil against some fungi and bacteria. The extent of efficacy of the essential oil was studied at two different growth stages of filamentous fungi and non-filamentous fungi, Gram-positive (*Staphylococcus* species and *Streptococcus* species) and Gram-negative bacteria (*Escherichia coli* and *Pseudomonas* species) by minimum inhibitory concentration (MIC)

techniques and spore germination test. Turpentine oil exhibited strong activity against tested bacteria.

Bhatt and Joshi (1999) studied the phytochemical and antimicrobial screening of *Coriaria nepalensis*. Extraction from different plant parts was done with different solvents like petroleum ether, diethyl ether, chloroform and methanol. Antimicrobial screening of the crude extracts of *Coriaria nepalensis* from different solvents were tested on *Escherichia coli, Staphylococcus aureus, Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. Methanolic extract showed significant antimicrobial activity on *Escherichia coli* and *Staphylococcus aureus* using amoxicillin and tetracycline as standards respectively.

Devkota *et al*. (1999) studied the antimicrobial activities of some medicinal plants used as medicine in different village areas of Nepal under Ayurvedic system. He also extracted the chemical compound from *Glycyrrhiza glabra*.

Pokhrel (2000) screened and evaluated the antimicrobial activity of some medicinal plants of Nepal and isolation of pure antimicrobial compound from *Bauhinia variegata*. Antimicrobial activities of twenty medicinal plants were performed against eight different pathogenic organism's *viz*. *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Shigella dysenteriae*, *Staphylococcus aureus*, *Vibrio chlolerae* and *Candida albicans*. It was noted that Gram-positive bacteria were more sensitive to medicinal plants than Gram-negative bacteria.

Sharma (2000) studied the antimicrobial activities of essential oils of some common spices. The essential oils were extracted from *Cinnamon*, *Cardamom*, etc. *Cinnamon*, clove and *timur* (*Zanthoxylum armatum*) oils showed high degree of inhibition whereas other like black pepper oil and coriander oil were found comparatively less inhibitor. Essential oils of species were found very useful in controlling pathogenic as well as spoilage type microorganisms.

Baidya (2001) screened and evaluated the *in vitro* antimicrobial activity of medicinal plants of Nepal. Antimicrobial study of twenty medicinal plants was tested against eight bacterial strains. Tested plants includes: *Acacia catechu*, *Acorus calamus*, etc, and tested bacteria includes *Escherichia coli*, *Staphylococcus aureus, Proteus mirabilis*, *Pseudomonas aeruginosa*, *Salmonella typhi* and *Shigella dysenteriae*.

Griggs *et al*. (2001) studied the effects of storage on the biological activity of medicinal plants from Nepal. Antimicrobial testing showed that after a storage period of six years the biological activity of some medicinal plant species decreased. The plant material was

extracted with methanol for both the previous and present study. Methanol extracts from the plants were assayed for activity against six strains of bacteria and three strains of fungi. Out of the nineteen plants tested, three lost all activity, six retained all activity, and ten had partial activity.

Parajuli *et al*. (2001) screened antibacterial activity of twenty nine medicinal plants used to treat skin ailments of Kaski district, Nepal. Eleven plant species including *Curcuma longa,* and *Zanthoxylum armatum* were able to produce zone of inhibition with all tested bacteria while seven plant species including *Ficus benghalensis*, *Maesa chaesa* were unable to produce inhibition zone with any of the test bacteria.

Rajbhandari *et al*. (2001) screened the Nepalese medicinal plants for antiviral activity. Methanolic and methanolic-aqueus extracts derived of 23 species were assayed in two virus *in vitro* systems, influenza virus/MDCK cells and herpes simplex virus/Vero cells. Two species *Bergenia ligulata* and *Nerium indicum* showed the highest antiinfluenzaviral activity with 50 % inhibitory dose of 10 µl/mL. None of the extracts showed cytotoxic effects.

Gautam (2002) studied the medicinal plants used to treat respiratory complaints in Nawalparasi District, Central Nepal and their antibacterial activities. Thirty three plant species were tested against three strains of bacteria *viz*. *Staphylococcus aureus, Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. The antibacterial activities of commonly used plants showed strong and positive result. Some of the plants that were reported to have high medicinal value were unable to create zone of inhibition.

Bhattarai (2003) screened a series of 31 Nepalese medicinal plants used by the *Manangi* community of Manang District, Nepal, for antibacterial activity. These plants are used to treat ailments thought to be caused by bacterial infection, including sore throat, cough, and diarrhoea. Bacteria screened were *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcus faecalis* and *Salmonella typhi*. Out of the 31 species examined, 19 showed antibacterial activity against *Salmonella typhi,* 18 showed antibacterial activity against *Escherichia coli*, 17 showed antibacterial activity against *Staphylococcus aureus,* 17 showed antibacterial activity against *Streptococcus faecalis* and 12 showed antibacterial activity against *Pseudomonas aeruginosa*. Five plant species i.e., *Bistorta affinis, Mentha longifolia, Anisodus luridus, Cynoglossum zeylanicum* and *Galium boreale* did not show any antibacterial activity.

Timsina (2003) screened 20 medicinal plants of Nepal against 10 microorganisms. Among the tested plants, seven species (35 %) were found to show activity against six or

more test microorganisms, and other four species (20 %) were active against four test microorganisms. *Rhododendron anthopogon* and *Rhus javanica* were the most active plants as they were effective for all microorganisms. *Boerhavia diffusa* did not show effect to any of the test microorganisms. Gram-positive bacteria were most sensitive to the medicinal plant extracts than Gram-negative bacteria. *Staphylococcus aureus* was the most susceptible microorganism being inhibited by 19 out of 20 medicinal plants. *Shigella dysenteriae* was found to be the most resistant species being susceptible only to the extract of three plant species.

Parajuli (2004) documented and screened the medicinal plants used to treat diarrhoea and dysentery for their antibacterial property. Among 42 plants recorded, extracts of 26 plant species were tested against four strains of bacteria. Extracts of 14 species showed positive effects against *Escherichia coli*, 16 species showed positive activity against *Shigella boydill*, 19 species showed positive effects against *Staphylococcus aureus*, 17 species showed positive effect against *Pseudomonas aeruginosa*. Five species showed positive effect against all the tested bacteria and three plant extracts did not show effect against any tested bacteria.

Panthi and Chaudhary (2006) studied the antibacterial activity of some selected folklore medicinal plants from West Nepal. Eighteen plant species used in folklore medicine in west Nepal were tested for their antibacterial activity by the disk diffusion method. The bacteria employed were Gram-positive (*Staphylococcus aureus*) and Gram-negative (*Escherichia coli*, *Pseudomonas aeruginosa* and *Shigella boydii*). Extracts of eight plants showed encouraging result against three strains of bacteria, while other showed activity against one or two strains.

Ghimire and Radha (2006) evaluated the antimicrobial activities of Nepalese indigenous medicinal plants. In their research acetone extracts of 6 species of lichens were tested against 8 bacterial strains (*Staphyloccus aureus*, *Escherichia coli*, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Proteus mirabilis*, *Klebsiella pneumonia*, *Shiegella dysenteriae*). Dried extracts were suspended separately in water, phosphate buffer pH 7, methanol and ethanol. Ethanolic suspensions were found inhibitory than the aqueous suspensions. Gram-positive bacteria *Staphylococcus aureus* was most sensitive to ethanolic and methanolic suspensions of all plant extract whereas *Escherichia coli* was found to be most resistant one. Since ethanolic suspensions of *Parmelia tinctorum* and *Parmelia sanctii-angelia* extracts inhibited all bacteria under investigation, they can be regarded as having broad-spectrum antibiotic activity.

Rajbhandari *et al*. (2007) tested some methanolic extracts of 41 plant species belonging to 27 families used in the traditional medicine in Nepal. These plants extracts have been investigated for *in vitro* antiviral activity against Herpes simplex virus type 1 (HSV-1) and influenza virus A by dye uptake assay in the systems HSV-1/Vero cells and influenza virus A/MDCK cells. The extracts of *Astilbe rivularis*, *Bergenia ciliata*, *Cassiope fastigiata* and *Thymus linearis* showed potent anti-herpes viral activity. The extracts of *Allium oreoprasum*, *Androsace strigillosa*, *Asparagus filicinus*, *Astilbe rivularis*, *Bergenia ciliata* and *Verbascum thapsus* exhibited strong anti-influenza viral activity. Only the extracts of *Astilve rivularis* and *Bergenia ciliata* demonstrated remarkable activity against both viruses.

3.3 Materials and Methods

3.3.1 Collection of Samples with Voucher Specimens for Antibacterial Testing

The samples for antibacterial testing were collected from the study area during summer 2004 to 2007. A total of 15 field visits to Manang, and Mustang were conducted for the collection of samples for antibacterial testing. Samples were selected and collected base on their use among the *amchis* and other knowledgeable local people. Only species that were consistently used to treat same illness by several healers, villagers and traders were selected.

Voucher specimens of all the species used for antibacterial testing were collected. Plant species were identified with the help of standard literatures as described in chapter 2. The useful parts of plants used in traditional medicine were collected in the cotton bags, cut into small pieces and air dried in the shade. Collection numbers was noted on each bag. Completely dried materials were transported to the laboratory. Antibacterial studies were carried out at Central Department of Botany and Research Centre for Applied Science and Technology of the Tribhuvan University, Kirtipur, Kathmandu.

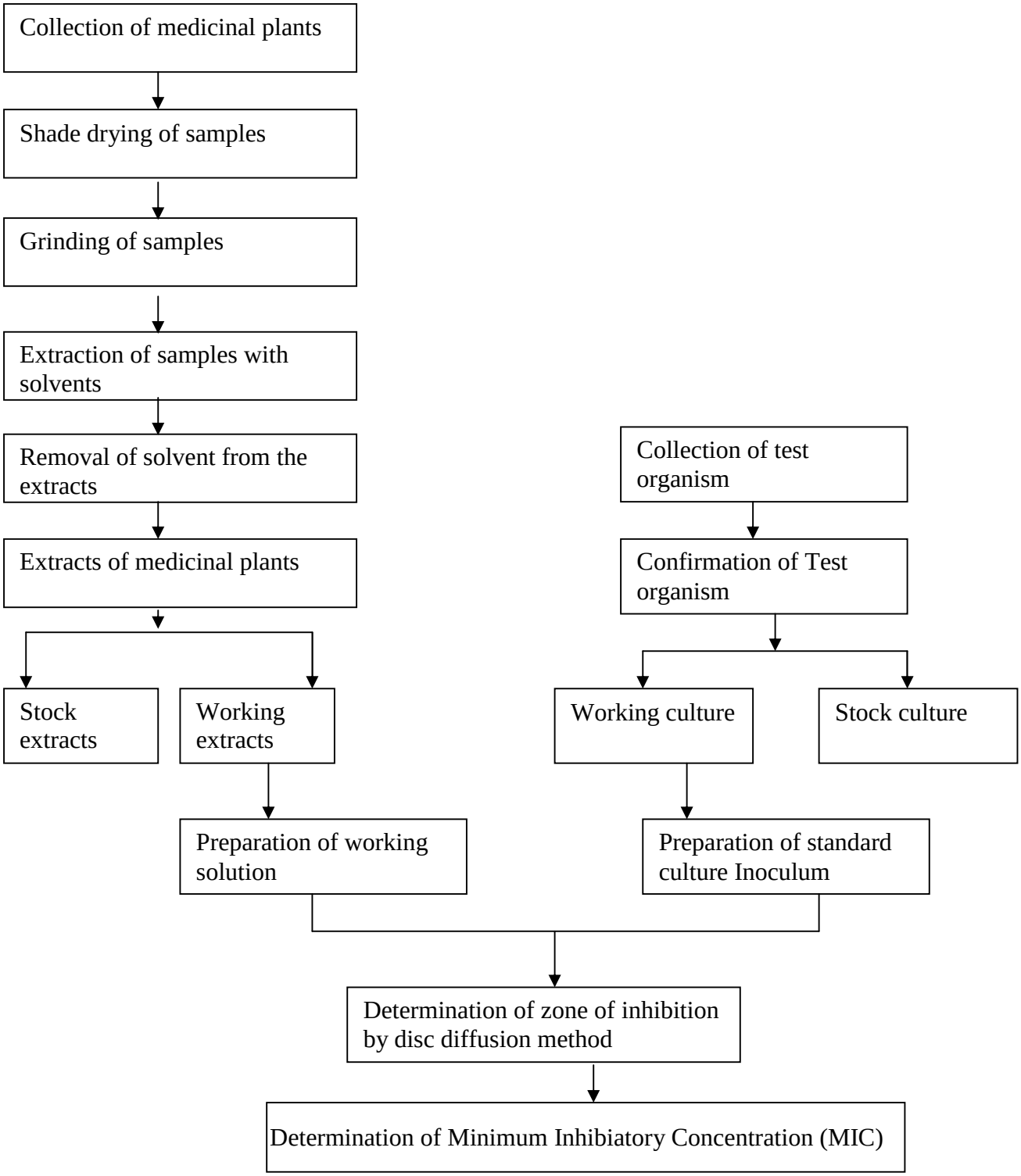


Figure 2: Flow Chart of the Methods (Evaluation of Antibacterial Activity of Different Medicinal Plants

3.3.2 Media Used

Two media used in the study are nutrient agar (Becton Dickinson and Company) and nutrient broth (DIFCO, Bacto: Dehydrated nutrient broth). Techniques for preparation are described in appendix I.

3.3.3 Preparation of Plant Extracts

(a) Preparation of Plant Extracts for Crude Screening

Plant material was air dried and grounded in an electric grinder. A 2 g sample of plant material was soaked in 25 mL methanol (MeOH) for a minimum of 24 h. The sample was then suction-filtered through Whatman number 1 filter paper and the residue was again soaked with another 25 mL MeOH for another 24 h. This process was repeated until the extracts became colourless. The filtrate was then dried with the help of a fan. After complete dryness, the extract was resuspended in 2 mL of MeOH. This gave an extract concentration equivalent to approximately 1g of dried plant material per mL, which varied slightly depending on the plant material.

(b) Preparation of Plant Extracts for Minimum Inhibitory Concentration Testing

Similarly, for finding out the minimum inhibitory concentration, plant material was air dried and ground in an electric grinder. Powder plant materials (each 10 g) were subjected to sequential Soxhlet extraction, using methanol, dichloromethane, and hexane respectively. Organic solvents were removed under reduced pressure and was evaporated *in vacuo* at 40^0C using a rotary evaporator. The crude evaporated plant extracts were dried at room temperature for 5-30 days. Then 50 mg of each crude plant extract was dissolved in 1 mL (1,000 microlitres) of the respective solvents (methanol, dichloromethane and hexane) to give a final concentration of crude extract in solvent of 50 mg/mL.

3.3.4 Preparation of Test Disks

(a) Preparation of Test Disks for Crude Extract Testing

Paper discs (6 mm diameter) (Schlecher and schuell USA) were impregnated with 20 µL (the maximum capacity of the disk) to give a final concentration equivalent to 1 mg dried plant material per mL solvent. The prepared disks were allowed to dry at room temperature.

(b) Preparation of Test Disks for MIC

From the 50mg/mL crude extract stock solution, 6 mm paper discs were impregnated with 20 µL extracts (20 µL/disc from a stock solution of 50 mg/mL) which is equivalent to 1 mg/disc. The stock solution was then subjected to serial dilution to find out the minimum inhibitory concentration using sterile solvent as the dilution medium.

(c) Preparation of Positive and Negative Control Discs

Negative control discs were prepared by dipping the discs into methanol solution or impregnating the discs with 20 µL of the methanol. Similarly, positive control discs were prepared by using the antibiotics i.e., ciprofloxacin, erythromycin and tetracycline. Paper discs were impregnated with 10 µL of 0.25 mg/mL erythromycin and ciprofloxacin with MeOH. As a positive control, erythromycin and tetracycline are used for Gram-positive and ciprofloxacin for Gram-negative bacteria.

3.4 Microorganisms Used

Six different strains of bacteria were used in the screening process including Gram-positive *Staphylococcus aureus, Streptococcus faecalis, Bacillus subtilis* and Gram-negative *Salmonella typhi, Escherichia coli* and *Pseudomonas aeruginosa*. These bacteria were supplied by the Department of Clinical Microbiology, Teaching Hospital, Maharajgunj, Kathmandu and the Central Department of Microbiology, Tribhuvan University, Kirtipur, Kathmandu. The description of the bacterial species can be found in appendix II.

3.5 Antibacterial assay

Antibacterial activity of a plant extract was determined by observing an inhibition zone. The extract containing disks were placed on a freshly seeded lawn of bacteria, which was then allowed to grow until the bacteria created an easily visualized lawn. The zone is seen as a clearing around the extract on this bacterial lawn. A positive result is obtained when the extract of a particular medicinal plant inhibited the growth of the microorganism and thus zone produced a 'zone of inhibition'. This zone indicates that the plant extract has antibacterial activity. A negative result is obtained when the extract of a particular medicinal plant did not inhibit the growth of microorganism *in vitro* and did not produce a zone of inhibition. In this case, the bacterial lawn grew right up to the extract containing disk. This negative result indicates that this plant extract does not have antibacterial activity *in vitro* against that particular microorganism. The bioassay used was the standard disc diffusion assay, adapted from Taylor *et al*. (1995, 1996a, 2002) to take into consideration the equipments available on site in Nepal. Results were recorded as presence or absence of zone of inhibition and testing was repeated three times to ensure reliability of results. The assays were performed in the following manner:

3.5.1 Preparation of Standard Inoculum

The inoculum for most of the bacteria was prepared by transferring a large number of bacteria from the agar slant to a tube containing 5 mL of liquid media (nutrient broth) and

incubating for 24 h at 37 ^{0}C. The tubes were shaken occasionally to aerate and promote growth. The overnight cultures were diluted 1/5 to 1/10 with nutrient broth before use.

3.5.2 Inoculating the Agar Plates

This overnight culture (and diluted 1/5 to 1/10 with nutrient broth) was used to inoculate the nutrient agar test plates. Petri dishes is poured with 100 microliter of this diluted bacteria solution in broth which had been growing overnight for 24 h at 37 ^{0}C and swabbed with a sterile cotton swab by rotating the Petri dishes.

3.5.3 Placing extracts Discs and Incubation

Once inoculated, dried discs of plant extracts and controls (negative and positive) were added. The discs containing extracts of plant material and control discs were placed on inoculated agar plates aseptically. Plates were incubated upside down for 18-24 h at 37 ^{0}C.

3.5.4 MIC Assay

The Minimum Inhibitory Concentration (MIC) method was applied on extracts that proved their high efficacy against microorganisms by the disk diffusion method. The active extract at 50 mg/mL concentration was subjected to sequential or serial dilution to find out the minimum inhibitory concentration using sterile solvent medium as a dilution. The highest dilution of a plant extract that still retains an inhibitory effect against the growth of microorganisms is known as MIC (Misra and Dixit, 1978). In other words, the highest dilution (lowest concentration) of the plant extract that retained its inhibitory effect resulting in no growth of a microorganism is recorded as the MIC value of the extract. A positive and negative control experiment was run in parallel to study the impact of the solvent itself (methanol), and the impact of antibiotics (ciprofloxacin, tetracycline, erythromycin) on growth of the test organisms.

3.6 Statistical Analysis

Univariate analysis of variance was performed in SPSS version 11.5 to compare the MIC values of different plant extracts against the tested bacterial strains.

3.7 Results and Discussion

3.7.1 Antibacterial Activity of Ethnomedicinal Plants

The present study was undertaken to determine if the therapeutic properties of some plants used in traditional medicine coincide with laboratory findings. For this research, *in vitro* antibacterial assays of 92 extracts from 79 ethnomedicinal plants belongs to 63

genera under 39 families which were used to diseases potentially caused by bacteria were examined.

Three bacterial strains *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa* were tested against all 92 extracts. Among 92 extracts examined, 73 (80 %) extracts showed antibacterial property against *Staphylococcus aureus*, 71 (78 %) extracts against *Escherichia coli*, and 64 (70 %) extracts against *Pseudomonas aeruginosa* (figure 5; appendix IX, plate VI for the positive results with inhibition zone). Among 60 extracts examined against *Bacillus subtilis*, 49 extracts (82 %) showed antibacterial activity. Out of 32 plant extracts examined, 20 extracts (63 %) showed antibacterial activity against *Salmonella typhi* and 18 extract (57 %) against *Streptococcus faecalis*.

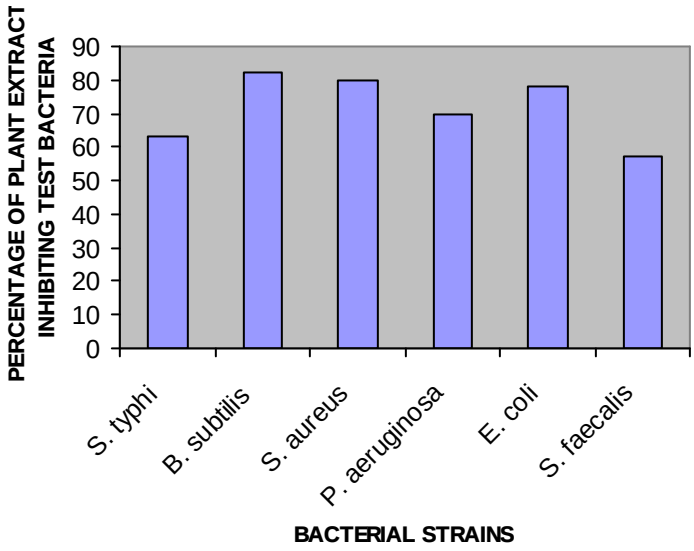


Figure 3: Activities of medicinal plant extracts against the bacterial strains tested during *in vitro* screening of medicinal plants of Manang and Mustang.

Activity of Medicinal Plant Extracts against Gram-positive and Gram-negative Bacteria

Plant extracts were more likely to inhibit Gram-positive bacteria. For example, most plant extracts were active against *Bacillus subtilis*, and then *Staphylococcus aureus*. Of the Gram-positive bacteria, the least number of plant extracts could inhibit *Streptococcus faecalis*. With respect to Gram-negative bacteria, it was more common for plant extracts to inhibit *Escherichia coli* than *Pseudomonas aeruginosa*, or *Salmonella typhi*. Overall, 73 % of plant extracts showed activity against both Gram-positive test bacteria, and 69 % showed activity against both Gram-negative bacteria (see figure 6).

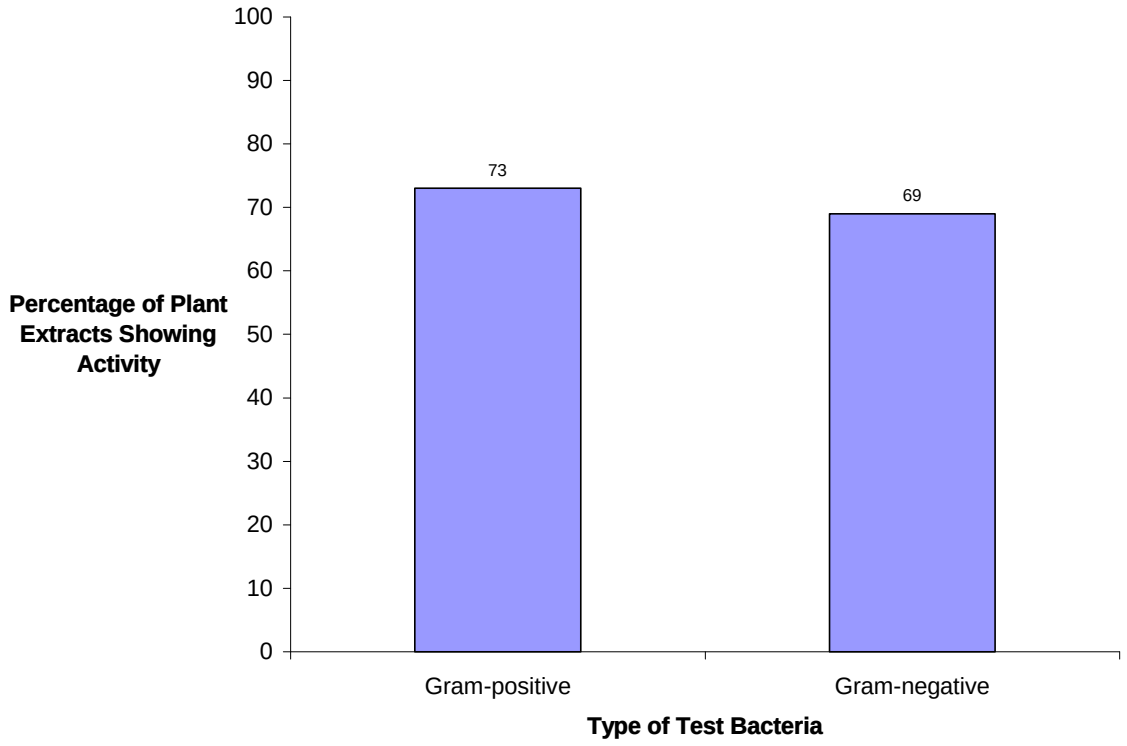


Figure 4: Percentage of plant extracts showing inhibitory activity against Gram-positive and Gram-negative bacteria.

Illnesses studied

These illness may be caused by at least one of the bacterial strain under tested is our hypothesis. For example, diarrhea and dysentery can be caused by *Escherichia coli*; fever may be caused by *Salmonella typhi*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*; skin infections may be caused by *Staphylococcus aureus*, *Pseudomonas aeruginosa*; urinary tract infections may be caused by *Escherichia coli*; pneumonia may be caused by *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*; conjunctivitis may be caused by *Staphylococcus* species, *Streptococcus* species; and cough and tonsillitis may be caused by *Streptococcus* species (Fauci *et al*., 2008).

Plants used against Diarrhea and Dysentery

Altogether, 30 extracts used to treat diarrhea and dysentery were tested against both Gram-positive and Gram-negative bacteria (see appendix IX & X). Of these, 28 extracts showed activity against at least one Gram-positive and one Gram-negative bacteria. In this study, a total of 27 plant extracts showed antibacterial property against *E. coli* which is considered the most probable test microorganism to cause diarrhea and dysentery (Fauci *et al*., 2008). There may be different reasons for inactivity of the remaining extracts of *Malva verticillata*, *Thalictrum cultratum* and *Urtica dioica* with *Escherichia*

coli. However these species showed antibacterial activity with at least one Gram-negative bacterial species. Therefore future antibacterial testing of these species with other diarrhoea causing bacterial strains such as *Shigella* species, *Salmonella* species, *Campylobacter* species, etc will be helpful to gain full information about these plants.

Plants used against Skin infections

Two bacterial strains *Pseudomonas aeruginosa* and *Staphylococcus aureus* under this research can be considered the probable causal microorganisms to cause skin infections (infected wounds and boils) (Fauci *et al*., 2008). A total of 38 plant extracts used to treat skin infections were tested against *Pseudomonas aeruginosa* and *Staphylococcus aureus*; of which 29 extracts showed antibacterial activity against *Pseudomonas aeruginosa* and or *Staphylococcus aureus* (see appendix IX & X). Of 38 extracts examined, 23 extracts showed antibacterial property against *P. aeruginosa* and 29 extracts showed antibacterial property against *S. aureus*. There are many possible reasons of inactivity of the rest extracts, such as (a) the tested plant species may not contain antibacterial compounds; (b) the plants may have other medicinal uses, such as analgesia and others. For example, *Galium boreale* may dry the skin around boils and wounds, making it more difficult for an infectious organism to survive, without being antibacterial in nature. It is also possible that these plants contain antibacterial compounds against pathogenic bacteria other than those tested in this study (such as *Streptococcus pyogenes*).

Plants used for Urological Disease

In total, 30 plant species used to treat urological diseases were tested with different microorganisms. Of which, three plant species namely: *Asparagus racemosus*, *Cissampelos pariera*, and *Onopordium acanthium* were used to treat urinary tract infections and all were active against at least one Gram-positive and Gram-negative bacteria (see appendix IX & X). Here, *Escherichia coli* can be considered the probable cause of urinary tract infection (Leigh, 1985; Fauci *et al*., 2008). In this study, *Asparagus racemosus*, and *Cissampelos pariera* produced a zone of inhibition but *Onopordium acanthium* was unable to produce zone of inhibition with *E. coli*. The negative results may be from degradation of an active chemical during the drying process or perhaps methanol may not be the proper chemical to extract the active chemical constituents of this plant species. Therefore, extraction of this species with other solvents will be helpful to know the full range of possible antibacterial activity.

Plants used against Gingivitis

A total of six extracts which were used to treat gingivitis were tested (see appendix IX). Of which, five extracts showed antibacterial property against all the bacterial strains but one plant, *Anisodus luridus,* used to treat gingivitis and tooth pain in Manang and Mustang districts was not active against any bacteria tested. It is reasonable to think that the medicinal activity may be analgesic (pain relief) rather than antibacterial. Positive results may be seen if the screening is carried out with different *Streptococcus* species (mostly *Streptococcus mutans*) because *Streptococcus mutans* is considered the probable microorganism to cause gingivitis (Fauci *et al*., 2008).

Plants used against Pneumonia

In this study *P. aeruginosa*, *S. aureus* were the test organisms that could cause pneumonia (Fauci *et al*., 2008), and one plant species, *Bergenia ciliata* has been used to treat pneumonia in traditional healing practices was tested against different bacterial strains. Here, *Bergenia ciliata* showed antibacterial activity against all the tested microorganisms. So further phytochemical screening of *Bergenia ciliata* is necessary to add more information to the preliminary screening.

Plants used against Conjunctivitis

For this research, *Staphylococcus aureus* and *Streptococcus faecalis* are considered the most probable test microorganism to cause conjunctivitis (Fauci *et al*., 2008). Here, *Artemisia indica*, *Cynoglossum zeylanicum*, *Nardostachys grandiflora*, *Thymus linearis* and *Valeriana jatamansii* were used to treat conjunctivitis. Except *C. zeylanicum*, all the tested plants inhibited at least one Gram-positive and one Gram-negative bacteria. *C. zeylanicum* is used in the fresh state for the treatment of conjunctivitis in the study area therefore lack of positive results may be due to the degradation of chemicals during drying process, or due to selection of inappropriate solvents.

Plants used against Fever

Altogether, 52 plant extracts used to treat fever were tested with different bacterial strains, of which 44 extracts were active against at least one Gram-positive and 48 extracts were active against at least one Gram-negative bacteria (see appendix IX & X). For this study, *S. aureus*, *E. coli*, *P. aeruginosa* and *S. typhi* were considered the most probable test microorganisms causing fever (Fauci *et al*., 2008). Here, 44 extracts were active against *S. aureus*; 38 extracts against *E. coli*; 36 extracts against *P. aeruginosa* and 15 out of 32 examined extracts were active against *Salmonella typhi*. In this case, any lack of activity may be because of degradation of active chemicals during the drying

process, the extraction process, or perhaps methanol was not an appropriate solvent to extract the active constituents of plant.

Broad Spectrum of Activity of Several Plants

Although the nature and number of active antibacterial principles involved in each extracts are not clear, the broad spectra of activity of several plants namely: *Artemisia caruifolia, Asparagus* species, *Dactylorhiza hatagirea, Dicranostigma lactucoides, Euphorbia longifolia, Hyoscyamus niger, Maharanga bicolor, Rheum australe, Rhododendron anthopogon, Selinum wallichianum, Swertia ciliata, Thymus linearis,* and *Valeriana jatamansii* is promising. This broad spectrum activity is a promising antibacterial property which may explain the importance of these species in traditional remedies.

Swertia ciliata, used to treat typhoid fever, jaundice, cough, cold, diabetes and headache, was noted by locals as one of the most important plants used in the study area (Manang). Used to treat typhoid fever, *Swertia ciliata* was active against both Gram-positive and Gram-negative bacteria. Notably, it is active against *Salmonella typhi,* the Gram-negative pathogen causing typhoid fever. *Swertia ciliata* is taken orally to treat typhoid fever, an illness that progresses from malaise, headache, intermittent fever, mild cough and constipation in the first week, to an overwhelming systemic bacterial infection and in weeks two through four of the illness, with mortality of up to 20% (Eddleston and Pierini, 2002).

The importance of *Swertia ciliata* in the community can perhaps be understood by the broad spectrum of its antibacterial activity. The ability to inhibit the growth of *Salmonella typhi* explains the use during typhoid fever. Typhoid fever is not easily diagnosed in the first 10 days, but instead resembles many other illnesses. The Gram-positive activity of the plant may treat other causes of fever that resemble typhoid during the first week.

Dactylorhiza hatagirea is considered the most important medicinal plant in Manang and Mustang as well as in other parts of Nepal (Bhattarai *et al*., 2006b; Ghimire *et al*., 2008). According to the locals, the paste of the root is applied around boils, cuts, wounds, burns, scabies, ringworm, snake and scorpion stings once a day until recovery. It showed active against both Gram-positive and Gram-negative bacteria. As both Gram-positive bacteria, such as *Staphylococcus aureus* and Gram-negative bacteria such as *Pseudomonas aeruginosa* are often the cause of skin infections (Fauci *et al*., 2008), the broad spectrum activity of this medicinal plant is not surprising.

The possible reasons of the strong results of the above species may be due to their use in the broad range of treatment of ailments in Nepal (see appendix X). Detailed study of these species in the future may help to find alternative medicines from plants. This study is the preliminary evaluation of antibacterial activity of the plants, and the positive results show that these plants may be useful in the discovery of new medications. It is expected that the plants demonstrating a broad spectrum of activity may be helpful to discover new chemical antibacterials that could serve as agents for the maintenance of human health (Srinivasan *et al*., 2001).

Inactivity of Some Plants

Some of the plant species *Aconitum spicatum*, *Anisodus luridus, Bistorta affinis, Cynoglossum zeylanicum*, *Galium boreale*, and *Mentha longifolia* were popular plant species used as medicine among the *Manangi* and *Mustangi* community, but they did not show activity with any of the tested bacteria (see appendix IX). The fresh leaves, flowers, roots and whole plant of these species are collected and used in the fresh form to treat the appropriate illness. The possible reasons of inactivity are (a) the tested plant species may not contain antibacterial compounds (b) the plants may have other medicinal uses, such as analgesia and others. For example, *Cynoglossum zeylanicum*, and *Galium boreale* may dry the skin around boils and wounds, making it more difficult for an infectious organism to survive, without being antibacterial in nature (c) the lack of activity may be because of degradation of active chemicals during the drying process, the extraction process, or perhaps methanol was not an appropriate solvent to extract the active constituents of these plant species (d) many antimicrobial screening studies use a relatively small number of microorganisms for testing. It is possible that these plants contain antibacterial compounds against pathogenic bacteria other than those tested in this study.

In addition, *Anisodus luridus*, used to treat gingivitis, is never used alone. It is always combined with *Malva verticillata* and tobacco, and therefore synergy may explain any potential relief a patient experiences. Similarly, *Aconitum spicatum* is only used by the *amchi* with confidential mixtures and no one can use it singly in the traditional remedies. Since both plant species (*Anisodus luridus* and *Aconitum spicatum*) extracts were not tested together with any additives or in combinations, it is impossible to say if the negative results were from the plant, or from the lack of synergy. In order to assess this, the test must be repeated in combination with the other additives.

Different Parts Tested from a Single Plant

Some of the plant species showed remarkable results in the study. Even different plant parts extracted with the same solvent showed different results from a single species. At first the root extract of *Bistorta affinis* was tested with different strains of bacteria. The root extract was inactive against all the bacterial strains tested. A second time, a mixture of roots and flowers was extracted and tested with different strains of bacteria. The mixture was tested because in Mustang a decoction of root and flower is used for diarrhea. This mixture was able to kill all the test bacteria including both *E. coli* and *S. typhi*, which supports the hypothesis that the antibacterial property of the plant seen in the laboratory will reflect the traditional use.

Three extracts separately from root, leaves and whole plants of *Ephedra gerardiana* were tested with different strains of bacteria because these parts are used to treat broad range of ailments in the study area (see appendix V, & X for detailed usage). These three extracts were tested separately to know the antibacterial property of the parts used to treat the appropriate illness. The whole plant extract was active against all the bacterial strains. Although the whole plant is not used to treat illnesses likely caused by bacteria, the results obtained from this study support the antibacterial property of the plant. However, extracts from leaves was inactive with *Escherichia coli* and root extracts was inactive to *Escherichia coli* and *Pseudomonas aeruginosa*. This study concluded that whole plant contained more important antibacterial compounds than the individual parts and also supports the view of the *amchi* of Mustang who say that usually the use of whole plant is more effective than only using the single parts of the plant species.

3.7.2 Minimum Inhibitory Concentration of Ethnomedicinal Plants

The MIC method was used to further investigate extracts that showed braod spectrum activity against microorganisms by the standard disk diffusion method. The active extract at 1 mg/disc concentration was subjected to serial dilution to find out the minimum inhibitory concentration. The highest dilution of a plant extract that still retained an inhibitory effect against the growth of microorganisms (absence of zone of inhibition) was reported as the MIC (Misra and Dixit, 1978).

In this study, 99 extracts (33 each of MeOH, CH_2Cl_2 and hexane) from 33 selected ethnomedicinal plants used to treat a variety of illnesses were tested against four pathogenic strains of bacteria: *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Bacillus subtilis* using the disc diffusion method. The plants were selected because they are used to treat illnesses caused by bacterial origin (see appendix V and X). These 33 different plant species belonging to 22 families under 28

genera were used to treat ailments thought to be caused by bacterial infection including sore throat, cough, dysentery, diarrhoea, sinusitis, fever, boils, etc.

MIC value of some Potential Extracts

A total of 33 dichloromethane extracts were examined with *Staphylococcus aureus*. Of which, *Anemone rivularis* and *Geranium donianum* extracts showed the most promising MIC of 2 µg/disc each whereas *Rhododendron anthopogon* and *Valeriana jatamansii* both showed MIC of 15 µg/disc. Similarly, 33 hexane extracts were tested againsth *S. aureus*. Of which, *Maharanga bicolor* extracts showed the lowest MIC of 0.9 µg/disc and *Maharanga emodi* and *Valeriana jatamansii* extracts both showed MIC of 1 µg/disc (see appendix XI).

Altogether, 33 dichloromethane extracts were examined with *Bacillus subtilis*. Among these extracts examined, *Maharanga bicolor*, *Maharanga emodi* and *Valeriana jatamansii* extracts showed the lowest MIC of 16.0 µg/disc. Similarly, 33 hexane extracts were examined with *B. subtilis*. In this case, extracts of *Maharanga bicolor*, *Maharanga emodi* and *Valeriana jatamansii* showed low MICs of 7 µg/disc, 1 µg/disc, and 3 µg/disc respectively (see appendix XI).

Altogether, 33 dichloromethane extracts examined with *E. coli*. Extracts of *Maharanga bicolor*, *Rhododendron anthopogon* and *Valeriana jatamansii* showed the best MIC of 16 µg/disc. The hexane extract from *Valeriana jatamansii* also showed the strongest MIC of 16 µg/disc (see appendix XI).

Similarly, 33 hexane extracts were examined with *Pseudomonas aeruginosa*. Extracts from *Astilbe rivularis,* showed low MICs of 15 µg/disc and *Maharanga bicolor*, *Maharanga emodi* and *Valeriana jatamansii* showed the lowest MIC of 7 µg/disc each. Full results can be seen in appendix XI.

The extraction with MeOH, CH_2Cl_2 and hexane crudely separated the chemical components into groups of varying polarity. The activity of these extracts gives insight into the chemical nature of the biologically active constituents. The strong activity of the highly non-polar hexane extracts (shown by the low MIC values) indicates that the bioactive chemical(s) of those plant species was best extracted in non-polar solvent, and therefore was likely to be non-polar as well.

Important and Interesting Activity

In this research, various solvents (MeOH, CH_2Cl_2 and hexane) were used for the extraction of the active chemical constituents of the plant parts used in the traditional medicine against bacterial infection.

Several plant species gave interesting results. *Maharanga bicolor*, for example, was found to have the most active extracts, with all solvents giving active extracts and the hexane extract showing the lowest MIC for all tested bacteria. Interestingly, in Manang the traditional use of *M. bicolor* calls for the juice to be mixed with mustard oil and dropped into the ear to treat ear pain, which is often a symptom of bacterial ear infection. Mustard oil is non-polar, and the most active extract is the non-polar hexane extract. The active component is also likely non-polar.

On the other hand, the only extract of the root of *Bistorta affinis* to show activity was the polar MeOH extract. The root powder of *B. affinis* is added to boiling water, which is ingested 2-3 times a day to treat cough and cold, tonsillitis, and fever (Bhattarai *et al*., 2006b). It is not surprising that the polar MeOH extract would contain the active component, as this plant is traditionally extracted with hot water (also polar) for medicinal use.

Although there is no obvious pattern of bacterial growth inhibition affect of the plant extracts in various solvents used, still the analysis clearly indicates significant ($P<0.001$) differences in the Minimum Inhibitory Concentration (MIC) values of the extracts of different plant species against tested bacterial strains (see Table 1). Only in the case of *Staphylococcus aureus* the MIC values differed significantly according to test solvents (see Table 2).

Table 1: Results of the Analysis of Variance of Minimum Inhibitory Concentration (MIC) values of the extracts of different plant species in various solvents against different bacterial strains (all bacteria are considered together).

Source	Type III Sum of Squares	df	Mean Square	F	Significance
Corrected Model	3.891(a)	12	0.324	4.677	0.000
Intercept	15.939	1	15.939	229.877	0.000
PARTS USE	0.046	1	0.046	0.668	0.415
BACTERIA	3.004	3	1.001	14.442	0.000
SOLVENT	0.211	2	0.105	1.520	0.220
BACTERIA * SOLVENT	0.411	6	0.069	0.989	0.433
Error	19.276	278	0.069		
Total	92.000	291			
Corrected Total	23.167	290			

a R Squared = 0.168 (Adjusted R Squared = .132)

Table 2: Results of the Analysis of Variance of Minimum Inhibitory Concentration (MIC) values of the extracts of different plant species in various solvents against *Staphylococcus aureus*.

Source	Type III Sum of Squares	df	Mean Square	F	Significance
Corrected Model	0.676(a)	3	0.225	2.866	0.043
Intercept	3.037	1	3.037	38.645	0.000
PARTS USE	0.102	1	0.102	1.303	0.258
SOLVENT	0.618	2	0.309	3.931	0.024
Error	5.265	67	0.079		
Total	20.035	71			
Corrected Total	5.940	70			

a R Squared = 0.114 (Adjusted R Squared = 0.074)

3.8 Conclusion

Overall, the activity of more plants against Gram-positive bacteria compared to Gram-negative (in both crude screening and MIC testing) was not a surprise finding because previous studies showed that greater number of extracts were active against Gram-positive bacteria than Gram-negative bacteria (including McCutcheon *et al*., 1992, Taylor *et al*., 1995, 1996a). This is likely explained by the more complex cell wall/membrane structure of Gram-negative bacteria.

The rationale behind screening these plants was two-fold. As they are used to treat bacterial infections, they are the most likely species to have antibacterial properties. The identification of biologically active plants may lead to the isolation of antibacterials in the future, providing both sustainable income and sustainable medication for the local community. The present laboratory work lends support to the claims by traditional medicinal healers regarding the biological usefulness of the above plants. This study is a preliminary evaluation of antibacterial activity of the plants. The antibacterial activities of the plants often explain their use by the local community.

The results are encouraging, as most of the selected plants appeared to contain antibacterial substances. In the future, a more thorough detailed phytochemical screening and minimum inhibitory concentration testing of all active extracts should be undertaken to add to the results gained from this preliminary screening. Once the bioactivity is known and linked to traditional use, it is hoped that government health posts and traditional healers can work together, in collaboration with researchers, to have the use of these medicinal plants standardised and analysed for adverse effects. It is hoped that this study will both encourage the scientific community in Nepal to search for alternative, affordable and easily available antibacterials of plant origin and encourage conservation

of the important ethnomedicinal plant and cultural resources of Manang and Mustang. This may provide an opportunity for both biological conservation of the medicinal plants through sustainable harvesting and protection of wild species, and cultural diversity conservation.

CHAPTER 4

4. PRIORITIZATION, TRADE, CONSERVATION AND MANAGEMENT OF ETHNOMEDICINAL PLANTS

4.1 Introduction

At present, research towards the general documentation of ethnomedicinal plants by different workers/scientists is taking place in different areas of Nepal, but it must be remembered that merely documenting the ethnomedicinal species within any particular area does not meet the basic needs of the indigenous people. It has long been recognized that partnership with indigenous people is needed for long-term conservation (Hamilton, 2004). Therefore, prioritization of a few ethnomedicinal plants for intensive research in Manang and Mustang will be the first steps towards conservation of valuable medicinal plants of Nepal and of others.

This researcher believes that it is very important to prioritize the ethnomedicinal plants of Manang and Mustang for the future bioprospecting research. Life is often difficult in both districts. Over 69 % of the residents are totally dependent on subsistence agriculture (CBS, 2004), and tourism has provided livelihood avenues to many *Manangi* and *Mustangi*. However, 60 % people of Manang and 52 % people of Mustang are literate. The district is ranked to the 18th (Manang) and 57 th position (Mustang), out of 75 districts of Nepal in literacy rate (ICIMOD, 2003). Other important socio-economic status of the district is given in appendix XIII.

Ethnomedicinal plants of Manang and Mustang are highly valued, so detailed research work on these selected plant species will be beneficial for Nepal as well as Manang and Mustang. There are available barren and abandoned lands in these districts where the cultivation of these prioritized species can take place. People have also keen interest to promote the medicinal plant sector. As per capita food production is very low (occupying 60th (Mustang) and 61st (Manang) rank in Nepal), production of these prioritized medicinal plants in large amounts will be helpful for future bioprospecting and will also be an alternate tool to uplift the economic status of local people (ICIMOD, 2003).

4.2 Review of the Literature

In Nepal many studies have investigated the uses of medicinal plants (for example see: Malla and Shakya, 1999; Manandhar, 2002; Bhattarai *et al*., 2006b, etc.), but few studies have been done on trade (Burbare, 1981; Aryal, 1993; De Coursey, 1993; Rawal *et al*., 1996; Olsen and Helles, 1997; Rawal, R.B., 1997; Olsen, 1997, 1998; Olsen *et al*., 2002; Rawal, J.R., 2004; and Olsen and Bhattarai, 2005) of medicinal plants and the knowledge

of prioritization of medicinal plants in Nepal (Karki and Williams, 1999; Bhattarai *et al*., 2007b) is insufficient. Only a few works regarding the prioritization, trade, conservation and management of ethnomedicinal plants in Nepal and abroad has been reviewed below in brief.

Olsen and Helles (1997) studied about medicinal plants, markets and margins in the Nepal Himalaya. The trade in medicinal and aromatic products (MAP) from the rural areas of Gorkha district in central Nepal to the wholesale markets in India was investigated over a two years period. The annual trade varies from 180,000 kg to 418,000 kg and was then composed of 36 products with an average collector's value of 12 million Nepali rupees (US $ 240,000). Approximately 98 % of the products are exported unprocessed to India.

Karki and Williams (1999) documented priority species of medicinal plants in South Asia and highlighted the background and rationale for selecting and prioritizing medicinal plant species for enhanced research attention. Altogether 30 plant species including *Tinospora cordifolia*, *Azadirachta indica*, *Saraca asoca*, *Centella asiatica*, *Oroxylum indicum* were reported to be in the priority lists as a whole in South Asia. Similarly 18 species including *Acacia rugata*, *Bergenia ciliata*, *Fritillaria cirrhosa*, *Rauvolfia serpentina*, etc, are found to be in priority lists in Nepal.

Rai *et al*. (2000) studied conservation threats to some important medicinal plants of the Sikkim Himalaya. Six species are taken as a case study, *viz. Aconitum heterophyllum*, *Podophyllum hexandrum*, *Nardostachys jatamansii*, *Picrorhiza kurrooa*, *Swertia chirayita* and *Bergenia ciliata*. The six species studied are considered as test cases for successful conservation for the large number of species in Sikkim that are claimed to have therapeutic value and whose survival in the wild is threatened.

Larsen (2002) studied about commercial medicinal plant extraction in the hills of Nepal, its local management system and ecological sustainability. This paper presents a case study from Jumla district Nepal, investigating local management system and ecological sustainability of commercial collection of medicinal plants, *Nardostachys grandiflora*. The combination of qualitative and quantitative investigation can provide a framework for the study of people-plant interactions.

Olsen and Larsen (2003) documented the alpine medicinal plant trade and Himalayan mountain livelihood strategies. The study indicated that the annual trade amounts to thousands of tons of roots, rhizomes, tubers, leaves, etc, worth millions of dollars. The annual Nepalese alpine and sub-alpine medicinal plant trade is conservatively estimated

to vary from 480 to 2,500 tons with a total harvester value of US $ 0.8-3.3 million. The average harvester value is estimated at US $ 66.0 +/- 99.0. Medicinal plant harvesting was found to constitute an integrated part of local livelihood strategies, contributing from 3 to 44 % (average of 12 %) of the annual household income.

Sherchan *et al*. (2005) studied the distribution, conservation practices and trade of 'yarsagumba' in Manang district of Annapurna Conservation Area, Nepal. Thirty-three pasturelands have been identified so far in Manang though the abundance greatly varies from one pasture to another. In the year 2004, local people from seven VDCs of Manang generated approximately NRs. 15,190900 (US $ 213,956) from the sale of 'yarsagumba'. Local people have gradually become aware about the economic importance of this species as shown by the increasing benefits to the collectors at the expense of shrinkage of middlemen's profits.

Olsen (2005) estimates the national-level annual volume and value of commercial medicinal plant harvest in Nepal. The annual trade volume is estimated to range from 7000 to 27,000 tons, with 14,500 tons harvested in the case year 1997-1998. The corresponding annual export value calculated using regional wholesaler purchasing price in the main markets in India, is estimated as US $ 7-30 million, with a value of US $16 million in 1997-1998. Around 10 % of rural households are involved in commercial harvesting. Around 36 % of volume and 51 % of value derived from destructive harvesting.

Olsen and Bhattarai (2005) discussed trade of plant species at local, regional and international levels. The research aims to enhance understanding of the Himalayan plant trade by developing a typology of economic agents. Interviews were conducted in Nepal and India with 639 harvesters, 149 traders and 143 wholesalers involved in trade with medicinal plants. These are the three main groups of economic agents distinguished and are further divided into six sub-types and 13 specific types. Basic data on agents are presented. The typology in developed to be applicable across the countries in the Himalayan range.

Larsen *et al*. (2005) gathered through 175 semi-structured interviews with persons from five stakeholders groups involved in commercial alpine medicinal plant exploitation and conservation in Nepal. It was found that current approaches to non-timber forest products policy formation and implementation need to be revised if objectives of conservation and sustainable managements are to be achieved.

Bisht *et al*. (2006) studied the prioritization and conservation of Himalayan medicinal plant *Angelica glauca* as a case study. Study reveled that the utilization patterns traditional knowledge base and trade of medicinal plants shows trends that are not ideal for sustainability in the Indian Himalaya. This research also attempts to integrate the analysis of several aspects of Himalayan trade in medicinal plants to reveal the threats to plants and to suggest ways to overcome the problem.

4.3 Materials and Methods

4.3.1 Prioritization of Ethnomedicinal Plants

The term 'prioritization' here refers to the ranking of important ethnomedicinal plant species within Manang and Mustang districts based on the five criteria determined to be important as cultural and economic factors during interviews with the local indigenous people. Prioritization is based on criteria recommended by Karki and Williams (1999) with slight modifications. These five categories are:

(a) Preventive health care: plant species that are used by common villagers in their daily lives to keep themselves healthy;

(b) Treatment of common ailments: plant species used to treat common ailments such as cough and cold, tonsillitis, etc. The uses are known to knowledgeable villagers;

(c) Treatment of a broad range of ailments: when one plant species is used to treat many common ailments;

(d) Usage by amchis: Tibetan traditional healers 'amchis' use the species to prepare medicines; and

(e) Economic value: The species are of high economic value for the family.

To prioritize ethnomedicinal plant species, local people of Manang and Mustang districts were first asked to select the ten most commonly used important ethnomedicinal plant species. The people were then asked about the importance of these plant species and to rank them into the five categories described above. This was repeated in different villages and the results combined to give the most important ethnomedicinal plants from the study area.

4.3.2 Trade of Ethnomedicinal Plants

It was very difficult to gain the reliable information regarding the trade of ethnomedicinal plants from the study area. At first, the traders did not want to give information regarding the trade because they thought that their work was illegal. However as far as possible,

information regarding the trade of ethnomedicinal plants from the study area was collected.

To investigate the trade in medicinal plants from the rural areas of Manang and Mustang districts, medicinal plant collectors, road-head traders and wholesalers were interviewed during each visit in the study area. A number of local medicinal plants traders, wholesalers and knowledgeable local community members who are engaged in plant collection were interviewed during 2002-2007 within the villages of Manang and Mustang districts. More than 75 road head traders from Manang and Mustang districts were also interviewed in the three city of Nepal i.e., Kathmandu, Pokhara and Narayanghat during the year 2005-2008. Detailed market prices were also obtained from the road-head traders of the Manang and Mustang districts who often go to the city for trade.

4.4 Results

4.4.1 Prioritization of Ethnomedicinal Plants

Altogether 157 ethnomedicinal plants were documented during the year 2002-2007 (see appendix V), and among them 39 ethnomedicinal plants were prioritized and categorised as high, moderate or low priority (see appendix XIV) in Manang and Mustang districts. Those plant species which had all five criteria were labelled as high priority and plant species having 2-3 criteria were labelled as moderate priority. The remaining species having only one criterion were put in low priority. The results are given in appendix XIV. Among the 39 prioritized species selected, 8 species were of high priority, 29 species of moderate priority and 7 species of low priority. Same six species listed with different criteria and with different priority lists in Manang and Mustang are: *Aconitum naviculare*, *Berberis aristata*, *Clinopodium umbrosum*, *Paris polyphylla*, *Rumex nepalensis* and *Taxus baccata* subsp. *wallichiana*.

Among the 39 prioritized species, six species namely *Taxus baccata* subsp. *wallichiana*, *Cordyceps sinensis*, *Dactylorhiza hatagirea*, *Juglans regia*, *Nardostachys grandiflora* and *Neopicrorhiza scrophulariiflora* are in the CITIES appendices (appendix XIV; Aryal, 2004) and seven species are in the priority lists of medicinal plants from South Asia. Of these seven species, all species are included in the priority list of medicinal plants from Nepal and one species each from Sri Lanka and Pakistan (Karki and Williams, 1999). Lists of priority species (matched within these 39 priority species from Manang and Mustang) from South Asia, Pakistan, Sri Lanka are given in the appendix XVII. However no priority species of Manang and Mustang were matched in the priority species lists of

Bangladesh and Central India. A total of 15 species (given by '+' in appendix XVII), among 39 species are also listed in (Hamilton and Radford, 2007) which adds more value to these prioritized species of Manang and Mustang in the global market (see appendix XVII).

4.4.2 Traders and Trade of Ethnomedicinal Plants

Of 39 prioritized species from Manang and Mustang, 15 species are in the list of top most medicinal plants traded to India (Rawal, 2004). The detailed market prices of 25 prioritized species in trade are given in appendix XIV (see Plate IX for the traders and trade of medicinal plants). Among the 25 prioritized species in trade, 8 are on the high priority list, namely *Aconitum naviculare*, *Aconitum orochryseum*, *Allium oreoprasum*, *Dactylorhiza hatagirea*, *Hippophae salicifolia*, *Juniperus indica*, *Neopicrorhiza scrophulariiflora* and *Zanthoxylum armatum*. Other species such as *Paris polyphylla*, *Rheum* species (*R. moorcroftianum, R. australe*), *Swertia* species (*S. ciliata* and *S. chirayita*), and *Taxus baccata* subsp. *wallichiana*, were also sold from the lower villages of Manang district (below Chame) legally with a royalty paid to the District Forest Office situated at Chame (record noted from District Forest Office, Chame). Among the 39 medicinal plants listed in appendix XIV, *Aconitum orochryseum*, *Allium wallichii*, *Dactylorhiza hatagirea*, *Nardostachys grandiflora*, *Neopicrorhiza scrophulariiflora* and *Cordyceps sinensis* are also traded illegally from Manang and Mustang. The detailed amount and royalties paid to the community forest for the legal trade of medicinal plants in Manang are given in appendix XV. However the record of legal trade of medicinal plants from Mustang district was not available with exception of short record of (2004-2006) of *Cordyceps sinensis* from lower villages of Mustang. The legal trade of *C. sinensis* was seen only in the two villages (Kobang and Kungo) of lower Mustang. According to the information obtained from Annapurna Conservation Area Project, Jomsom the royalty paid from these two villages was NRs. 30,000 to the government and NRs. 113,000 to the community user group between 2004-2006. Approximately 12 kg of the *C. sinensis* was collected from two villages during these three years (2004-2006).

The high priced medicinal plants in Manang are *Cordyceps sinensis*, *Fritillaria cirrhosa* and *Taxus baccata* subsp. *wallichiana*. *Cordyceps sinensis* is sold at the rate of about NRs. 200,000/kg (NRs. 50- 100/item). During the field research period (2002-2006), one kg of *Fritillaria cirrhosa* bulbs was sold for between NRs. 2,200 and 7,000. *Fritillaria cirrhosa* is mainly found in the forest and pasture of Gyasumdo (Lower Manang above 3000 m) up to the villages of Lamjung districts (Ghirmu Phat and Bahun Dada). The market price of *Fritillaria cirrhosa* before the year 2002 was low (about NRs 500 per kg)

but the market price increased suddenly probably after 2004 when there was an increase in its use in Tibetan medicine. The Nepali market price is paid by Tibetan traders who come to Manang and then it was sold in double to triple price over the Tibetan border. Similarly, demand for the collection of *Taxus baccata* subsp. *wallichiana* leaves has increased recently in Manang. For example, a Nepali trader had paid NRs. 1,500,000 to the villagers in lower Manang (Gyasumdo) for the collection of leaves of *Taxus baccata* subsp. *wallichiana* during the years of 2002-2006.

Medicinal plants in high priced in Mustang are *Cordyceps sinensis* and *Morchella esculenta*. *Cordyceps sinensis* is sold at the rate of about NRs. 200,000 to 250,000/kg (NRs. 50- 90/item). The approximate number in one kg of *Cordyceps sinensis* is about 3,500 to 4,000 (unpublished Report from ACAP Office). During the field research period (2004-2007), one kg of dried *Morchella esculenta* whole plant parts was sold for between NRs. 4000 and 4500 in Mustang but the price was greatly variable in other districts of Karnali zone, and in Kathmandu whole seller markets (EFEA, 1997; Rawal, 2004; and recent information of interview). *Morchella esculenta* is most often collected from the pine forest of Marpha villages (Lower Mustang above 3000 m).

The price of medicinal plants varied at the local level, however, the price at the trade centers is almost always fixed. The variation in the price of medicinal plants at the local level can be seen easily for *Cordyceps sinensis*. The local level price varies due to competition among collectors. Local traders most often choose Kathmandu, Pokhara and Narayanghat for their trading sites because they have relatives in these cities who will help in exploring high rate for plant species as well as provide a place to stay while they are there. They also sell these medicinal plants in small stalls on foot paths along the road. In this way trading activities are helping people to improve their livelihood. The results of market price of medicinal plants (see appendix XIV) were also obtained from the interviews with the foot path medicinal plants traders of Manang and Mustang (who now trade medicinal plants in Kathmandu, Pokhara and Narayanghat).

4.5 Discussion

4.5.1 Prioritization of Ethnomedicinal Plants

In the extensive survey conducted during these periods, the importance of long-term research into the sustainable trade of medicinal plants became apparent. On the one hand, the illegal harvesting of *Cordyceps sinensis*, *Allium wallichii*, *Aconitum orochryseum* along with other medicinal plants raises concern over local extinction of the species in the next few years, and on the other, the medicinal plant trade provides much needed income

to common labourers in Manang and Mustang, and has the potentiality to represent a way out of poverty. It is difficult to conduct long-term research in these remote districts with limited funds, so prioritization of the most important medicinal plants will be an effective tool for focused future work in Manang and Mustang.

Medicinal plants prioritization based on the above five criteria is important and unique to Nepal. In Manang and Mustang some prioritized species play an important role in uplifting rural livelihood strategies, but as mentioned above, this often leads to over-harvesting. Therefore, we argue that focused study of these medicinal plants will be necessary for long term conservation and economic development.

The most important species in the eyes of the *Manangi* was *Aconitum naviculare*. It was prioritized first in seven villages out of ten villages. The species was ranked so favorably because of its use to treat fever and jaundice. It is very positively regarded and considered to be an effective medicinal plant without side effects when used appropriately. *Aconitum naviculare* is found in higher altitudes mainly in the Khangsar, Manang, Braga, Hongde, Pisang, Ngawal, Ghyaru, Yakkharka, and Ledar (Shrestha *et al*., 2007). *Neopicrorhiza scrophulariiflora* was ranked first in the village of Dhukurpokhari. This was because of its use in treatment of a broad range of ailments. It is used to treat fever (typhoid, malarial, and fever with jaundice), diarrhoea, paralysis, stomachache, dyspepsia (indigestion), snake bite, scorpion sting, heart diseases, cuts and wounds, boils, scabies and ringworm. Another high ranking plant, *Cordyceps sinensis* was given first priority in Nar and Phoo because of its high economic value in these two most remote villages of Manang. *Cordyceps sinensis* provides supplemental cash income in these two villages.

In Mustang the most important species of the *Mustangi* is *Allium wallichii*. It was prioritized first in six villages out of ten villages. The species was ranked so favorably because of its high economic value. It is distributed in upper Mustang mainly in the pastures of Samar, Ghami, Charang, Lomanthang, Dhee etc. *Aconitum orochrseum* was ranked first in the village of Kagbeni and Jharkot because of its use in treatment of a broad range of ailments. It is used to treat fever, diarrhoea, dysentery, cough, cold, tonsillitis, headache, high altitude sickness problems, to counteract the poison of *A. spicatum*, feeling higher level of heat inside the body, patient who got false medicine (to reduce the effect of false medicine), bile disorders, sinusitis and allergy. *Neopicrorhiza scrophulariiflora* was ranked first in the village of Jomsom. This was because of its use in treatment of a broad range of ailments. It is used to treat fever (typhoid, malarial and fever with jaundice), diarrhoea, paralysis, stomachache, dyspepsia (indigestion), snake and scorpion sting, heart diseases, cuts, wounds, boils, scabies, ringworm, cough and

cold. Another two high ranking plant, *Morchella esculenta* and *Hippophae salicifolia* was given first priority in Marpha and Larjung respectively because of its high economic value which has been providing supplemental cash income in these two villages.

Interestingly, some medicinal plants were prioritized by the local people even though they are not available in the local forests. These types of medicinal plants were prioritized because of their perceived ability to cure some diseases completely. For example in Manang, *Aconitum orochryseum* is used to treat fever, diarrhoea, dysentery, cough, cold, tonsillitis, headache and high altitude sickness problems, and only found in the forests of Pisang, Dhukurpokhari, Chame and some places in lower Manang. It was prioritized to high priority by the villagers of Dhukurpokhari, Ghyaru, Ngawal, Hongde and Khangsar, located far from the collection sites. Similarly In Mustang, *Dactylorhiza hatagirea* is used to treat cough, cold, burns, headache, tonsillitis, stomachache, white intestinal worms and high altitude sickness, and only found in the few places of upper Mustang and some high altitudes pastures in lower Mustang, but was prioritized to high priority by the villagers of Lomanthang, Ghami, Charang, Jharkot, Chaile and Larjung located far from the collection sites.

4.5.2 Traders and Trade of Ethnomedicinal Plants

An estimated 323,000-470,000 households (2.6 million people) are engaged in the collection of wild medicinal plants for sale in Nepal (Olsen and Bhattarai, 2000). The medicinal plant trade continues to play an important economic role for *Manangi* and *Mustangi*. Trade continues at an alarming rate with the participation of the local communities. Manang and Mustang can be described as having three categories of people who participate in medicinal plant trade knowingly or unknowingly. The first category includes rich *Manangi* and *Mustangi* who now live in Kathmandu and Pokhara and sometimes go to Manang and Mustang at the time of *pujas* (religious ceremonies) and other festivals to meet their relatives and former neighbors. They tend to have strong beliefs regarding the benefits of the use of alpine medicinal plants and often collect some for their own use in Kathmandu, Pokhara and Narayanghat. From my own experience, I found that one rich person from Manang who now stays in Kathmandu bought about one kg of *Cordyceps sinensis* for his yearly use. Some are involved in medicinal plant trade only during the harvesting seasons.

The second category people are rich *Manangi* and *Mustangi* who run their own hotels, lodges and farms in the district. Direct involvement in the collection of medicinal plants is a difficult task for them because of their busy schedule running their businesses, so they buy medicinal plants from the poor people of Manang and Mustang (or collectors from

Gorkha, Dhading, Lamjung district who often come to Manang and Mustang looking for seasonal work) and sell them to the local traders or national traders. Profits are made from acting as the intermediate.

The third category of *Manangi* and *Mustangi* are those who face financial adversity in daily life, and those who come from outside Manang and Mustang districts (generally from Gorkha, Dhading and Lamjung districts) to earn money as day labourers. These people do not own sufficient farm land to grow crops and cannot survive by farming and working as farm labourers in non-farming seasons, so they are forced into non-farming activities. One of the easier non-farming activities includes collection of *Cordyceps sinensis, Allium wallichii, Allium oreoprasum* and *Aconitum orochryseum* in the peak seasons (May-June) which can earn significant amounts of money in a limited time. They collect medicinal plants and sell them to local traders for prices well below the final market value. In this way the three categories of people make a chain of medicinal plants trade which helps the local poor people to earn cash to sustain their life, but ultimately it profits the richer people of the area.

Bulk Trade of Ethnomedicinal Plants

The bulk of the medicinal plant trade from Manang is comprised of *Cordyceps sinensis, Fritillaria cirrhosa, Taxus baccata* subsp. *wallichiana, Neopicrorhiza scrophulariiflora, Dactylorhiza hatagirea, Allium oreoprasum* and *Zanthoxylum armatum*. Over the duration of this field research, (from 2002 to 2006) the going rate of one piece of *Cordyceps sinensis* increased from NRs. 25 to >85 (Bhattarai *et al*., 2006b). Approximately 75% of households are involved in *Cordyceps sinensis* trade in Nyeshang, Nar and Phoo and *Fritillaria cirrhosa* trade in Gyasumdo (lower Manang). Similarly, trade in *Allium oreoprasum* is of great importance for Nar and Phoo villages who exchange for wheat or buckwheat at a ratio of 1:1 to 1:3 by volume or sell for cash. The impact of this trade on both the livelihood of *Manangi* and the environment is undeniable. The prices of these medicinal plants increase as they become scarcer because of over-exploitation and habitat loss. Unfortunately wild medicinal plants are seen as a cash crop and many people of Manang feel forced to trade in these medicinal plants to survive.

Bulk amount of medicinal plant trade from Mustang is comprised of *Allium wallichii, Aconitum orochryseum, Cordyceps sinensis, Dactylorhiza hatagirea, Juniperus indica, Morchella esculenta* and *Neopicrorhiza scrophulariiflora*. Over the duration of this field research, (from 2004 to 2007) the going rate of one piece of *Cordyceps sinensis* increased from NRs. 50 to >100. The legal trade of *C. sinensis* was observed from the two villages of lower Mustang (Kobang and Kungo) during the year 2004-2006 (information provided

by ACAP). The royalty paid from these two villages was NRs. 30,000 and NRs. 113,000 to the government and to the community user group. Approximately 12 kg of the *C. sinensis* was collected from the two villages during these periods but this official record looked low compared to my interview results of the fields (Mustang) and with the road head traders (Kathmandu, Narayanghat and Pokhara). I observed the bulk of *C. sinensis* trade during these periods (2004-2006). The probable reasons of low and unsatisfied royalty paid results of *C. sinensis* and no record of royalty paid (for other medicinal species) from Mustang was due to discontinuous and disjointed available information on internal and external trade. This discontinuous and disjointed information is in terms of geographical distribution, time series, quantity of harvests, national level value addition and exports, price information and margins to producers and other market intermediaries (Nagpal and Karki, 2004). Researches have shown that the total export value of produce from Nepal to be US $ 8.1 million but the official value was put at U $ 600 thousand by the Central Bureau of Statistics, Nepal in 1999.

I also observed the bulk of *Morchella esculenta* (see plate V), trade from Mustang. In the past local people harvested it for their daily uses as a substitute of vegetables. The use of *Morchella esculenta* as a substitute of vegetable do not remains for a long period of time because of its increasing markets demand in the national and international markets. The trade of *Morchella esculenta* has been started recently in different districts of Karnali zone. According to the respondents (traders), more than 5 tons (dry) every year could be easily collected from the Karnali zone (EFEA, 1997; Rawal, 2004). This increasing demand in the international market attracted many traders even from Kathmandu to visit Karnali zone like Dolpa, Humla, Mugu, Jumla, Manang and Mustang for export. According to the recent information, one kg of *Morchella esculenta* dried whole plant sells for NRs. 2,500 in Dolpo followed by 4,000 in Mustang, 4,480 in Tanakpur, 5,500 in Nepalgunj and 6,400 in Delhi but the price even increases in Kathmandu whole seller markets to NRs. 4,500-6,000 (EFEA, 1997; Rawal, 2004).

The market price of *Morchella esculenta* before the year 2005 was low (about NRs. 2,000 to 3,000 per kg) within the Karnali zone, but suddenly after 2005 more demand increased the market price. The Nepali as well as foreigners who visit Karnali zone (including Mustang) uses it in their daily diets. The production of the *Morchella esculenta* was higher in the *Pinus wallichiana* forest of Marpha village (lower Mustang). For the bulk production, local people have been using the traditional techniques of firing the forest before one year because *Morchella esculenta* is produced in the post fire *Pinus wallichiana* forest in bulk amount. The germination of *Morchella esculenta* normally

occurs during succession, which involves plants, animals and microbes. To reduce the strong environmental influences (intra-specific and inter-specific competition), environmental stresses and bulk production traditional method of firing was found the appropriate. Demand for the collection of *Allium wallichii* leaves, *Aconitum orochryseum* root and *Dactylorhiza hatagirea* root (see Plate IV), has increased recently in Mustang. I met several road head trader with these species in their road head shops. The price of one kg dried *Allium wallichii* leaves, *Aconitum orochryseum* and *Dactylorhiza hatagirea* root was NRs. 250-1,000; 2,000-2,500 and 2,200-3,000 respectively during the years of 2006-2007 (information obtained from road-head traders).

Over Harvesting and Sustainability

As described above, there are different 'types' of traders involved in the medicinal plants trade in Manang and Mustang. Local medicinal plants traders, wholesalers and road-head traders may be equally involved in the trade, but share is an unequal distribution of profits from the medicinal plant trade. The profit earned by road-head traders is less than that earned by the wholesalers, but the bulk of the collectors see even less of the profits from trade. These days' labourers from Manang, Mustang, Gorkha and Lamjung take on this employment to make enough money to survive. Over-exploitation of a medicinal plant within a particular area has changed the habitat conditions, causing a gradual decrease of this and other associated species. This trend of over-harvesting increases as the price paid by the traders for the species increases because of the increasing rarity of these plants in a vicious cycle which, if left unchecked, could lead to extinction. High price is seen as the main cause of over-harvesting in Manang and Mustang today, as high prices create more incentive to collect the medicinal plant species.

Traders obtain medicinal plants through untrained and unskilled labourers. Roots, stems, leaves, rhizomes, tubers, bulbs, and barks are often collected before maturation, which decreases the regeneration status of the important medicinal plant species as well as their quality. Most traders and wholesalers did not express concern regarding the unskilled collection of medicinal plants trade, perhaps as they are interested in immediate profits rather than the environment and sustainability, or perhaps they do not understand the impact of over-harvesting that will have on their future livelihood.

Illegal trade of prioritized species is an on going problem in Nepal, and needs to be addressed immediately. India is the destination of about 97 % of all medicinal plants collected in Nepal (Rawal, 2004). The collected herbs are being exported either through the traders of Terai or after being processed in the country. About 19 species of medicinal plants are being traded regularly from Nepal to India in significant quantities. Among

these, 15 species were also included in priority list of this research (see appendix XVII), and six species are either under banned in the Forest Act, 1993 or comes under CITIES appendices. The important medicinal plants go to India due to high market price rate. As for example the market price rate is almost 300 % high in the case of *Aconitum heterophyllum* and almost 100 % in the case of *Swertia chirayita*, than the rates available in Nepal (Nagpal and Karki, 2004).

Examples of local control over Ethnomedicinal Plants

However, legal trade in medicinal plants also takes place in Manang. *Taxus baccata* subsp. *wallichiana*, *Neopicrorhiza scrophulariiflora*, *Swertia* species, *Rheum* species, etc are traded in large amounts from the community forest of Gyasumdo (lower Manang), with royalties paid to the Village Development Committee (VDC) (see appendix XV). This legal trade of medicinal plants could at least be regulated, unlike the illegal trade found in different villages of Upper Manang (Nyeshang), Nar, and Phoo. If properly regulated, asnd harvesting done sustainably, then the legal trade of medicinal plants in Manang, could benefit the environment, livelihood of the labourers, wholesalers and also the healers and population which rely on the medicine. However, the legal trade of medicinal plants has not been seen in Mustang except the data mentioned above for the *Cordyceps sinensis*.

Local people of several different villages, including Khangsar, Tanki-Manang, Manang, Braga, Hongde, Ngawal, Ghyaru and Pisang are actively involved in the conservation and management aspects of medicinal plant harvesting, especially *Cordyceps sinensis*. They camp in the pastures Yakshed (4,600 m) in a rotational manner to guard against the illegal collection of *Cordyceps sinensis*. Gurung (2003) has identified 33 different pasturelands as the habitat of 'Yarsagumba' (*Cordyceps sinensis*) from 12 VDCs of Manang, although in some VDCs pastureland is quite rare. *Cordyceps sinensis* is frequently the target of illegal harvesting. To counter this, small groups of local people patrol the pastures, hoping to discourage the illegal collectors. This is not easy, as the traders come to the pastures in large numbers. The illegal collectors also have the backing of local traders, who often feel that the risks of illegal collecting are outweighed by the profits.

Tibetan doctors (*amchis*) also play important role in the conservation and management of medicinal plants in Manang (Nar and Phoo villages) and Mustang (Lomanthang, Jomsom, Jharkot) by educating local people about the use of medicinal plants. Interestingly, *Cordyceps sinensis* was ranked first by the communities of Nar and Phoo for enhancing family income (see appendix XVI), but was not prioritized for its medicinal qualities. While not everyone may be aware of the medical importance, many poor people depend

directly on the collection and trade of *Cordyceps sinensis* at some point in the year in order to enhance their family income.

The collection of *Aconitum orochryseum*, *Cordyceps sinensis*, *Dactylorhiza hatagirea*, and *Neopicrorhiza scrophulariiflora*, has been banned in Manang district by local communities, but because of a lack of proper coordination and enforcement, this ban is only in words and has done nothing for conservation. These species are banned for collection in Khangsar, Manang, Tanki-Manang, Braga, Munjii, Hongde, Pisang, Ngawal and Ghyaru. Unfortunately large quantities of these medicinal plant species are still being collected illegally in these areas and traded locally, nationally and internationally.

The local communities are working towards a sustainable collection of these wild medicinal species. For example, in Manang, traditional village council still controls and manages natural resources at the local level including collection of *Cordyceps sinensis* to a period of one month, generally from mid May to mid June (Sherchan *et al*., 2005). During the household survey (my field visits in May-June) to the remote villages of Nar and Phoo, only small children and the elderly people were found staying in the village, whereas other family members were engaged in collection of *Cordyceps sinensis*. They camp in the pasturelands for between 30 and 60 days from May to until they finish the collection. During this season the government schools in the villages are also closed because students leave the village with their families to collect *Cordyceps sinensis*. It is sold by the local community to local traders and also at an increased price to national traders. Similar results observed in Mustang during the periods of harvesting of *Allium wallichii* because most of the third category people (those who face financial adversity in daily life, and those who come from outside Manang and Mustang districts (generally from Gorkha, Dhading and Lamjung districts) to earn money as day labourers) depend directly on the collection and trade of *Allium wallichii* to enhance their family income.

4.6 Conservation and Management

In Nepal, valuable medicinal plants are under serious threat due to lack of local control over the resources and over-exploitation (Malla *et al*., 1995; Edwards, 1996; Hertog, 1997; Subedi, 1997; Chaudhary, 1998; Ghimire *et al*., 2001, 2004, 2005). Manang and Mustang are not exempt from this issue, with commercially valued medicinal plants in a state of jeopardy as a result of over-harvesting possibly due to high reputation in global trade, over-grazing, and global warming. Collectors who remove the species in unskilled ways from the natural habitat begin the cycle. Proper documentation and assessment of conservation threats, cultivation practices and regularized systems for conservation and

management are major activities and challenges for sustainable utilization of medicinal plants in Manang and Mustang. If the conservation and management aspects of this plant are not given proper attention, over-exploited species such as *Cordyceps sinensis* will continue on the road to extinction.

In Manang and Mustang districts, most people are unaware of the market sector and prices of important prioritized medicinal plants. This is being addressed in the village Hongde of Manang and most of the villages of Mustang, where medicinal plant garden has been started and cultivation of medicinal plants is in the first phase. Important species of medicinal plants are grown in these gardens of Manang and Mustang. The cultivation of important medicinal plants in other parts of Manang and Mustang could be successful if modeled on this small program.

Although medicinal plant gardens of Manang (Hongde) and Mustang (most of the villages) are positive initiatives, sustainable harvesting of medicinal plants is challenged by many factors, from both social and ecological perspectives (see plate IX). Therefore, the involvement of local institutions such as District Forest Office, Annapurna Conservation Area Project (ACAP), local community groups and knowledgeable people of Manang and Mustang (including spiritual leader *amchi* Karma Sonam Lama, *amchi* Gyasto Bista, *amchi* Tenzing Bista Lama, *amchi* Tshampa Ngawang Gurung) becomes an essential step towards sustainable utilization, conservation and management of medicinal plants. The natural resource management is the responsibility of local communities which are involved in conservation, planning and management at the local level; and as being permitted to continue their traditional land use practices and those activities are monitored by the trust (Bajracharya *et al*., 2006).

4.7 Conclusion

The local communities of Manang and Mustang have rich knowledge regarding the use of plant resources. Community leaders and academicians alike agree that such indigenous practices must be documented and preserved as a process that both acknowledges the value of the information, and normalizes it in the eyes of academics and policy makers. Prioritization of selected medicinal plants will be an important tool towards conservation.

Traders collect wild medicinal plants through untrained and unskilled labourers who have little experience in conservation, management and sustainable utilization. The present study concludes that prioritization of medicinal plants gives a concrete way for

conservation and management aspects of the important medicinal plants of Manang and Mustang districts which includes many of the important medicinal plants of Nepal.

The medicinal plant trade in Manang and Mustang is quite inefficient and would benefit from closer management and regulation. The implication for developing the trade and thus increasing a collector's income at the local level must be emphasized, and involvement of local institutions towards conservation and management of medicinal plants must be strengthened. Over-exploitation of the important medicinal plant species within particular places may change the habitat conditions causing a gradual loss of the same and other associated species. If the process of trading of important medicinal plants continues on this scale for several years, important medicinal plant species such as *Cordyceps sinensis*, *Dactylorhiza hatagirea*, *Neopicrorhiza scrophulariiflora*, *Allium wallichii*, *Aconitum naviculare* and *Aconitum orochryseum* will become increasingly rare.

If the trade of important medicinal plants can be adequately regulated and local people are adequately empowered to harvest sustainably, this may become a viable long-term source of alternate income, while at the same time it will help conserving local habitat. The domestication of local (previously wild growing) medicinal plants on currently barren and abandoned lands could provide sustainable cash income without losing biodiversity and thereby help improving lives of locals. This alternate source of cash income will be an integral part of rural livelihood strategies, and therefore, a detailed study of the prioritized medicinal plant species will be beneficial for conservation and management.

CHAPTER 5

5. RECOMMENDATIONS

Over harvesting of important medicinal plants is increasing day by day in the remote mountainous regions of Nepal, and Manang and Mustang districts are not exempt from this issue. Multiple uses of medicinal plant are also one of the causes of overharvesting. Therefore I suggest immediate recommendations to be followed for the conservation of traditional knowledge along with the local resources of the study area (Manang and Mustang districts).

(a) Local traditional healers (*amchi*) are not well compensated by their occupation. Therefore they are to be encouraged for their occupation but subsidy should be provided by the local governmental or non-governmental organization which will be helpful to conserve the traditional healing system to some extent.

(b) Prioritized species of medicinal plants such as *Cordyceps sinensis*, *Dactylorhiza hatagirea*, *Neopicrorhiza scrophulariiflora*, *Aconitum orochryseum*, *Aconitum naviculare* etc, need special protection determined by the local people.

(c) Illegal trade of prioritized species of medicinal plants from common land should be reduced because these species are threatened due to uncontrolled harvesting and over exploitation. Appropriate care and protection laws should be enacted by the local government, so that illegal collection and over exploitation may be checked to some extent.

(d) Encouragement of local people, local governmental and non-governmental institutions towards the cultivation of medicinal plants, sustainable harvesting and processing of non-timber forest products in the barren lands will be helpful to reduce the pressure of collection from the wild. Conservation and dissemination of traditional knowledge could be an important tool to increase awareness of the people regarding non-timber forest products.

(e) Conservation education towards the management of medicinal plants in these remote districts should be given by special training programme. Training should be focused to the forest user groups regarding cultivation, sustainable harvesting and processing of useful plants. In addition, the role of Annapurna Conservation Area Project should be strengthened towards the conservation and management of natural resources.

(f) Altogether 79 ethnomedicinal plants used to treat different diseases of Manang, and Mustang districts were screened for their antibacterial properties. Antibacterial properties of remaining plants with different microorganisms should be examined to confirm their validity. The validity may gain popularity and help to uplift the health status of the country like Nepal with very limited modern health care facilities.

(g) Only 33 ethnomedicinal plants have been screened for the Minimum Inhibitory Concentration (MIC). Minimum Inhibitory Concentration of each active extracts should be evaluated for the future biospropecting research. This will add the information obtained from the preliminary screening.

(h) Potential species (as for example *Maharanga bicolor*) that showed high inhibitory activity in this preliminary screening should be further investigated towards isolation and structural elucidation of active compounds.

(i) Sustainable use of multipurpose ethnomedicinal plants (as for example which is used for construction materials (wood) for house, bridge, furniture, etc) should be encouraged.

(j) Alternative income opportunities should be identified for all groups of people to minimize the pressure on forest resources for fuelwood. Local people should be encouraged towards the plantation of multipurpose trees such as *Salix babylonica*, *Populus ciliata* etc., in the fallow land and to increase in use of alternative sources of energy such as a solar power, electricity and biogas. Such activities will reduce the pressure on harvesting of multipurpose ethnomedicinal plants.

CHAPTER 6

6. EXECUTIVE SUMMARY

6.1 Introduction

A comprehensive ethnomedicinal study and bioassay testing of selected medicinal plants of Manang and Mustang has been carried out. This scientific exploration of traditional knowledge of plant resources helped in finding new resources, which could be sold and possibly exported.

The field information contained in this research was gathered by direct observation of locals in the fields and forests and through semi-structured interviews. Information regarding the bioassay test was obtained through laboratory research. To prioritize the documented ethnomedicinal plant species, local people of Manang and Mustang districts were first asked to select the ten most commonly used important ethnomedicinal plant species. The people were then asked about the importance of these plant species and to rank them into the five categories. This was repeated in different villages and the results combined to give the most important ethnomedicinal plants from the study area. To investigate the trade in medicinal plants from the rural areas of Manang and Mustang districts of Nepal, medicinal plant collectors, road-head traders and wholesalers were interviewed during each visit in the study area. Detailed market prices were also obtained from the road-head traders of the Manang and Mustang districts who often go to the city for trade.

6.2 Ethnomedicinal Plants

Altogether 157 medicinal plant species belonging to 56 families and 114 genera are reported from the study area. These 157 locally used medicinal plants treat 150 ailments. This study found that many different parts of medicinal plant species are used as medicine. It would follow that the most commonly used plant parts have been selected because they contain more active principles in comparison to the least commonly used parts. Leaves, roots, stems and flowers are physically more vulnerable to attack by herbivores or pathogens than the more hardy bark, latex or cones and therefore it is not surprising that they contain more chemical defense compounds in the form of biologically active secondary metabolites.

The allopathic health care system in Manang and Mustang districts is rudimentary. Few allopathic medicines are available, and for this reason and because of traditional and cultural customs and beliefs, many people rely on local healers or *amchis* for health care. The senior *amchis* of Phoo, Lomanthang and Jomsom feel that it is of utmost important to conserve the traditional healing system and maintain awareness in the local community

about the importance of medicinal plants. Such awareness will lead to the conservation and management of medicinal plants in the villages.

Of 157 ethnomedicinal plants documented, 88 plants were used for other purposes including food, miscellaneous purposes (for fodder, fertilizer, as construction materials, decoration materials, dye and soap, household articles, manure, paper, recreational drug, tea substitute and others), fence and fuelwood, and ritual and religious purposes. Several medicinal plants having other uses (other uses, i.e., multiple uses), i.e., *Allium* species, *Hippophae* species, etc., have great medicinal value with high market value in Kathmandu and Pokhara. Even though the market price of these species has been increasing steadily, the local consumption has not yet decreased. Further bioprospecting research on these species *c*ould help with the conservation and management of these local resources as well perhaps benefits the local people economically. But, over harvesting of such important medicinal plants is increasing day by day in Manang and Mustang due to their wide multiple uses, which has created a worrying situation. Therefore I suggest immediate steps of cultivation of these species in the barren lands and use of sustainable harvesting approaches which may be helpful to conserve these species as well as othere wild plant resources in their natural habitats.

6.3 Antibacterial Activity of Ethnomedicinal Plants

In the present study, *in vitro* antibacterial assays of 92 extracts from 79 ethnomedicinal plants which were used to diseases potentially caused by bacteria were examined. Plant extracts were more likely to inhibit Gram-positive bacteria. For example, most plant extracts were active against *Bacillus subtilis*, and then *Staphylococcus aureus*. Of the Gram-positive bacteria, the least number of plant extracts could inhibit *Streptococcus faecalis*. With respect to Gram-negative bacteria, it was more common for plant extracts to inhibit *Escherichia coli* than *Pseudomonas aeruginosa*, or *Salmonella typhi*. Overall, 73 % of plant extracts showed activity against both Gram-positive test bacteria, and 69 % showed activity against both Gram-negative bacteria.

Although the nature and number of active antibacterial principles involved in each extracts are not clear, the broad spectra of activity of several plants namely: *Artemisia caruifolia*, *Asparagus* species, *Dactylorhiza hatagirea*, *Dicranostigma lactucoides*, etc, is promising. This broad spectrum activity is a promising antibacterial property which may explain the importance of these species in traditional remedies. The possible reasons of the strong results of the above species may be due to their use in the broad range of treatment of ailments in Nepal. Detailed study of these species in the future may help to find alternative medicines from plants. This study is the preliminary evaluation of antibacterial activity of the plants, and the positive results show that these plants may be useful in the discovery of new medications.

6.4 Minimum Inhibitory Concentration of Ethnomedicinal Plants

In this study, 99 extracts (33 each of MeOH, CH_2Cl_2 and hexane) from 33 selected medicinal plants used to treat a variety of illnesses were tested against four pathogenic strains of bacteria: *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Bacillus subtilis* using the disc diffusion method. The plants were selected because they are used to treat illnesses caused by bacterial origin. The extraction with MeOH, CH_2Cl_2 and hexane crudely separated the chemical components into groups of varying polarity. The activity of these extracts gives insight into the chemical nature of the biologically active constituents. The strong activity of the highly non-polar hexane extracts (shown by the low MIC values) indicates that the bioactive chemical(s) of those plant species was best extracted in non-polar solvent, and therefore was likely to be non-polar as well.

Several plant species gave interesting results. *Maharanga bicolor*, for example, was found to have the most active extracts, with all solvents giving active extracts and the hexane extract showing the lowest MIC for all tested bacteria. Interestingly, in Manang the traditional use of *M. bicolor* calls for the juice to be mixed with mustard oil and dropped into the ear to treat ear pain, which is often a symptom of bacterial ear infection. Mustard oil is non-polar, and the most active extract is the non-polar hexane extract. The active component is also likely non-polar.

On the other hand, the only extract of the root of *Bistorta affinis* to show activity was the polar MeOH extract. The root powder of *B. affinis* is added to boiling water, which is ingested 2-3 times a day to treat cough and cold, tonsillitis, and fever. It is not surprising that the polar MeOH extract would contain the active component, as this plant is traditionally extracted with hot water (also polar) for medicinal use.

Although there is no obvious pattern of bacterial growth inhibition affect of the plant extracts in various solvents used, still statistical analysis clearly indicates significant ($P<0.001$) differences in the Minimum Inhibitory Concentration (MIC) values of the extracts of different plant species against tested bacterial strains. Only in the case of *Staphylococcus aureus* the MIC values differed significantly according to test solvents.

6.5 Prioritization, Trade, Conservation and Management of Ethnomedicinal Plants

Altogether 39 medicinal plants were prioritized and categorised as high, moderate or low priority in Manang and Mustang districts. Among the 39 prioritized species selected, 8 species were high priority, 29 were moderate priority, and 7 species were low priority. The high priced medicinal plants in Manang and Mustang are *Cordyceps sinensis*, *Fritillaria cirrhosa*, *Morchella esculenta* and *Taxus baccata* subsp. *wallichiana*. The

price of medicinal plants varies at the local level; however, the price at the trade centers is almost always fixed. The local level price varies due to competition among the collectors.

Bulk amounts of medicinal plant trade from Manang and Mustang are comprised of *Allium wallichii*, *Allium oreoprasum*, *Aconitum orochryseum*, *Cordyceps sinensis*, *Dactylorhiza hatagirea*, *Juniperus indica*, *Morchella esculenta* and *Neopicrorhiza scrophulariiflora*. The local communities are working towards a sustainable collection of these wild medicinal species. Proper documentation and assessment of conservation threats, cultivation practices and regularized systems for conservation and management are major activities and challenges for sustainable utilization of medicinal plants in Manang and Mustang. If the process of trading of important medicinal plants continues on this scale for several years, species such as *Cordyceps sinensis*, *Dactylorhiza hatagirea*, *Neopicrorhiza scrophulariiflora*, *Allium wallichii*, *Aconitum naviculare*, *Aconitum orochryseum* will become increasingly rare.

6.6 Conclusion

The present survey concludes that the local populations of Manang and Mustang districts have a wide knowledge on the use of plants for various purposes, including medicinal, food, fuelwood, fence, fodder, timber, household article, ritual, religious, etc. With regards to the uses of plants as medicines, this research confirms the vast knowledge of the traditional healers such as *amchis*, local healers and village elders on the subject of the plants used for medicinal purposes. Wild plant species used as foods are seen to be beneficial for the whole community. In addition to dietary benefits, wild plant resources can be linked to the preservation of biodiversity and alleviation of poverty. Wild plants also provide opportunities for income generation in Manang and Mustang.

The present laboratory work lends support to the claims by traditional medicinal healers regarding the biological usefulness of the above plants. This study is a preliminary evaluation of antibacterial activity of the plants. It indicates that many plant species of Nepal have crude extracts that show antibacterial activity, and may be helpful in the discovery of novel antibacterial agents. The antibacterial activities of the plants often explain their use by the local community.

The present study concludes that prioritization of medicinal plants gives a concrete way for conservation and management aspects of the important medicinal plants of Manang and Mustang districts which includes many of the important medicinal plants of Nepal. In the quest to increase earnings, important medicinal plants are now being harvested for profit, which may put some species at risk. If the local people of Manang and Mustang begin to derive economic benefits from the region's plants, the natural environment will automatically be conserved *in situ*, and links in the ecosystem will be maintained.

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Appendix I - Preparation of Media for the culture of Microorganisms

Preparation of Nutrient Agar

Nutrient agar was prepared for the culture of bacteria. Twenty-eight grams of powder were dissolved in 1000 mL of tap water in a conical flask or round bottom flask. The mouth of the flask was covered with alminum foil and put in autoclave at 125 ^{0}C for 30 minutes at a pressure of 15 lbs. About 15-20 mL of liquid nutrient agar was poured into the sterilized petridishes before solidification. The agar petridishes were left in the laminar flow for one hour for setting.

Preparation of Nutrient Broth

Nutrient broth was necessary for the fresh culture of bacteria. Thirteen grams of the powder were dissolved in 1000 mL of tap water in a conical flask or round bottom flask. The mouth of the flask was covered with alminum foil and put in autoclave at 125 ^{0}C for 30 minutes at a pressure of 15 lbs. About 5-10 mL of liquid media (nutrient broth) was put in a sterilized glass bottle.

Appendix II - General Description of the Bacteria Used in the Study

(a) *Bacillus subtilis*

It is a Gram-positive rod that grows aerobically on nutrient agar and forms resistant endospores. Spores are ellipsoidal, non bulging sporangium, centrally located in the vegetative cell and very resistang to heat. They can tolerate 100 ^{0}C for several hours. *B. subtilis* is the commenest saprophytes found as contaminants in foods, clinical specimens and lobarotory cultures. It is facultative thermophile, capable of growth over the range 12-25 ^{0}C, grows well on ordinary media, forming large colonies that are circular or irregular, grey yellow, granular and difficult to emulsify. It is less commonly found opportunistic pathogen. It sometimes causes food poisoining (Collee *et al*., 1996).

(b) *Escherichia coli*

Escherich (1885) was first to isolate *E. coli* from faeces of infant suffering from diarrhoea (Holmes and Gross, 1985). It is referred to as colon bacillus because it is the predominant facultative species in the large bowel. It is Gram-negative, nonsporing, motile, rods with petritrichous flagella. *E. coli* is an aerobe and facultative anaerobe and grows on ordinary culture media. Infection caused by *E. coli* can broadly be classified into two groups. **(i) Urinary Tract Infection:** *E. coli* is major UTI (urinary tract infection) causing organism. About 90 % of uncomplicated UTI and 50 % of complicated UTI is caused by *E. coli*. The routes of infection are ascending routes, lymphatic route and hematogenous route (Leigh, 1985). **(ii) Respiratory Tract Inflection:** *E. coli* is also responsible for lower respiratory tract infection like other Gram negative bacteria such as *Klebsiella*, and *Pseudomonas. E. coli* may cause bronchial pneumonia in the elderly people. *E. coli* is abundant in human and animal faeces, where it may attain concentrations in fresh faces of 10^9 per gram (WHO, 1996). **Pathogenicity:** *E. coli* forms a part of normal intestinal flora of both humans and animals. The virulent strains of *E. coli* cause urinary tract infections, gall bladder and wound infections, appendicitis, peritonitis bacteraemia and meningitis especially in new borne. Diarrhoeal disease especially in infants but also in adults is caused by *E. coli*. Three pathogenic groups of *E. coli* responsible for diarrhoeal disease are as follows enterotoxigenic *E. coli* (ETEC), Enteroinvasive *E. coli* (EVEC) and Enteropathogenic *E. coli* (EPEC). The other strain Enterohaemorrhagic (EHEC) is also called VTEC entero-cytotoxin producing causing haemorrhagic colitis (Collee *et al*., 1996).

(c) *Salmonella typhi*

The genus *Salmonella* is frequently present in water from different sources like faeces, soil. It is a Gram-negative, non-capsulated, non-sporing, motile with peritrichous flagella, aerobic and facultative anaerobic bacilli. It grows on simple media at the temperature range 15-45 ^{0}C, optimally at 21 ^{0}C. It is non-lactose fermenter, indole, voges-proskaver, urease negative. Species of *Salmonella* that invade the blood and cause severe salmonellosis and typhoid fever are *S. typhi* and *Salmonella paratyphi*. Typhoid fever and salmonellosis are major cause of illness and death is developing countries (Old, 1985; Collee *et al*., 1996). **Pathogenicity:** It causes typhoid (Enteric Fever), gastrointestinal tract infections, nephrotyphoid in those with urinary schistosomiasis, osteomyelitis in children with sickle cell disease and thalassaemia meningitis (Cheesbrough, 1993).

(d) *Staphylocous aureus*

It is Gram-positive spherical cocci appears in three dimensional bunches of grape like structure in Gram staining. In nutrient agar it forms 1-3 mm in diameter with smooth, low convex, glistening, and densely opaque and of a butyrous consistency. In mannitol salt medium, it forms 1mm diameter yellow colonies surrounded by yellow medium due to acid formation. It grows optimally at 31 ^{0}C. It ferments a range of sugar, inducing mannitol. The tube coagulase, and clumping factor (bound coagulase) catalase, acetosis production (Voges-proskaver), gelatinalse are positive but indole is negative (Collee *et al*., 1996). **Pathogenicity:** It causes pyogenic infections including folliculitis, impetigo furuncles, carbuncles, breast abscess; post operative wound infections, cellulitis, pyomyosites, osteomyelitis, septic arthritis (bone), broncho-pneumonia, lung abscess, empyema, acute endocarditis, septicaemia, staphylococal food poisoning (Collee *et al*., 1996).

(e) *Pseudomona aeruginosa*

It is Gram-negative, motile, aerobic, non fermentative, non spore forming rod shaped bacteria. It is widely distributed in nature. It grows readily on minimal media. Cetrimide agar and *Pseudomonas* isolation agar are best selective media for *P. aeruginosa*. In blood agar it may produce diffuse haemolysis. Unlike other *Pseudomonas*, *P. aeruginosa* grow at 42 ^{0}C. After overnight aerobic incubation in nutrient agar at 37 ^{0}C, six distinct colonial type of *P. aeruginosa* may be observed (Phillip, 1969). It produces characteristic green pycocyanin pigment when aerobically cultured in nutrient agar. **Pathogenicity:** It is a classic opportunist pathogen which innate resistant to many antibiotics and disinfectants. It may cause ear infection and corneal ulceration. This organism is the major cause of burn wound infection (Philip, 1969).

(f) *Streptococcus faecalis*

S. faecalis is a Gram-positive bacteria. It is called Lactic acid bacteria which can grow in media of the relatively high PH of 9.6-10.5. *S. faecalis,* are extremely resistant to high salt concentration. This bacteria has been focused to be stable when carried as liquid cultures in the complete assay medium for long periods of time (Carpenter, 1967).

Appendix III - Publications of the Research, in the order found in the Thesis

1. **Bhattarai, S,** Chaudhary, RP and Taylor, RSL. 2006b. Ethnomedicinal plants used by the People of Manang district, Central Nepal. *Journal of Ethnobiology and Ethnomedicine*, **2:** 41.

2. **Bhattarai, S,** Chaudhary, RP and Taylor, RSL. 2009e. Ethnomedicinal plants used by the people of Mustang District, Nepal (Submitted).

3. **Bhattarai S,** Chaudhary RP and Taylor RSL. 2009a. Wild edible plants used by the people of Manang District, Central Nepal. *Ecology of Food and Nutrition***, 48 (1):1-20.**

4. **Bhattarai, S** and Chaudhary, RP. 2006. Ethnobotany of wild *Allium* species in Manang district, Central Nepal. *Plant Archives*, **6 (2):** 471-476.

5. **Bhattarai S,** Chaudhary RP and Taylor RSL. 2008a. Ritual and Religious plants of Manang district, Central Nepal. *Plant Archives,* **8 (2):**973-980.

6. **Bhattarai S,** Chaudhary RP and Taylor RSL. 2007a. Plants used as Fence and Fuelwood in Manang district, Central Nepal. *Scientific World,* **5 (5): 107-111.**

7. **Bhattarai S,** Chaudhary RP and Taylor RSL. 2009d. The use of plants for fencing and fuelwood in Mustang district, Nepal. *Scientific world* (Submitted).

8. **Bhattarai S,** Chaudhary RP and Taylor RSL. 2009c. The Uses of Wild Plants by the People of Mustang District, Nepal with Reference to Fodder and Decoration. *Journal of Natural History Museum* (in Press).

9. **Bhattarai, S,** Chaudhary, RP and Taylor, RSL. 2006a. Ethnobotany of wild Junipers (*Juniperus* species) in Manang district, Central Nepal. *Scientific World,* **4 (4):** 109-112.

10. **Bhattarai, S,** and Chaudhary, RP. 2005. Ethnobotany of wild rose in Manang district, Central Nepal. *Environmental Biology and Conservation*, **10:** 33-36.

11. **Bhattarai S,** Chaudhary RP and Taylor RSL. 2008c. Screening of selected ethnomedicinal plants of Manang District, Central Nepal for antibacterial activity. *Ethnobotany* (in Press).

12. **Bhattarai S,** Chaudhary RP, Taylor RSL and Ghimire SK. 2009b. Biological Activity of Several Plants of Nepal Used to treat Bacterial Infections (In Preparation).

13. **Bhattarai S,** Chaudhary RP and Taylor RSL. 2008b. Antibacterial Activity of selected Ethnomedicinal plants of Manang District, Central Nepal. *Journal of Theoretical and Experimental Biology,* **5 (1 & 2):** 01-09.

14. Rajbhandari M, Mentel R, Jha PK, Chaudhary RP, **Bhattarai S,** Gewali MB, Karmacharya N, Hipper M & Lindequist U. 2007. Antiviral activity of some Plants used in Nepalese traditional medicine. *Evidence-Based Complementary and Alternative Medicines***,** doi:10.1093/ecam/nem156.

15. **Bhattarai S,** Chaudhary RP and Taylor RSL. 2007b. Prioritization and trade of ethnomedicinal plants by the People of Manang district, Central Nepal. In: Chaudhary RP, Aase TH, Vetaas OR, Subedi BP (eds.), *Local Effects of Global Changes in the Himalayas: Manang, Nepal*, Tribhuvan University, Nepal and University of Bergen, Norway, pp. 151-169.

Appendix IV - Villagers, healers and *amchis* of Manang and Mustang Districts, Nepal, who contributed their knowledge regarding wild plant use, and consented to have their names published. All other interviewees asked to remain anonymous.

The local knowledgeable villagers, healers and *amchis* interviewed who consented to have their names and knowledge published from Manang district are: Mukhiya Ghala, 64 years, male; Chakki Gurung, 61 years, female; Dipli Gurung, 52 years, male; Kancha Bishwakarma, 50 years, male; Kalu Gurung, 50 years, male; Karki Gurung, 67 years, male; Aoda Bishwakarma, 45 years, male; Kali Gurung, 46 years, male; Galchen Gurung, 57 years, male; Kazi Gurung, 31 years, male; Sonam Chiring, 27 years, male; Kalu Gurung, 27 years, male; Karma Gurung, 45 years, male; Sengla Gurung, 66 years, male; Chiring Gurung, 50 years, male; Sher Bahadur Gurung, 68 years, male; Karma Sonam Lama, 68 years, male; Lopsang Lama, 42 years, male; Polchom Lama, 21 years, female; Katkha Gurung, 58 years, male; Kamala Gurung, 38 years, female; and Shangma Gurung, 32 years, female.

Similarly, the local knowledgeable villagers, healers and *amchis* interviewed who consented to have their names and knowledge published from Mustang district are: Seta Nepali, 30 years, male; Dhanbir BK, 46 years, male; Maan Prasad Thakali, 52 years, male; Rupa Thakali, 48 years, female; Maana Devi Thakali, 32 years, female; Sana Devi Thakali, 29 years, female; Bhim Prasad Thakali, 58 years, male; Suresh Sherchan, 38 years, male; Lal Kumari Gauchen, 46 years, female; Seram Gurung, 48 years, male; Sonam Gurung, 53 years, female; Mahiela Gurung, 35 years, male; Chhyaa Lama, 66 years, male; Ram Chandra Thakali, 37 years, male; Mangala Lalchand, 50 years, female; Shyam Prasad Lalchan, 51 years, male; *Amchi* Tshampa Ngawang Gurung, 58 years, male; *Amchi* Thurthjock Lama, 64 years, male; *Amchi* Neengma lama, 37 years, male; Chendhen Gurung, 35 years, female; Laxhi Gurung, 39 years, female; Nathue Gurung, 60 years, male; Nophhue Chiring, 52 years, male; Indra Gurung, 40 years, male; Chiring Gurung, 60 years, male; Rajhendra Thakuri, 41 years, male; Bisnu Gurung, 48 years, male; Tenzing Gurung, 50 years, male; Khyaoomo Chiring Gurung, 35 years, female; Maya Gurung, 25 years, female; Ghulii Chamang, 64 years, male; Asmitha Gurung, 17 years, female; Prem Gurung, 53 years, male; Pasang Gurung, 38 years, female; Chiring Yangghung Gurung, 87 years, female; Ghyangh Chusang Bista, 64 years, male; Raju Bista, 39 years, male; Maya Bista, 40 years, female; *Amchi* Gyasto Bista, 49 years, male; Tsering Wangmo Bista, 45 years, female; *Amchi* Tensing Bista Lama, 43 years, male; Pema Dolma Bista, 21 years, female; Chndup Gyato Bista, 18 years, male; Chhime Dolkar Bista, 23 years, female; Tsewang Bista, 15 years, male; Tashi Bista, 14 years, male; Sonam Sangmo Bista, 82 years, female; and Rinzin Wangmo Bista, 22 years, female.

APPENDIX V - PLANTS USED BY THE PEOPLE OF MANANG AND MUSTANG DISTRICTS, NEPAL

Enumeration and mode of preparation: An alphabetical listing of local plants by species, with family; voucher numbers; local vernacular name; locality of collection; collectors; habit; distribution; as well as a detailed description of preparation and use. *Indicates species not previously known for its medicinal use in Manang and Mustang in Manandhar (1987); Phole (1990); Bista and Bista (2005); Borhl (2006); Kunwar *et al*. (2006); Chetri *et al*. (2006) [*68 species but may be reported in other parts of the country].

(1) Abies spectabilis (D. Don) Mirb. (Pinaceae); V 341, 2411; 'Kye, Thangwha, Gobresalla' (G, A, N). **Dist.: Pakistan** (Chitral), **Himalaya** (Kashmir to Nepal), **Nepal** (WC, 2400-4400m), **Ma.** (way to Pisang from Hongde, 3060m), **Mu.** (in the Kobang forest, 2580m).

(a) In Manang, to heal broken bones, fresh leaves and cone are pulverised on a stone slab and the paste is applied to the site of the fracture two times a day until recovery. This is not used on compound fractures that have broken the skin. (b) Also for bone fractures approximately 20g cones and leaves are mixed with two cups of water and boiled it for sometime. Half a cup of decoction is again mixed with a cup of hot water and drunk 1-2 times a day until recovered. If the patient is suffering from fever (fever due to bone fracture) then the decoction is mixed with cold water instead of hot.

(c) Small cut branches are used as fence in the crop fields in Mustang.

(d) In Manang and Mustang, wood is used as fuelwood and furniture. (e) Small branches are cut with leaves and cones and used as a decorating material by displaying them inside a pot on the table.

(2) ***Acanthopanax cissifolius** (Griff. ex Seem.) Harms (Araliaceae); V 2429; 'Panghroo, Chhokhar' (T/G, A). **Dist.: Himalaya** (Uttar Pradesh to Bhutan), **W. China**, **Nepal** (WCE, 3000-4000m), **Mu.** (near the Larjung village, 2530m).

(a) Fruits are roasted in a clay pot and one fruit is eaten at a time with a cup of hot water for gastritis three times a week until recovery. (b) Dried small mature branches (about 25 cm) are used to make fire at the time of ritual and religious ceremonies. Many additives in worship (for example, *Sesamum orientale, Hordeum vulgara*, cow ghee etc.) are mixed together and thrown to the fire with right hand within the time intervals. During the time interval *Lama* or *amchi* spelled *Mantras* and the repetition of *Mantras* continues until the end. (c) Wood is used as fuelwood (d) Small cut branches are used as fence in crop fields.

(3) Aconitum naviculare (Bruhl) Stapf (Ranunculaceae); V 761, 3861; 'Ponkar' (T/G/A). **Dist.: Himalaya** (Nepal to Bhutan); **Nepal** (WC, 4100-4900m), **Ma.** (way to Manang yakkharka, 4500m), **Mu.** (way to ThorangPhedi, 3710m).

(a) In Manang, about 15g of whole plant is pounded on stone slab and boiled on two cups of water. About 5-10 spoonfuls of decoction is mixed with a cup of water and the decoction is drunk two times a day after meal for fever (any kind of fever) and jaundice. It is necessary to take a 'vitamin' tonic of 'Yarsagumba' (*Cordyceps sinensis)* and 'Lovha' (*Dactylorhiza hatagirea*) after using the medicine. It is said that the medicine works as an antibiotic. Regular use of this medicine causes weakness, so in order to counteract that, as well as to make refreshing the mouth, equal amounts of 'Yarsagumba', 'Lovha', and cow's milk sweetened with honey are taken as a

source of 'vitamins'. This mixture is known as the best type of 'vitamin' of that area. (b) Half a spoonful of powder (made from dried whole plant) is mixed with a cup of boiled water and drunk 2-3 times a day for fever and jaundice until recovery. (c) Half a spoonful of powder (made from dried whole plant) is mixed with two spoonfuls of Chauri ghee (butter from the female cow) and taken two times a day for fever and jaundice until recovery. (d) In Mustang, half a spoonful of root paste is drunk with a cup of hot water for fever, blood fever, headache, bile diseases and liver diseases two times a day until recovery. (e) *Amchi* also mixes the root with different additives including other medicinal plants (confidential mixture) and prepares pill medicine. The pills are given to the patients for the same diseases mentioned above until recovered.

(4) Aconitum orochryseum Stapf (Ranunculaceae); V 1613, 3862; 'Nirmasi, Bhonghnama' (T/G, A). **Dist.: Himalaya** (Nepal, Bhutan), **Nepal** (CE, 3600 – 4900m), **Ma.** (Chame pasture, 4250m), **Mu.** (way to Kagbeni pasture, 3310m).

(a) In Manang and Mustang, half a spoonful of ground root powder is taken with a cup of milk/hot water 2-3 times a day until recovery for fever, diarrhoea, dysentery, cough, cold, tonsillitis, headache, malarial fever, feeling higher level of heat inside the body, patient who received inappropriate medication (self medication) and high altitude sickness problems (see appendix VII for symptoms). It is necessary to take a 'vitamin' tonic of 'Yarsagumba' (*Cordyceps sinensis)* and 'Lovha' (*Dactylorhiza hatagirea*) after using the medicine. It is said that the medicine works as an antibiotic. Regular use of this medicine causes weakness, so in order to counteract that, as well as to make sweeten the mouth, equal amounts of 'Yarsagumba', 'Lovha', and cow's milk sweetened with honey are taken as a source of 'vitamins'. This mixture is known as the best type of 'vitamin' of that area.

(b) In Mustang, *A. orochryseum* is used to counteract the poison of *A. spicatum*. The preparation and dosage of *A. orochryseum* as an antidote to the poisonous *A. spicatum* is confidential. It is interesting that the collectors differentiate the two species only by taste because the two species have the same morphological structure. (c) Half a spoonful of whole plant is taken with a cup of hot water/milk for bile disorders, sinusitis and fever two times a day until recovery. (d) The paste of the whole plant is applied for allergy two times a day until recovery.

(5) ***Aconitum spicatum** (Bruhl) Stapf (Ranunculaceae); V 3871; 'Chandruck, Menchangh' (T/G, A). **Dist.: Himalaya** (Nepal to Bhutan), **China** (Xizang), **Nepal** (WCE, 1800-4200m), **Mu.** (way to Syangbochae pasture, 3940m).

(a) It is highly poisonous and difficult to differentiate between *A. orochryseum* and *A. spicatum*. Using the wrong species by mistake can result in death. The medicine from this plant can only be prepared by highly experienced *amchi*. Medicine must be made by *amchi* with other medicinal plants of the Himalaya so that the poison of that plant is inactivated without inactivating the medicinal properties. (b) Whole plant (mainly root) of *A. spicatum* is used to make medicinal pills by the *amchi* to treat: infected wounds; as a tonic to provide relief from general weakness; to counteract the effects of poison, including inappropriate self medication, poison ingested on purpose or accidentally, poisonous animal stings or bites; boils; fever; allergy; and edema. It is never used alone and is always mixed with other medicine of the Himalaya. (c) A paste of the roots is applied for allergy, boils, cuts, wounds and edema after mixing with other medicinal plants. These other plants remove the poisonous effects of *A. spicatum*. (d) Root is used by *amch*'

to tie on the neck of the patients. As the *amchi* ties the root, he/she softly chants ritual *mantras* to wish good luck to the patient.

(6) Allium carolinianum DC. (Alliaceae); V 1745, 4439; 'Rotangtea' (G). **Dist.: C. Asia**, **Afghanistan**, **Himalaya** (Kashmir to Nepal), **Nepal** (WC, 4800-5100m), **Ma.** (way to Manang yakkharka, 3980m), **Mu.** (near the Jharkot goatshed, 3710m).

(a) In Manang, fresh parts of whole plant are pounded on a stone slab and 1-2 spoonfuls are used as a spice substitute in curry dishes (vegetable or meat curry). The dish is eaten two times a day for stomachache, headache, diarrhoea and dysentery until recovery. (b) One-forth spoonful of powder (made from dried whole plant) is drunk with a cup of boiled water two times a day for the same diseases mentioned above until recovery. (c) The whole plant is also given as a meat substitute to a recently post-partum mother (with a baby of 3-12 days) because it is highly nutritious, as a substitute to meat and 'increases the blood'. The plant is collected and washed with water, and then a small quantity is added to other vegetables which are fried in oil and then simmered for sometime. The whole plant is also cooked mixing with other vegetables. (d) In Mustang, especially leaves are cooked as vegetables and eaten by pregnant women close to their child delivery because it helps to 'break blood in the body during child birth'. (e) In Manang and Mustang, the mature bulb and stem are added to other vegetable ingredients and also used to prepare a pickle (*achar*) which is said to be highly nutritious. At first they are softened by pounding on a stone slab and then fried it on oil. After this, they are added to the other ingredients (such as radish, carrot, cabbage, etc.) and cooked for a while longer. This pickle is used but the same day it is prepared, not stored for later use. Sometimes the mature bulbs are mixed with *Allium prattii* bulbs in a mixed vegetable pickle with other items such as radish, carrot, or cabbage, which can be stored for longer periods of time (for details see *Allium prattii*). It is also commonly cultivated in kitchen gardens and bulbs are stored for colder seasons by hanging in the rafters. (f) The dried leaves and root are also used as spice. Small pieces of a half a spoonful of dried plant parts is fried in oil/ghee and cooked with vegetables/pulses for sometime, which is said in adding flavour to the vegetables/pulses.

(7) Allium fasciculatum Rendle (Alliaceae); V 355, 5301; 'Nosyante' (G). **Dist.: Himalaya** (Nepal to Bhutan), **China** (Xizang), **Nepal** (WC, 2800-4500m), **Ma.** (in the Bhratang forest, 3290m), **Mu.** (way to Larjung pasture, 2990m).

(a) In Manang, about 10g of whole plant is pounded and boiled by mixing with two cups of water. Half a cup of decoction is drunk two times a day to reduce gastritis and to increase and purify the blood.

(b) The whole plant is used as a vegetable in a curry, either with other vegetables or alone in Manang and Mustang. This species is found in large amount in Manang, compared to other *Allium* species, so it is often used alone rather than mixed with other vegetables. The plants are washed in water, cut into small pieces and then cooked in oil with salt, chilli and water. The dried leaves with stems are stored for use in colder seasons in the rafters of the home. They are stored in a sack (bags – plastic or cotton) after drying in sunlight.

(8) ***Allium oreoprasum** Schrenk (Alliaceae); V 1721; 'Lungho' (G). **Dist.: Pakistan**, **C. Asia**, **Nepal** (W, 2700-5000m), **Tibetan borderlands**, **Ladakh**, **Ma.** (way to Kanglapass, 3940m).

(a) About one spoonful of dried whole plant by cutting it in small pieces is put on one spoonful of mustard oil fried and mixed with pulse/lentil and/or vegetable dishes as a spice to treat cough, cold, headache, tonsillitis, stomachache, check white intestinal worms and/or give relief from high altitude sickness. (b) Half a spoonful of the same powder (made from dried whole plant) is taken with a cup of hot water two times a day to treat the same diseases mentioned above. An over dose can give vertigo/dizziness. (c) The whole plant is used as a vegetable in Nar and Phoo villages. It is cooked as curries with other vegetables as mentioned in *Allium carolinianum*. This species is mainly found in the pasture surrounding the villages of Nar and Phoo. (d) Vast amount of the plants are prepared for storage for colder seasons by drying them in sunlight. These dried plants are also sold to people in other villages of Manang, where they are used to prepare pickle dishes. *Allium oreoprasum* locally called '*Jimboo*' in Nepali is commonly traded to earn money or exchanged for crops such as wheat or buckwheat. Dried plants are sold in every street of the big cities of Nepal including Kathmandu, Pokhara, Narayanghat etc, and to the people of lower Manang.

(9) ***Allium prattii** C.H. Wright apud Forbes & Hemsl. (Alliaceae); V 407, 3847; 'Chhaphi, Nyeshing' (G, A). **Dist.: Himalaya** (Nepal to Sikkim), **W. China**, **Nepal** (WCE, 2400-4500m), **Ma.** (above the Khangshar goatshed, 4420m), **Mu.** (way to Kalopani yakshed, 2980m).

(a) In Manang and Mustang, in season (July-September), leaves are used as a vegetable. The method of preparation is the same as for *Allium carolinianum*. The bulbs are stored for use in colder seasons. (b) The mature bulb and stem are also mixed with other typical pickling foods (such as radish, carrot, cabbage etc) and pickled. The methods for making of pickle to be consumed that day is the same as *Allium carolinianum*. *A. prattii* bulbs more often used to make pickle for storage and later consumption. *A. prattii* is mostly pickled alone if it can be collected in sufficient amounts. If not, it is mixed with the bulbs of other *Allium* species. To prepare the pickle, the bulbs are first softened by pounding on a stone slab and then mixed with salt, chilli and spices. Mainly *Zanthoxylum armatum*, locally called *Timur* in Nepali, is used as a supplement spice. The mixture is then transferred into glass or plastic bottles after the mixture is dipped in mustard or soybean oil. The more oil used, the longer the pickle can be stored. (c) The dried leaves and root are used as spice and the detailed method of use is same as described in *A. oreoprasum*. (d) In Mustang, about five root bulbs are eaten with a cup of hot water once a day before going to bed for chronic diseases (described in appendix VII) or infection which have resisted other treatments. It is said that those illnesses can be completely cured by the use of this medicine.

(10) Allium wallichii Kunth (Alliaceae); V 3878; 'Khanakhanshaa' (A). **Dist.: Himalaya** (Nepal to Bhutan), **W. China**, **Nepal** (WCE, 2400-4650m), **Mu.** (Tsarang pasture, 3910m).

(a) Half a spoonful of dried whole plant is mixed with one-forth of a spoonful of root of *Curcuma angustifolia* (Turmeric), two cups of hot water and boiled for sometime. Then one cup of the decoction is drunk two times a day for fever, tonsillitis, cough, cold, loss of appetite and during periods when the patient is weak or lethargic until recovery. This treatment is said to help to completely cure the above mentioned diseases in one day. (b) The whole plant is used as vegetable in upper Mustang during the seasons (June-August). Sometimes, it is also mixed with leaves of *Fagopyrum esculentum*, *F. tataricum*, *Brassica* species, potato and other vegetables

ingredients. The detailed method of cooking is same as mentioned above in *Allium carolinianum*. Vast amount of *A. wallichii* are dried and prepared for storage for colder seasons. (c) The dried leaves are also used as spice and the detailed methods of use are same as described in *A. oreoprasum* (see above). Dried plant parts are in sell in every street of the big cities of Nepal including Kathmandu, Pokhara, Narayanghat etc, and is sold to the people in other villages of lower Mustang for cash money or exchange for wheat or buckwheat.

(11) Alnus nepalensis D. Don (Betulaceae); V 4322; 'Utish' (N). **Dist.: Himalaya** (Uttar Pradesh to Bhutan), **NE India**, **Myanmar**, **Indo-China**, **W. China**, **Nepal** (WCE, 500-2600m), **Mu.** (way to Ghasa, 2050m).

(a) One spoonful of bark powder is taken with a cup of hot water two times a day for body pain and fever until recovery (see appendix VII for symptoms). (b) Sometime leaves are used as fodder and mixed with cow and buffalo dung to make organic fertilizer. (c) Wood is used as fuelwood. (d) Small cut branches are used as fence in the crop field.

(12) ***Amaranthus lividus** L. (Amaranthaceae); V 2966; 'Bakhrakhana' (N). **Dist.: Tropics and Temperate regions**, **Nepal** (WC, 1500-2300m), **Mu.** (way to Kalopani, 2310m).

(a) About two spoonful of whole plant parts is pounded in stone slab by mixing with other mixtures i.e., special type of cloth called *Banad* (one spoonful ashes of *Banad* after being heated in the fire), and one spoonful of color *Neer* (this is the blue laundry colouring powder or liquid used in brightening white cloth and clothing in Nepal). The total amount now becomes four spoonfuls. Four spoonfuls of this mixture (medicine) is taken with a cup of hot water once a day for women at the times of over flow of blood in menstruation (bleeding) and over flow of blood during child birth until recovery. (b) Whole plant is used as fodder. (c) Young leaves and stems are used as vegetables. The detailed method of preparation of vegetable is same as described in *Allium carolinianum* above.

(13) ***Anaphalis nepalensis** (Sprengel) Hand.-Mazz. (Asteraceae); V 348, 4539; 'Tachha' (A). **Dist.: Himalaya** (Kashmir to Bhutan), **NE India** (Meghalaya), **Myanmar**, **Nepal** (WCE, 1500-2900m), **Ma.** (way to Pisang from Hongde, 3050m), **Mu.** (way to Samar from Chele, 3360m).

(a) Half a spoonful powder (made from dried whole plant) is taken with a cup of hot water 2-3 times a day after meal for fever and edema until recovery. (b) Inflorescence is used as decorating materials by putting it inside the glass/mud/wood pot in the tables. (c) Dried whole plant is used as *dhup* (incense). The detailed method of use is same as described above in *Ajania nubigena*. This plant is not commonly used because of its inferior quality. It is only used after it has been dried thoroughly in sunlight.

(14) Anaphalis triplinervis (Sims) C.B. Clarke (Asteraceae); V 129, 4522; 'Fojormendho, Taa/Tayung' (G, A). **Dist.: Himalaya, S. China**, **Taiwan, Nepal** (WCE, 3400-5500m), **Ma.** (way to Phoo from Dharmasala, 3010m), **Mu.** (way to Jomsom from Thini, 2840m).

(a) In Manang, the whole dried plant is ground to a powder. Half a spoonful of powder is put on red fire coal and the scent/smoke is sniffed by the patient two times a day after meals for cough, cold and tonsillitis. (b) The paste of leaves and flowers is applied daily on abrasions that have become inflamed, infected and/or swollen. The abrasion is then 'dried' by placing the affected body part close to a fire once a day to 'remove water', until recovery. (c) About 10g of whole plant is boiled in one cup of water and ten spoonful of decoction is drunk two times a day after

meal for cough, cold, tonsillitis and fever. (d) One-forth of a spoonful powder (made from dried whole plant) is taken 2-3 times a day after meal for fever, menstrual disorders (heavy flow), and edema (swelling of the body) until recovery. (e) The whole plant is used as *dhup*. Five to ten plants are placed on a glowing ember in the same manner that *Ajania nubigena* is used (see above). It is only used after it has been dried thoroughly in sunlight because the fresh plant does not burn well. *Anaphalis triplinervis* is not commonly used as incense and is perceived to be low or inferior quality when compared to other incense plants.

(f) In Mustang, whole plant is rolled into a ball and put over the swollen part of the body. Over this, a glowing ember (red coal) is placed to draw water out from the skin. This process is continued until the patient recovers completely.

(15) ***Androsace robusta** (Knuth) Hand.-Mazz. (Primulaceae); V 3880; 'Panghdhum' (A). **Dist.: Pakistan**, **Himalaya** (Kashmir to Nepal), **China** (Xizang), **Nepal** (WC, 3100-5600m), **Mu.** (way to Tsarang, 3660m).

(a) One spoonful of whole plant is drunk with a cup of hot water for cough, cold, tonsillitis and allergy once a day before going to bed until recovery. (b) The paste from whole plant is applied on the part of the body affected by allergy (which is the cause attributed to a skin lesion or rash) once a day until recovered.

(16) ***Androsace muscoidea** Duby (Primulaceae); V 4590; 'Phangdhum' (A). **Dist.: Himalaya** (Kashmir to Sikkim), **Nepal** (WCE, 2500-4000m), **Mu.** (way to Chele pasture from Chele, 3340m).

(a) Half a spoonful of whole plant paste is taken with a cup of hot water for fever (defined in appendix 4), collection of water in joints and allergy three times a day until recovery. (b) The paste is applied on skin affected by 'allergy' once a day until recovery. This is the same illness and treatment process as described above for *A. robusta* and described in appendix VII.

(17) Androsace strigillosa Franch. (Primulaceae); V 217; 'Gadhikanakyo' (G). **Dist.: Himalaya** (Nepal to Bhutan), **China** (Xizang), **Nepal** (WC, 2400-4700m), **Ma.** (way to Chame from Pisang, 2810m).

(a) Half a spoonful of powder (made from dried whole plant) is taken with a cup of boiled water two times a day after meal for edema (swelling of the body), and/or fever until recovery. (b) The paste of the whole plant is applied on skin and then dried with a red fire coal to remove water from the skin that occurs with 'skin swelling'. This 'skin swelling' refers to the accumulation of water inside the skin in the cold seasons in the hands and legs where there has been an abrasion.

(18) ***Androsace tapete** Maxim. (Primulaceae); V 2511; 'Phangdhum' (A). **Dist.: Himalaya** (Nepal), **China** (Sichuan), **Nepal** (WC, 3800-5200m), **Mu.** (way to Jharkot goatshed, 3510m).

(a) Half a spoonful of whole plant powder is drunk with a cup of hot water for 'allergy' once a day until recovery. This is the same illness and treatment process as described above for *A. robusta*. (b) The paste is applied on 'allergic' skin once a day until recovery.

(19) Anemone rivularis Buch.-Ham. ex DC. (Ranunculaceae); V 456, 3219; 'Angsoup' (G). **Dist.: India, Sri Lanka, Myanmar, China, Nepal** (WCE, 1600-4000m), **Ma.** (way to Hongde from Munji, 3290m).

(a) Half a spoonful of ground powder (made from dried whole plant) is taken with a cup of boiled water for cough, cold, white intestinal worms, stomachache and edema (swelling of the body), once a day until recovery.

(20) Anisodus luridus Link & Otto (Solanaceae); V 212, 3689; 'Langtang, Bajharbhanghoo' (G, A). **Dist.: Himalaya** (Kashmir to Nepal), **China** (Sichuan, Xizang, Yunnan), **Nepal** (WCE, 2500-3800m), **Ma.** (way to Ngawal from Kanglapass, 3840m), **Mu.** (near the Jomsom airpoprt, 2700m).

(a) In Manang and Mustang, dried flowers are cut into small piece and mixed with tobacco taken from inside a cigarette. The mixture is rubbed between the palm and thumb and rolled into a cigarette. The cigarette is smoked two times a day for gingivitis and to relieve tooth pain.

(b) In Mustang, one spoonful of seed powder is put on red fire coal and the scent/smoke is blown on the infected part of the teeth with special *mantra*[6] by the healers, *Dhami*[7] and *amchi*[8] for teeth affected by worms (black worms inside the teeth which cause pain in the teeth, decay the teeth, and remain in the teeth for many years) once a day until recovery. (c) Infrequently whole plant is mixed with the dung of cattle to make organic fertilizer.

(21) ***Arabidopsis himalaica** (Edgew.) O.E. Schulz (Brassicaceae); V 3876; 'Chhakrakhmaa' (A). **Dist.: Afghanistan**, **Himalaya** (Kashmir to Bhutan), **China**, **Nepal** (WCE, 3000-4100m), **Mu.** (way to Bhena village, 3670m).

(a) Half a spoonful of juice from whole plant is taken with a cup of hot water for leg pain or backbone pain three times a day until recovery.

(22) Arctium lappa L. (Asteraceae); V 3894; 'Jisung' (A). **Dist.: Eurasia**, **Nepal** (WC, 2100-3700m), **Mu.** (way to Tsarang, 3620m).

(a) Half a spoonful of fruit is used with a cup of hot water in nerve diseases (no detailed given by the healers) and kidney stone (symptoms defined in appendix VII), once a day until recovery. (b) The *amchi* prepares pills using other many medicinal plants with additives and the detailed process of preparation of this medicine is confidential. (c) To identify kidney stones it is necessary to test the patient's urine and have an ultrasound examination. Patients are sent to Kathmandu or Pokhara hospital for the ultrasound. After a kidney stone has been confirmed by an allopathic doctor, villagers return back to Mustang to be treated by the *amchi* and take medicine prepared from herbal medicine. The medicines should be taken regularly and the *amchi* states that 100 patients have recovered by using this medicine.

(23) ***Argyrolobium roseum** (Cambess.) Jaub. & Spach (Fabaceae); V 2907; 'Shamraphool, Marbhan, Mushuhangh' (N, T, A). **Dist.: W. Asia** (Iran, Iraq), **Himalaya** (Kashmir to Nepal), **Nepal** (WC, 1900-3200m), **Mu.** (way to Chele village, 3005m).

(a) About two to three ripe fruits are boiled in two cups of water for sometime and one cup of decoction is drunk three times a day (morning, afternoon and evening) only after eating, for fever (it can be used for any kinds of fever) and any types of communicable diseases (e.g. cough, cold),

[6] *Mantra*: A confidential ritual chant wishing the good of the anything undertaken, there is a belief that the *mantra* overcome anything bad.

[7] *Dhami*: Traditional healers who treat people using mantras and traditional medicinal practices.

[8] *Amchi*: Traditional Tibetan doctors.

until recovered. The dosage can be increased up to six times a day if needed, but there is a high chance of recovery if used for two days.

(24) Arisaema flavum (Forssk.) Schott (Araceae); V 360, 4477; 'Timtry, Tangdhung/ Dhawa' (G, A). **Dist.: Afghanistan, Himalaya** (Kashmir to Bhutan), **W. China**, **Nepal** (WC, 2400-3800m), **Ma.** (way to Chame from Bhratang, 2650m), **Mu.** (way to Jomsom pasture, 2800m).

(a) In Manang, the root tuber is put on fire coal under ash and one-forth part is taken one time a day for skin diseases, wart, edema (swelling of the body), wounds on skin and in the vagina ('*Bhringhee*') until recovery. (b) The root tuber after put on fire coal under ash is used as paste on the infected part for the same diseases mentioned above until recovery. (c) In Mustang, root tuber paste (prepared by putting it on red fire coal and by pounding it on stone slab) is used for sinusitis, skin diseases and bone spurs once a day before going to bed until recovery. It is given by the *amchi* to the patients to eat but only *amchi* knows the detailed methods of preparation of this medicine and remain confidential. It is poisonous so *amchi* prepares medicine by mixing with confidential mixture of other medicinal plants of the Himalaya. (d) Flowers are used as medicine for pregnant woman. During pregnancy sometimes blood diseases occur (defined in appendix VII). Half a dose of flower is mixed with flowers or fruits of *Podophyllum hexandrum* 25 % and 25 % other confidential medicines of the Himalayas. Then *amchi* prepare pills or powder medicine. The detail method of preparation with dosage is given by *amchi* and the medicine is taken once a day until recovery. (e) The fresh plant is poisonous, so care must be taken in the cooking process. In Manang and Mustang, fresh leaves are used as a vegetable after suitable preparation. First they are boiled for about 10 minutes, after which the water is discarded and replaced with clean water. It is boiled for more time to remove the poisonous chemicals. These cooked leaves are then fried in oil with salt, chilli and spices. The spices used normally are *Zanthoxylum armatum*, *Allium prattii*, *Allium oreoprasum*, etc. After adding the spices, some water is added and the leaves are simmered until done. Leaves are also used as vegetable after drying on the roof of the house, or outside on a frame etc., for about six months. The process of cooking these dried leaves is same as when the leaves are fresh. (f) The root tuber can also be eaten. To prepare the root tuber, it is continuously boiled in water and wood ash is also added in the water. The boiling process continues for approximately 24 hours. After 24 hours the root tuber is taken out from the hot water and washed with clean water two or three times. The outer covering (skin) of the tuber is removed and the tuber can be used as vegetable as a substitute for potato or can be eaten directly.

(25) Arisaema jacquemontii Blume (Araceae); V 118, 4492; 'Thomo, Dhaba' (G, A). **Dist.: Afghanistan**, **Himalaya** (Kashmir to Bhutan), **NE India**, **China** (Xizang), **Nepal** (WCE, 2700-4000m), **Ma.** (way to Chame from Pisang, 2820m), **Mu.** (way to Jomsom pasture, 3600m).

(a) In Manang, one-forth of a root tuber is eaten to treat pain of the nose (internal or external), eye pain and warts. The tuber is baked in the hot coals from a fire and eaten once a day until recovery. (b) The paste of a roasted ('*polnu*' in Nepali) root tuber is applied on the infected part of the body one time a day until recovery. It can be applied inside the infected part as well as outside the infected part as long as it has been properly prepared ('*Polnu*') on red fire coal, otherwise it is poisonous. (c) In Mustang, the medicinal uses of *Arisaema jacquemontii* is same as described above in *A. flavum* of Mustang. It is more poisonous than *A. flavum* so care should be taken while

using it. (d) In Manang and Mustang, leaves and root tubers are used as a vegetable. The detailed method of use is same as described to the *Arisaema flavum* mentioned above.

(26) Arnebia benthamii (Wall. ex G. Don) I.M. Johnst. (Boraginaceae); V 3587; 'Dimok, Cithoup' (A). **Dist.: Himalaya** (Kashmir to Nepal), **Nepal** (WC, 2800-4500m), **Mu.** (Jharkot pasture, 3560m).

(a) About half a spoonful of root powder is taken with a cup of hot water once a day for unmanaged pain in upper part of the body, lung diseases, to increase hair and to decrease hemorrhoids until recovered, which usually happens quickly. (b) Half a spoonful of root is pounded on a stone slab then mixed with a cup of water and boiled for sometime. Half a cup of decoction is drunk for the same diseases mentioned above until recovery. (c) Root is used as soap to wash face once a day in the morning which helps to remove facial hair and make the face bright once a day in the morning. (d) Infrequently the whole plant is used as fodder.

(27) Artemisia biennis Willd. (Asteraceae); V 3849; 'Chhaphong' (A). **Dist.: Asia, North America, Nepal** (WCE, 3200-4600), **Mu.** (way to Thini Gomba, 2780m).

(a) Half a spoonful of whole plant powder is mixed with two cups of water and boiled for sometime. Half a cup of decoction is drunk once a day for 'fever inside the lungs' until recovery. (b) The whole plant is used as *dhup* (incense). Two to five plants are placed on a glowing ember in the same manner that *Ajania nubigena* is used (see *A. nubigena* above). It is only used after it has been dried thoroughly in sunlight because the fresh plant does not burn well. *A. biennis* is not commonly used as incense and is perceived to be low or inferior quality when compared to other incense plants. (c) Whole plant is used as fodder in the colder seasons.

(28) Artemisia caruifolia Buch.-Ham. (Asteraceae); V 876, 4003; 'Chhaphong/Serphang, Titapathi' (A, N). **Dist.: Himalaya**, **NE India**, **Myanmar**, **China, Nepal** (WC, 3900-4600m), **Ma.** (way to Manang village from yakkharka, 3550m), **Mu.** (way to Samar village, 3635m).

(a) In Mustang, one-fourth of a spoonful of leaf and stem is boiled in two cups of water and reduced to one cup. One cup of decoction is drunk once a day for cough, cold and 'fever in the lungs' until recovery. (b) Pounded leaf paste is applied for allergies of the skin once a day before going to bed until recovery. (c) It is also used in the diseases of elephant and goat by the *amchi* but the detailed diseases and methods remain confidential to the *amchi*. (d) Whole plant is used as fodder in the colder seasons. (e) In Manang and Mustang, mature branches are used as incense in the same manner that *A. nubigena* is used (see above). It is only used after it has been dried thoroughly in sunlight because the fresh plant does not burn well. Interestingly, this species is not used by *Manangi* and *Mustangi*, because it is also perceived to be of inferior quality. It is collected by the people who have migrated to cities such as Kathmandu and Pokhara when they return back from Manang and Mustang.

(29) ***Artemisia dubia** Wall. ex Besser (Asteraceae); V 4302; 'Khangkhar' (A). **Dist.: Himalaya**, **China**, **Korea**, **Japan**, **Nepal** (WCE, 1200-3400m), **Mu.** (way to Chele from Kagbeni, 3005m).

(a) Pounded leaf paste is applied for backbone pain, allergies and skin wounds once a day before going to bed until recovery. (b) One-fourth of a spoonful of leaf paste is drunk with a cup of hot water for backbone pain once a day until recovery. (c) Mature branches are used as incense in the

same manner that *Ajania nubigena* is used (see above). Rest of the description is same to *Artemisia caruifolia* (see above). (d) Whole plant is used as fodder in the colder seasons.

(30) ***Artemisia gmelinii** Weber ex Stechm. (Asteraceae); V 203, 4133; 'Bajha, Fumungh' (G, A). **Dist.: India, China**, **Afghanistan**, **Pakistan, Nepal** (WC 2800-4300m), **Ma.** (near the Nar village, 4040m), **Mu.** (way to Chele from Samar village, 3240m).

(a) In Manang, the plant parts (leaves, stem and flowers) are collected and ground to make powder. Half a spoonful of powder is mixed with a cup of boiled water 2–3 times a day after meal to treat fever. (b) About 10g of plant parts (leaves, stem and flowers) are boiled in two cups of water and five spoonfuls of this decoction is drunk with a cup of milk 2-3 times a day after meals for fever, cough, cold and sore throat until recovery. (c) In Mustang, one spoonful of whole plant paste is boiled in a cup of water until it becomes thick (the consistency of jam). This jam-like paste is applied for nose swelling, ear pain, allergies and skin wounds once a day before going to bed until recovery. (d) One-fourth of a spoonful of paste is drunk with a cup of hot water for the same diseases mentioned above until recovery. (e) Whole plant is used as fodder in the colder seasons. (f) Mature branches are used as incense in the same manner that *A. nubigena* is used (see above). Rest of the description is same to *A. caruifolia*.

(31) Artemisia indica Willd. (Asteraceae); V 4134; 'Khambha, Khankharr' (T/G, A). **Dist.: Himalaya**, **India**, **Myanmar**, **Thailand**, **S. China**, **Japan**, **Nepal** (CE, 300-2400m), **Mu.** (near the Kagbeni village, 2810m).

(a) Half a spoonful of whole plant paste is taken with a cup of hot water for sinusitis once a day until recovery. (b) The paste is applied on the nose for sinusitis once a day before going to bed until recovery. (c) Mature branches are used as incense in the same manner that *Ajania nubigena* is used (see above). Rest of the description is same to *Artemisia caruifolia* (see above). (d) Whole plant is used as fodder in the colder seasons.

(32) Asparagus filicinus Buch.-Ham. ex D. Don **(Liliaceae);** V 1752, 2075; 'Nirshing' (G). **Dist.: Himalaya** (Kashmir to Arunachal Pradesh), **NE India** (Meghalaya, Nagaland), **Myanmar**, **Thailand**, **IndoChina**, **China**, **Nepal** (WC, 2100-2900m), **Ma.** (way to Bhratang, 2640m), **Mu.** (way to Lete, 2510m).

(a) In Manang, one spoonful of root powder is taken once a day after a meal with a cup of hot water for menstrual disorders and menstrual problems; as a tonic, to increase body size, to stop bleeding from nose, heart diseases and stomach disorders until recovery. (b) One spoonful of pounded root is mixed with two glass of milk and boiled it until it becomes one cup. The one cup of decoction is drunk once a day after a meal for the same conditions mentioned above. (c) The paste of the root is applied two times a day for skin diseases until recovery. (d) Young stems are pickled after removing the bark. This is used in lower Manang villages including Chame, Bagarchap, Dharapani. The process of pickling the stems is same for *Allium carolinianum* mentioned above. (e) In Mustang about 50g root is mixed with ¼ spoonful of *neer* color, one spoonful rice, one spoonful whole plant paste of *Cynadon dactylon*, one-fourth spoonful of Tortoise bone and two spoonfuls of *Vitis vinifera* fruits. One spoonful of the mixture is taken two times a day for pneumonia (described in appendix VII), until recovery. (f) The paste of the same mixture can be applied two times a day on joints of the body for the children for pneumonia until recovery. (g) Occasionally root is used as a substitute of soap.

(33) *__Aster diplostephioides__ (DC.) C.B. Clarke (Asteraceae); V 404, 4515; 'Mara, Motolugmick' (G, A). **Dist.:Himalaya** (Kashmir to Bhutan), **W. China**, **Nepal** (WCE, 3200-4900m), **Ma.** (near the basecamp of Gangapurna Glacier, 3600m), **Mu.** (Returning to Jomsom from pasture, 3000m).

(a) In Manang, about 10g of flower is boiled in two cups of water and one cup of the decoction is drunk two times a day after meal for cough, cold, headache and sore throat. (b) The flower is ground to a powder and half a spoonful of powder is taken with a cup of hot water two times a day after meal for for cough, cold, tonsillitis, headache, snake bite, scorpion sting, wound problems, chest pain, backbone pain, pulse pain and numbness of limbs until recovery.

(c) In Mustang, half a spoonful of powder from the flower is mixed with half a spoonful of powder of different types of confidential medicines of the Himalaya and drunk two times a day for fever, wounds, chest pain, nerves diseases, anti-poison, stomach diseases and liver diseases until recovery.

(34) Aster stracheyi Hook. f. (Asteraceae); V 404, 4438; 'Mara' (G). **Dist.: Himalaya** (Kulu to Bhutan), **Nepal** (WCE, 2900-4700m), **Ma.** (near the Gangapurna Glacier, 3620m), **Mu.** (way to Jharkot, 3210m).

(a) In Manang, about 10g of pounded flower is mixed with a cup of boiled water. Half a cup of decoction is drunk two times a day for cough and cold until recovery. (b) Half a spoonful powder (made from dried whole plant) is mixed with a cup of milk and drunk two times a day after meal for cough, cold, headache and fever until recovery.

(c) In Mustang, half a spoonful of powder of flowers is mixed with half a spoonful of powder of different types of confidential medicines of the Himalaya and drunk two times a day for fever, wounds, chest pain, nerves diseases, anti-poison, stomach diseases and liver diseases until recovery.

(35) Astilbe rivularis Buch.-Ham. ex D. Don (Saxifragaceae); V 1716, 3763; 'Bhadhangoo, Subkha' (N/D, A). **Dist.: Bhutan**, **N India**, **Indonesia**, **Kashmir**, **Laos**, **N Myanmar**, **China**, **Thailand**, **Vietnam**, **Nepal** (WCE, 2000-3600m), **Ma.** (near Koto village, 2650m), **Mu.** (way to Ghasa, 2000m).

(a) In Manang, one spoonful of ground root powder is taken with a cup of hot water or milk once a day for fever, vertigo/dizziness, headache and infertility until the patient has recovered.

(b) In Mustang, half a spoonful of root and fruit powder mixture is mixed with half a spoonful of powder mixture of 16-17 types of confidential medicine of the Himalaya. One spoonful of this powder mixture is used as digestive medicine once a day until recovery.

(36) *__Berberis angulosa__ Wall. ex Hook. f. & Thomson (Berberidaceae); V 444, 3879; 'Kyunudzu, Kerbhha' (G, A). **Dist.: Himalaya** (Nepal to Sikkim), **NE India**, **China; Nepal** (CE, 3400-4500m), **Mu.** (way to Tsarang village, 3610m).

(a) In Manang, about 15g of root is boiled on two cups of water and five spoonful of decoction is drunk 2-3 times a day after meal for cough, cold, fever and/or dysentery until recovery. (b) Half a spoonful of root powder is mixed with a cup of milk and drunk 2-3 times a day after meal for fever.

(c) In Mustang, one spoonful of flowers, leaves and root powder is taken with a cup of hot water for jaundice, eye pain, kidney diseases and bile disorders two times a day until recovered. No side

effect is seen by using this medicine and it can be used by mixing with other confidential medicines of the Himalaya. (d) Small branches are used as fuelwood in upper Mustang. (e) In Manang and Mustang, due to its thorny nature, whole plant is used to fence the agriculture fields by spreading the cut dead branches over a stone or wood wall. (f) The sweet-sour fruits are eaten raw and are said to be rich in vitamins.

(37) Berberis aristata DC. (Berberidaceae); V 279, 4464; 'Karya, Kyerwa' (G, A). **Dist.: Himalaya** (Nepal to Bhutan), **India, Nepal** (WCE, 1800-3500m), **Ma.** (way to Thorang Phedi, 3855m), **Mu.** (way to Eklebhatti, 2710m).

(a) In Manang, the decoction of the paste of flowers, leaves and bark is applied on the body for edema (swelling of the body), 2-3 times a day until recovery. (b) One-two drops of filtered decoction of flower is put on the eye for eyes diseases (eye infection i.e., eye pain and conjunctivitis), until recovery. (c) In Mustang, fruits are eaten raw for bile disorders and are eaten raw regularly to increase 'blood filtration' and 'blood circulation'. (d) One cup of fruit is cooked in two cups of water and reduced to one cup. Half a cup of this decoction is drunk two times a day after meal for diarrhea, dysentery, jaundice and eyes diseases (defined in appendix VII), and other diseases associated with eye until recovery. (e) The inside bark of the root and stem is yellow and juice made from it is filtered and used for eye diseases and other diseases associated with eye twice a day until recovery. (f) Fruit is also considered as a substitute of red fruit called red Phyllanthus (*Amala*) or 'Himalayan *Amala*'. (g) Small branches are used as fuelwood in upper Mustang. (h) In Manang and Mustang, the method of use for fence and raw edible is same as described in *Berberis angulosa*.

(38) Berberis ceratophylla G. Don (Berberidaceae); V 447, 4446; 'Kyerpa' (G). **Dist.: Himalaya** (Nepal to Bhutan), **Myanmar, Nepal** (CE, 1800-4000m), **Ma.** (way to Hongde from Manang, 3335m), **Mu.** (way to Kagbeni, 2810m).

(a) About 10g of pounded bark is mixed with two cups of boiled water and 10 spoonfuls of decoction is mixed with a cup of milk and taken 2-3 times a day for fever. (b) Bark is ground to make a powder. Half a spoonful of powder is mixed with two spoonfuls of chauri-ghee two times a day for fever. (f) The method of use for fence and raw edible is same as described in *Berberis angulosa*.

(39) ***Berberis koehneana** C.K. Schneid. (Berberidaceae); V 3874; 'Kerwa' (A). **Dist.: Himalaya** (Uttar Pradesh to Nepal), **Nepal** (WC, 2500-3200m), **Mu.** (way to Ghemi from Syangboche, 3470m).

(a) Half a spoonful of stem powder is taken with a cup of hot water for eye diseases and bile diseases (defined in appendix VII) two times a day until recovery. (b) Flowers and fruits are eaten raw. (c) Due to its thorny nature, whole plant is used to fence the agriculture fields by spreading the cut branches over a stone or wood wall. (d) Small dried branches are used as fuelwood in upper Mustang.

(40) Berberis lycium Royle (Berberidaceae); V 358, 4000; 'Matimru, Kirmuree phaal' (G, A); **Dist.: Himalaya** (Kashmir to Nepal), **Nepal** (E, 1800-2900m), **Ma.** (way to Chame from Bhratang, 2605m), **Mu.** (way to Chele from Kagbeni village, 3905m).

(a) In Manang and Mustang, the method of use for fence and raw edible is same as described in *Berberis angulosa*.

(b) In Mustang, half a spoonful of stem paste (yellow in color) is put on the painful part of the hand, leg or body once a day for edema, nerve dispersed conditions (nerves not being in their original place or original shape) in the body until recovery. After applying the paste outside in the skin swollen parts and nerve dispersed parts, the body feels hot and blisters develop. These side effects are known, but the treatment is considered safe and stops the pain. (d) Small dried branches are used as fuelwood in upper Mustang.

(41) ***Berberis mucrifolia** Ahrendt (Berberidaceae); V 4213; 'Kerwa' (A). **Dist.: Nepal** (WCE, 2100-4500m), **Mu.** (way to Kagbeni from Chele village, 2815m).

(a) Half a spoonful of flowers, fruits and stem powder is boiled in a cup of water and half a cup of decoction is drunk two times a day for kidney diseases and bile disorders once a day until recovery. (b) The method of use for fence and raw edible is same as described in *Berberis angulosa*. (c) Small dried branches are used as fuelwood in upper Mustang.

(42) Bergenia ciliata (Haw.) Sternb. (Saxifragaceae); V 1618, 2476; 'Pakhanved, Khadur' (G/N, A). **Dist.: Himalaya** (Afghanistan to S.E. Tibet), **Nepal** (WC, 1600-3200m), **Ma.** (way to Chame pasture, 4010m), **Mu.** (way to goatshed of the Larjung village, 2580m).

(a) In Manang and Mustang half a spoonful of ground root powder is taken with a cup of hot water/milk two times a day after meals for diarrhoea, dysentery, stomachache, blindness, as a digestive agent or to treat liver diseases and bile disorders until recovery.

(b) In Mustang, half a spoonful of root paste is given with a cup of hot water for diarrhea, and dysentery once a day until recovery. (c) About 250g of root is given by mixing with fodder for animals to treat red coloured urine once a day until recovered.

(43) Betula utilis D. Don (Betulaceae); V 227, 3529; 'Buspath' (G). **Dist.: Himalaya, W. China; Nepal** (WCE, 2700-4300m), **Ma.** (way to Khuli goatshed, 3740m), **Mu.** (Samar forest, 3690m).

(a) In Manang, bark and leaves are ground to make powder and mixed with other different medicinal plants of the Himalayas (confidential mixture because they mix many kinds of plants). Half a spoonful of powder is mixed with two spoonfuls of cow ghee and taken two times a day for fever until recovery. (b) The *lama*[9] uses the outer covering of bark to write *chena*[10]. People show *chena* to the *lama* to have their horoscope read. The *lama* then interprets the present status, future luck and past luck of the person from the *chena*. (c) As well, the *amchi* or *lama* may place various kinds of medicine (confidential medicinal plants and or minerals) inside the bark of *Betula utilis* and tie the small package with a thread. This is then used as *buti*[11] on the arms to help the person recover from a 'ghost-attack'. The person becomes physically ill at the time of a ghost-attack but no details regarding the exact presentation were given by the *lamas* or *amchis*. It is said that the *buti* will protect a person from being attacked by a ghost while it is worn. The *buti* can be changed after one month or one year or can be worn forever. (d) The wood of *Betula utilis* is also used as a sacred fuel. In Manang, when people die they are sometimes cremated (see body of text for more detail) and the wood of *Betula utilis* is the major source of wood for the ritual cremation fire.

[9] *Lama*: Traditional religious healer, or priest.

[10] *Chena:* Sacred writing, or horoscope, where the person's present, past and future luck or fortune, birth place, present age, predicted age of death, and future events.

[11] *Buti*: A small package containing medicinal plants and other confidential materials covered with black cloth which is then tied by a thread to the arm, waist or neck.

(e) In Manang and Mustang, the plant is a good source of fuelwood and is said to give good burn in comparison to the others fuelwood. It is ranked first in Manang and third (fuelwood) in Mustang by the local people. In Mustang it is ranked third due to its low availability. (f) Wood is used to make chopping boards and other household articles. It is said that the wood is not affected by water, so it is also used in constructions of roofs and bridges.

(g) In Mustang, small cut branches are used as fence in the crop field.

(44) ***Bistorta affinis** (D. Don) Greene (Polygonaceae); V 231, 3129; 'Khaldi' (G). **Dist.: Afghanistan, Himalaya** (Kashmir to Nepal), **China** (Xizang); **Nepal** (WCE, 3500-4800m), **Ma.** (above the Khuligoatshed, 4300m), **Mu.** (Tsarang pasture, 3840m).

(a) In Manang, the root is collected and pounded on a stone slab. About 10g of this pulverized root is boiled with a cup of water and half a cup of the decoction is drunk 2-3 times a day for cough, cold, tonsillitis and fever until recovery. (b) The root is ground to powder and half a spoonful of powder is mixed with a cup of boiled water and drunk 2-3 times a day for the same diseases mentioned above until recovery.

(c) In Mustang, about half a spoonful of root and half a spoonful of flower powder is mixed and boiled in two cups of water. Half a cup of decoction is drunk two times a day for diarrhea until recovery. The root and flower powder quickly stops diarrhea. (d) About half a spoonful of root and half a spoonful flower powder is mixed and taken with a cup of milk once a day to increase blood in the period of blood deficiency (defined in appendix VII) in the body.

(45) ***Bistorta macrophylla** (D. Don) Sojak (Polygonaceae); V 132, 3069; 'Khaldhi' (G). **Dist.: Himalaya, NE India, W. & C. China, Nepal** (WCE, 2700-4500m), **Ma.** (near the Gangapurna glacier forest, 3650m).

(a) About 10g of root is pounded on a stone slab and mixed with a cup of boiled water. Five spoonfuls of this decoction is mixed with a cup of milk and drunk two times a day for typhoid fever until recovery. (b) The root is ground to make powder. Half a spoonful of powder is taken with a cup of boiled water 2-3 times a day after meal for typhoid fever until recovery. (c) In the past, seeds (after proper ripening) were ground to make a powder, which was used to make bread in times of food scarcity.

(46) Bupleurum longicaule Wall. ex DC. (Apiaceae); V 764; 'Mirmire' (G). **Dist.: Himalaya** (Kashmir, Uttar Pradersh, Nepal, Bhutan, Arunanchal Pradesh), **China** (Xiang, Yunan), **Nepal** (WCE, 3000-4900m), **Ma.** (way to Manang yakkharka, 4110m).

(a) About 10g of flowers and seeds were boiled in two cups of water and one cup of the decoction is drunk two times a day for cough, cold and tonsillitis until recovery.

(47) Cannabis sativa L. (Cannabaceae); V 509, 3584; 'Kantsya, Bhango' (G, Ti). **Dist.: C Asia; Nepal** (WCE, 200-3150m), **Ma.** (Hongde to Pisang, 3150m), **Mu.** (Jharkot to Mukthinath, 3265m).

(a) In Manang, a pinch of flower and seed powder is taken with a cup of boiled water for stomachache, constipation or urinary tract infection (defined in appendix VII). An overdose of this tea will cause vertigo/dizziness and headache.

(b) In Mustang, about one-forth of a spoonful of seed powder is mixed with one-forth of a spoonful of leaves and mixed with tobacco from cigarette. This is then rolled into a cigarette and smoked for gastritis and constipation once a day until recovery.

(c) In Manang and Mustang, seeds are used in different food items in festivals and also pickled. (d) Parts of the plants are smoked. Seeds and flowers are dried in sunlight and then mixed with tobacco from a cigarette by rubbing the *Cannabis* and the tobacco together in the palm of the hand, with the thumb. Once thoroughly mixed, the cigarette is re-rolled and smoked for enjoyment/psychoactive properties.

(48) ***Caragana brevispina** Royle (Fabaceae); V 4135; 'Momosing, Thangchhar' (G, A). **Dist.: Himalaya** (Kashmir to Nepal), **Nepal** (WC, 2400-3200m), **Mu.** (way to Chele village, 3049m).

(a) In Manang, half a spoonful of stem powdered is taken two times a day after meal for cough, cold, skin diseases, heart pain or defects in vision until recovery.

(b) In Mustang, half a spoonful of flower paste is drunk with a cup of hot water for blood diseases (any blood diseases), as a blood purifier, for liver diseases, 'diseases due to urine infection', rib pain and as a tonic once a day until recovery. (c) The paste of the flowers is used in allergy (same as described above) once a day until recovery. (d) Popularly called as *Santalum album* of the Himalayas; Flowers are used as substitute of *Santalum album*. (e) Cut whole plants are used as fence in the agriculture fields and fuelwood in upper Mustang. (f) Leaves and flowers are used as fodder and browsed by goat/sheep in upper Mustang.

(49) Caragana gerardiana Royle (Fabaceae); V 4405; 'Tanglikhtha' (A). **Dist.: Himalaya** (Uttar Pradesh, Nepal), **Nepal** (WC, 3200-4200m), **Mu.** (way to Kobang village, 2625m).

(a) Half a spoonful of flower and fruit is pounded on stone slab and taken with a cup of hot water for fever until recovery. (b) Uses of fence, fuelwood and fodder are same as described in *C. brevispina*.

(50) Caragana jubata (Pall.) Poir. (Fabaceae); V 4041; 'Thanglang, Bhaa' (T, A). **Dist.: Central Asia, Himalaya** (Nepal to Bhutan), **Tibet, China, Mongolia, Siberia, Nepal** (C, 3300-4400m), **Mu.** (way to Chele, 3110m).

(a) Local people belief in increasing sexual desire when flower is eaten raw. (b) Flowers are sweat and eaten raw or by mixing with honey. (b) Uses of fence, fuelwood and fodder are same as described in *C. brevispina*.

(51) Carum carvi L. (Apiaceae); V 225, 4468; 'Chir' (G). **Dist.: Karakorum**, **Himalaya** (Kashmir to Bhutan), **Tibet**, **Nepal** (WC, 2500-5100m), **Ma.** (way to Khuli goatshed, 3750m), **Mu.** (way to Jomsom pasture, 2810m).

(a) About 20g of seeds are pounded on stone slab and boiled it on one cup of water and half a cup of decoction is drunk two times a day for cough, cold until recovery. (b) About 10-30 seeds are boiled in mustard oil and massaged on the head for headache and when the body feels cold. It is mostly used for infants less than a year old.

(52) ***Chenopodium foliolosum** (Moench) Asch. (Chenopodiacece); V 4459; 'Nihaue' (A). **Dist.: Europe, N. Africa, W. & C. Asia, Himalaya, Nepal** (C, 2600-3800m), **Mu.** (way to Kagbeni village, 2780m).

(a) About, 5-10 fruits are boiled in two cups of water and reduced to a cup. Half a cup of decoction is drunk once a day for edema, and to draw out water from swollen parts of the body until recovery. (b) Leaves are used as vegetables and the detailed method of preparation is same as described above in *Allium* species. (c) Red fruits are eaten raw.

(53) Cicerbita macrorhiza (Royle) Beauv. (Asteraceae); V 305; 'Mendho' (G). **Dist.: N. Pakistan**, **Himalaya** (Kashmir to Bhutan), **Myanmar**, **China** (Xizang, Yunnan), **Nepal** (WCE, 1300-4500m), **Ma.** (way to Khangshar from TilichoLake, 3910m).

(a) Half a kg of root is cooked with 1 kg of wheat flour for half an hour with 10L of water and given to the animals for fever one time a day until recovery.

(54) ***Cirsium wallichii** (Hook. f.) Petr. (Asteraceae); V 4528; 'Thaikhailo, Chyangsher' (N, A); **Dist.: Himalaya** (Nepal to Bhutan), **Nepal** (C, 2200m), **Mu.** (way to Larjung pasture, 2920m).

(a) The paste of the whole plant is used on (edema) swollen part of legs, hand, mouth and wounds once a day until recovery. (b) About 5-6 spoonfuls of pounded root is mixed with 100g black sugar cube, 5 spoonfuls of pounded root of *Musa sapientum*, half a kg of curd and the mixture is put outside the house in shade by covering with lid. The mixture is then taken early in the morning for painful urination, to stop excessive urination, on an empty stomach once a day regularly until recovery. The patients get recovered after the dose of two-three days.

(55) ***Cissampelos pareira** L. (Menispermaceae); V 3791; 'Aalungh, Aalunkha' (T, G). **Dist.: Pantropical, Nepal** (WCE, 150-2200m), **Mu.** (near the Ghasa village, 2010m).

(a) Half a spoonful of root juice is taken with a cup of hot water two times a day in the morning and evening for gastritis and constipation until recovery.

(56) Clematis barbellata Edgew. (Ranunculaceae); V 168, 2766; 'Laharajhar, Kramay' (N, G). **Dist.: Himalaya** (Kashmir, Uttar Pradesh, Nepal), **Nepal** (WC, 3000-3200m), **Ma.** (way to Kyeng from Dharmasala, 3280m), **Mu.** (way to Jharkot goatshed, 3480m).

(a) In Mustang, leaf, stem and flower are pounded on stone slab and about 50g is boiled in two cups of water and reduced to a cup. One cup of decoction is drunk two times a day for jaundice until recovery.

(b) In Manang, the leaf and flower paste is applied around boils, scabies, cuts, wounds, fracture of hand and leg and massages to relieve back pain and 'waist' pain once a day until recovery. (c) Half a spoonful of leaf and flower powder is taken two times a day after meal for cough, cold and body pain until recovery.

(d) In Manang and Mustang, whole plant is used as fodder (during snowy seasons) at the time of scarcity of other fodder in that area. It is cut and stored for use in snowy seasons. At the periods of snow this is used for the cattle because no other stored grass is left.

(57) Clematis tibetana Kuntze (Ranunculaceae); V 501, 3114; 'Damongnakyo' (G); **Dist.: Himalaya** (Uttar pradesh), **China; Nepal** (CE, 1700-4500m), **Ma.** (way to Manang village from Hongde, 3425m), **Mu.** (Samar village, 3650m).

(a) In Manang, half a spoonful of ground powder of leaves, stems and flowers are taken with a cup of hot water two times a day for cough, cold and tonsillitis until recovery. (b) The paste of the plant parts (leaves, stems and flowers) are applied on wounds two times a day until recovery.

(b) In Mustang, leaf is pounded on stone slab and half a spoonful of paste is drunk with a cup of hot water once a day for constipation, feeling higher level of heat inside the body and liver diseases until recovery.

(c) In Manang and Mustang, whole plant is used as fodder during snowy seasons at the time of scarcity of other fodder in that area. It is cut and stored for use in snowy seasons. At the periods of snow this is used for the cattle because no other stored grass is left.

(58) *__Clematis vernayi__ C. Fischer (Ranunculaceae); V 4533; 'Yaawaangmaa' (A). **Dist.: C. & S. Tibet, Nepal** (WC, 1800-4000m), **Mu.** (way to Chele from Jomsom, 3005m).

(a) About, one spoonful of whole plant paste is boiled in two cups of water and a cup filtrate decoction is drunk for gastritis once a day until recovery. (b) Leaf paste is used for warts once a day until recovery. (c) Whole plant is used as fodder (during snowy seasons) at the time of scarcity of other fodder in that area. It is cut and stored for use in snowy seasons. At the periods of snow this is used for the cattles because no other stored grass is left.

(59) *__Clinopodium umbrosum__ (M. Bieb.) K. Koch (Lamiaceae); V 209, 4358; 'Sarshang, Nemayahuuloo/Yauckhching' (G, A). **Dist.: Iran, Afghanistan, Chitra, Pakistan, Himalaya** (Kashmir to Bhustan), **India, Burma, Ceylon, Tibet, China, Taiwan, Malaysia**, **Nepal** (WCE, 1800-3400m), **Ma.** (way to Ngawal from Nar, 4620m), **Mu.** (near the Kobang village, 2630m).

(a) In Manang, the plant parts (leaves, stems and roots) are ground to make powder. Half a spoonful of powder is put on red fire coal and the scent is smelled by the person affected from paralysis, high blood pressure, pain and inflammation of body and difficulty moving hands and legs (but not paralysis) two times a day until recovery.

(b) In Mustang, half a spoonful of whole plant paste or powder is used with a cup of hot water for gastritis and joints bone fractures once a day until recovered.

(60) *__Convolvulus arvensis__ L. (Convolvulaceae); V 4398; 'Shulughawaniwa' (A). **Dist.: Temperate regions, Nepal** (WC, 2600-4100m), **Mu.** (near the Tucukhe village, 2935).

(a) Half a spoonful of whole plant paste is boiled with a cup of hot water and drunk two times a day for cough, cold, typhoid fever and 'disease of air or wind' (defined in appendix VII) until recovery. (b) Used as fodder in lower Mustang.

(61) Cordyceps sinensis (Berk.) Sacc. (Clavicipitaceae); V 518, 3333; 'Yarsagumba, Jibanbhuti' (A/G, T/N). **Dist.: Himalaya** (China, India, & Nepal), **Ma.** (Nar pasture, 4733), **Mu.** (way to Kobang pasture, 3643).

(a) In Manang, half a spoonful of 'Yarsagumba' powder (from dried whole plant) is mixed with a cup of milk or honey and used during the periods of weakness when taking the 'antibiotics' (*Aconitum naviculare, Neopicrorhiza scrophulariiflora*) of that area as a tonic once a day until recovery. (b) Half a spoonful of 'Yarsagumba' powder (made from dried whole plant) + half a spoonful of *Dactylorhiza hatagirea* powder (made from root) + half a cup of honey or milk is mixed and used as tonic during enervate periods. (c) One piece of 'Yarsagumba' is put in one cup of local home made alcohol and drunk continuously in the morning and evening by male as a tonic (they believe that it serves as tonic).

(d) In Mustang, one whole plant is cooked in two cups of milk and drunk during periods of fatigue and low energy once a day until recovery. (e) *Amchi* has been using it in traditional medicine as a source of tonic since 100 years. It is used to increase sexual power. *Amchi* advised some strict rules to prepare tonic and patients needs thorough check up to know dosage. Tonic can be made by mixing with ghee. The dosage can be changed according to the age of the patients. The mixture becomes the consistency of jam over time, and takes a lot of time, labor and costs. *Amchi* do not want to share their knowledge about this confidential procedure. One bottle of this medicine costs approximately NRs. 5000-6000. It is necessary to take 40 to 50 bottles of this medicine regularly for a complete recovery.

(62) ***Corydalis govaniana** Wall. (Papaveraceae); V 4318; 'Longshill' (A). **Dist: Himalaya** (Kashmir to Nepal), **Nepal** (WCE, 3000-4800m), **Mu.** (way to Kobang pasture, 2810m).

(a) Half a spoonful paste from whole plant is mixed with two cups of water and boiled reducing to a cup. One cup of a filtrate decoction is drunk two times a day for tonsillitis, fever, bile disorder and allergy until recovery.

(63) ***Cupressus torulosa** D. Don (Cupressaceae); V 4301; 'Ghueejhokphha, Shukphha' (T/G, A); **Dist.: Himalaya** (Kashmir to Nepal), **Nepal** (WC, 1800-3300m), **Mu.** (bridge of Jomsom, 2715m).

(a) Half a spoonful of fruit powder is taken with a cup of milk or hot water two times a day for bodyache, leg pain and sinusitis until recovered. (b) One-forth of a spoonful of fruit powder is put on infected part of the teeth for gingivitis once a day until recovery. (c) Fruit paste is applied around the infected part of mouth during mouth swelling once a day until recovered. (d) The *amchi* also prepares pills medicine for the same diseases mentioned above. (e) Small cut branches with fruits are used as decoration materials by displaying them in the table. (f) Wood is used as fuelwood. (g) Small cut branches are used as fence in the cultivated fields. (h) The whole plant is used as incense. Five to ten small branches are placed on a glowing ember in the same manner that *A. nubigena* is used (see above *Ajania nubigena* and *Juniperus indica* below for detail). *Cupressus torulosa* is said to be of good quality and ranked second after *Juniperus* species.

(64) ***Cynanchum canescens** (Willd.) K. Schum. (Asclepiadaceae); V 983; 'Dhugmoyung' (G). **Dist.: SW Asia, Pakistan, Afghanistan, Himalaya** (Kashmir, Nepal, Bhutan), **India, China** (Sichuan, Xizang, Yunnan), **Russia, Nepal** (WC); **Ma.** (way to Chame from Pisang, 2775m).

(a) Half a spoonful of ground powder (made from leaves and flowers) is taken with a cup of boiled water 2-3 times a day for cough, cold, diarrhoea, dysentery, kidney diseases, fever and stomachache until recovery. (b) Two to four drops of the fresh juice of the flowers and seeds are put on ear for ear pain 2-3 times a day until recovery.

(65) Cynoglossum zeylanicum (Vahl ex Hornem.) Thunb. (Boraginaceae); V 233; 'Thina' (G). **Dist.: Afghanistan**, **Himalaya** (Kashmir to Bhutan), **India**, **Ceylon**, **East to China** and **Japan**, **Malaysia**, **Nepal** (WCE, 1200-4100m), **Ma.** (near the Khuli goatshed, 3930m).

(a) Flowers are pounded on a stone slab and the paste is applied around boils. It helps to draw out pus and quickens the healing process.

(66) Dactylorhiza hatagirea (D. Don) Soo (Orchidaceae); V 362, 3839; 'Panchaaule, Lovha' (G, A). **Dist.: Pakistan, Himalaya** (Kashmir to Bhutan), **China** (Xizang), **Nepal** (WCE, 2800-3960m), **Ma.** (Chame pasture, 3550m), **Mu.** (way to Kalopani yakshed, 2970m).

(a) In Manang, the paste of the root is applied around boils, cuts, wounds, burns, scabies, ringworm, snake and scorpion stings once a day until recovery. (b) Half a spoonful of root powder of *Dactylorhiza hatagirea* is mixed with half a spoonful powder of *Cordyceps sinensis* made from whole plant and then mixed both powder again with a cup of honey or milk. This can be used as a general health tonic once a day until recovery.

(c) In Mustang, half a spoonful of root paste is mixed with one-forth of a spoonful powder of horn of *Moschus chrysogaster*, half a spoonful urine of *Moschus chrysogaster* and taken with a cup of hot water at the time of 'snake diseases' (defined in appendix VII) and after a snake bite once a day until recovery.

(67) Datura stramonium L. (Solanaceae); V 4377; 'Dhuglomaa, Thangthungkarpoo' (D/T, A). **Dist.: Tropical America, Nepal** (WCE, 200-2200m), **Mu.** (way to Tuckhe village, 2910m).

(a) Fruit is use in sinusitis by the *amchi* and the method of use is confidential. It is poisonous and humans using it without supervision can become incoherent and die. (b) Fruits are poisonous and make man mad when eaten. (c) Roasted seeds are used in different food items and also pickled by Thakali in lower Mustang. (d) Few seeds are smoked infrequently mixed with tobacco from a cigarette by rubbing the seeds and the tobacco together in the palm of the hand with the thumb. Once thoroughly mixed, the cigarette is re-rolled and smoked for enjoyment/psychoactive properties.

(68) ***Delphinium brunonianum** Royle (Ranunculaceae); V 408; 'Ponmar' (G). **Dist.: Afghanistan, Himalaya** (Kashmir, Uttar Pradesh, Nepal), **China** (SE Xizang); **Nepal** (WC, 3500-6000m), **Ma.** (above the goatshed of Khangshar pasture, 4510m).

(a) About 10g of whole plant is boiled in two cups of water and half a cup of decoction is drunk two times a day after meal for jaundice and fever until recovery.

(69) ***Delphinium stapeliosum** Bruhl ex Huth (Ranunculaceae); V 259; 'Ponmar' (G). **Dist.: NE India** (Meghalaya), **N. Myanmar, Nepal** (WCE, 1200-3000m), **Ma.** (near Thorang Phedi, 3710m).

(a) About 10g of pounded whole plant is mixed with two cups of water, then five spoonful decoction is mixed with a cup of milk two times a day after meal for fever (typhoid, malaria) and jaundice. It acts as an antibiotic, and is said to result in a lack of energy in the patient. So it is necessary to take vitamin or tonic (Yarsagumba + Lovha). (b) Half a spoonful of powder (made from whole plant) is mixed with three spoonful of Chauri ghee and taken two times a day after meal for fever.

(70) ***Descurainia sophia** (L.) Webb ex Prantl (Brassicaceae); V 4447; 'Khangyoo, Kaphoo' (A). **Dist.: Europe**, **N. Africa**, **W. & C. Asia**, **Himalaya, Nepal** (WC, 2200 – 4100m), **Mu.** (way to Kagbeni village, 2800m).

(a) Half a spoonful of whole plant powder is taken with a cup of hot water for cough and cold two times a day until recovery.

(71) Dicranostigma lactucoides Hook. f. & Thomson (Papaveraceae); V 232, 4417; 'Rhafendhi, Khumangh' (G, A). **Dist.: Himalaya to Uttar Pradesh**, **Nepal** (WC 2700-4000m), **Ma.** (near the Khuli goatshed, 3890m), **Mu.** (Tuckhe to Kobang, 2740m).

(a) In Manang, about 500g, root is collected and pounded on stone slab. It is cooked by mixing it with wheat flour and rice for 15 minutes and then given to the animals which are going to have a baby to quicken labour and delivery.

(b) In Mustang, half a spoonful of flowers and leaves are pounded in stone slab and drunk with a cup of hot water once a day for bile disorder, headache and diuretic until recovery. The medicine will be in good quality if mixed with 5 to 9 other medicinal plants of the Himalaya. (c) *Amchi* also prepares pills or use juice from flower and leaf which reduces fat in blood and thins the blood when the patient has trouble with blood coagulation. It is prepared by mixing with other 5 to 9 confidential medicinal plants of the Himalaya. The pills or juice is taken with a cup of hot water three times a day until recovery and considered without side effect and use after eating something.

(72) Elsholtzia eriostachya (Benth.) Benth. (Lamiaceae); V 776; 'Thupme, Chirukgherna' (G, A). **Dist.: Himalaya** (Kashmir to Bhutan), **India**, **China, Nepal** (WCE 3000-4800m), **Ma.** (way to Manang, 3550m).

(a) About half a spoonful of ground powder (made from leaves, stem and flowers) is taken with a cup of hot water 2-3 times a day for stomachache until recovery. (b) The paste (made from leaves, stem and flowers) is applied on wounds, boils and other skin diseases two times a day until recovery. (c) About one-forth of a spoonful of powder (made from dried leaves, stem and flowers) is applied on an infected tooth once a day before going to bed until recovery.

(73) Ephedra gerardiana Wall. ex Stapf (Ephedraceae); V 163, 4208; 'Somalatha, Chhayaa' (G, A). **Dist.: Himalaya** (Nepal to Bhutan); **Nepal** (WCE, 2300-5200m), **Ma.** (way to Phoo village from Dharmasala, 3260m), **Mu.** (way to Chhuksang village, 2910m).

(a) In Manang and Mustang, root is ground to make powder. Half to one spoonful of powder is drunk with a cup of boiled water 2-3 times a day after meal for respiratory diseases, i.e., asthma, bronchitis, to reduce sound production (wheezes or stridor) during breathing, cough, cold, diuretic, dysuria, to stop sweating, chest pain, vertigo/dizziness, headache and high altitude sickness problems until recovery.

(b) In Manang, the root paste is applied in cuts and wounds two times a day until recovery. (c) About 20g of pounded root is mixed with two cups of water and boiled. Half a cup of decoction is drunk two times a day for body pain, bone pain, cough, cold, diuretic, dysuria, to stop sweating, high altitude sickness problems and asthma. For the treatment of these diseases it is often mixed with other different kinds of medicine such as *Cordyceps sinensis*, and/or honey in equal amounts. (d) In Mustang, root is pounded on stone slab. About two spoonfuls of root powder is mixed with a cup of hot or cold water and then filtered. Two spoonful filtrate for old people and three spoonfuls for young people is drunk three times a day after having meal or breakfast for the same diseases mentioned above until recovered. An over dose may be dangerous and more water is needed by the patients because it increases thirst, but the dosage can be increased according to the age and stage of the diseases. (e) Half a spoonful powder from whole plant is used with a cup of hot water for bleeding from the nose, cuts, wounds and gastritis two times a day until recovery. (f) The paste from whole plant is applied in cuts and wounds once a day until recovery. (g) Used as fodder in upper Mustang. (h) Occasionally during the scarcity of other fuelwood in upper Mustang, cut dried whole plant is used as fuelwood in the snowy seasons.

(74) ***Erysimum hieraciifolium** L. (Brassicaceae); V 2397; 'Pihili Phool' (N). **Dist.: Europe, Caucasus, C. Asia, Himalaya, Mongolia, Siberia, Nepal** (WCE, 1600-3800m), **Mu.** (way to Kalopani village, 2500m).

(a) About one spoonful of pounded whole plant is boiled in two cups of water and a cup of decoction is drunk three times a day for fever (all types of fever) until recovery.

(75) ***Euphorbia longifolia** D. Don (Euphorbiaceae); V 983; 'Dhurbi, Si' (G, A). **Dist.: Nepal** (WCE, 1700-2900m), **Ma.** (way to Chame from Pisang, 2770m).

(a) About one-forth of a spoonful of root powder is taken with a cup of boiled water one time a day after meal at night for cough, cold, fever and/or sinusitis until recovery. (b) The decoction of root is applied on the infected part of the body for skin diseases one time a day at night until recovery.

(76) Fragaria nubicola Lindl. ex Lacaita (Rosaceae); V 228, 2859; 'Shafaltang, Shagi' (G, A). **Dist.: Afghanistan, Bhutan, Kashmir, Myanmar, Pakistan, Sikkim, Nepal** (WCE, 1600-4000m), **Ma.** (Manang to Khuli goatshed, 3630m), **Mu.** (above the Mukthinath temple, 3420m).

(a) In Manang, about 20g of whole plant parts is pounded on stone slab and boiled it with two cups of water. Half a cup of decoction is drunk two times a day for menstrual disorders such as heavy periods (menorrhagia), cough, cold, veins pain, edema (swelling of the body) and numbness of limbs until recovery. (b) One-forth of a spoonful of powder (made from whole plant) is taken two times a day after meal for the same diseases mentioned above. (c) To obtain juice, ripe fruits are squeezed through cloth into a clean pot. Old people, who cannot eat the fruit because the seeds become lodged in their teeth, will drink the juice which is said to be highly nutritious.

(d) In Mustang, fruit is eaten raw for diarrhea until recovery. (e) About half a cup juice is extracted from fruits and given to old people for diarrhea two times a day until recovery.

(f) In Manang and Mustang, fruits are considered delicious and eaten once ripe.

(77) ***Galium boreale** L. (Rubiaceae); V 198; 'Mara' (G). **Dist.: Pakistan to Himachal Pradesh, Temperate Eurasia, N. America,** (2100-3600m), **NC Nepal, Ma.** (near Phoo Monestary, 4100m).

(a) The paste of whole plant parts is applied around boils and is said to remove pus and quicken the healing process two times a day until recovery.

(78) Gentiana robusta King ex Hook. f. (Gentianaceae); V 218; 'Kiyce, Kicchakarba' (G, A). **Dist.: Himalaya** (Sikkim), **Nepal** (C, 3200-4000m), **Ma.** (way to Chame from Pisang, 2780m).

(a) About 10g of leaves and flowers is boiled on two cups of water and half a cup of decoction is drunk two times a day after meals for stomachache, fever and edema (swelling of the body) until recovery. (b) The paste of flowers is applied on cuts, wounds, boils and edema (swelling of the body) two times a day until recovery. (c) Plant is collected with its root and put inside a vase or water bottle with water for decoration.

(79) Geranium donianum Sweet (Geraniaceae); V 308; 'Kagheshurti' (G). **Dist.: Himalaya** (Nepal to Bhutan), **China** (Xizang), **Nepal** (WCE, 3200-4800m), **Ma.** (way to Khangshar from Tilicho Lake, 3850m).

(a) Plant part (leaves and flowers) are collected, rubbed in the palm of the hand by the thumb and put in a smoking 'hukkha' (pipe). The smoke of the 'hukkha' is taken twice a day for gingivitis, toothache and to reduce the pain in the teeth.

(80) ***Gynura nepalensis** DC. (Asteraceae); V 349; 'Mendho' (G). **Dist.: Himalaya** (Kashmir to Bhutan), **Assam, Burma, Thailand, China, Nepal** (WCE, 250-3100m), **Ma.** (way to Pisang from Hongde, 3035m).

(a) Fresh latex of the plant can be used to stop bleeding of fresh cuts. The latex cannot be stored and is used fresh each time.

(81) Halenia elliptica D. Don (Gentianaceae); V 4235; 'Shekwahooha/Tikthha, Jackthick' (G/T, A). **Dist.: W. Asia, Himalaya,** (Uttar Pradesh to Bhutan), **NE India, Myanmar, N. & W. China, Nepal** (WCE, 2000-4500m), **Mu.** (Eklebhatti village, near the bank of river, 2750m).

(a) Half a spoonful of whole plant parts is pounded on stone slab and ground to make powder. It is then boiled with a cup of water. Half a cup of decoction is drunk two times a day to maintain the nerve pulse, bile disorders and fever from bile until recovery.

(82) ***Hedychium ellipticum** Buch.-Ham. ex Sm. (Zingiberaceae); V 3798; 'Kachur' (N). **Dist.: Himalaya** (Uttar Pradesh to Bhutan), **NE India, Nepal** (WCE, 300-3100m), **Mu.** (near the agriculture field of Kalopani village, 2500m).

(a) About half a cup of root paste is drunk with a cup of hot water three times a day for rib pain and during difficult breathing until recovery. (b) Root paste is applied externally to the painful rib once a day until recovery.

(83) Heracleum candicans Wall. ex DC. (Apiaceae); V 506, 2908; 'Tokar' (G). **Dist.: Himalaya** (Kashmir to Bhutan), **Tibet, Yunnan**, **Nepal** (WCE, 2200-3800m), **Ma.** (way to Braka from Munji, 3350m), **Mu.** (way to Samar village, 3640m).

(a) In Manang, about 10g of root is boiled on two cups of water and half a cup of decoction is drunk two times a day after meal to reduce blood pressure, bone diseases, stomachache, diarrhoea, dysentery and joint pain until recovery. (b) Half a spoonful of root powder is mixed with a cup of water and taken two times a day after meal for the same diseases mentioned above. (c) The paste of the root is applied for wounds, boils, skin diseases and blisters two times a day until recovery.

(d) In Mustang, about four spoonfuls seeds are boiled in two cups of water and reduced to a cup. Half a cup of decoction is drunk two to three times a day for cough, cold, during periods of fatigue and low energy until recovery.

(84) Hippophae salicifolia D. Don (Elaeagnaceae); V 1735, 2095; 'Tarbu, Cheeche' (G, T). **Dist.: Himalaya** (Punjab to Bhutan), **China**, **Nep**al (WC, 2200-3500m), **Ma.** (way to Koto from Chame, 2640m), **Mu.** (way to Sekung Taal, 2600m).

(a) In Manang, half a cup of fruit juice extract is mixed with one cup of water and drunk two times a day for cough, cold, chest pain, stomachache, diarrhoea, dysentery, worms, rheumatism and gastritis. (b) About one cup of fruit is boiled on two cups of water and reduced it to a cup and half a cup of decoction is drunk two times a day until recovery for the same diseases mentioned above.

(c) In Mustang, about one cup of fruit is boiled with two cup of water until it is reduced to a cup. Half a cup of decoction is drunk during periods of low energy once a day until recovery. (d) It is most popular juice in Mustang because large amount of *H. salicifolia* forest is in lower Mustang and the local people have been using the fruits to prepare juice. The juice is taken after boiling or without boiling. It is considered very tasty and energetic. (e) The wood is used as fuelwood in lower Mustang.

(f) In Manang and Mustang, these sour fruits are eaten raw or used as a substitute for a sour citrus when making mixed pickle which can be stored for the cold season. (g) It is used on the shores of rivers and in the fields as a living fence that also helps to check soil erosion also harvested for fencing.

(85) Hippophae tibetana Schltdl. (Elaeagnaceae); V 192, 3127; 'Tarbu' (G). **Dist.: Himalaya** (Punjab to Bhutan), **S. Tibet**, **NW China**, **Nepal** (CE, 3800-4500m), **Ma.** (near the Phoo village, 3910m), **Mu.** (Jhaite village, 3580m).

(a) In Manang and Mustang, half a cup of fresh juice of fruit is drunk by mixing with one cup of water two times a day for diuretic, tonic, cough, cold, fatigue, enervate period (weakness periods) and to treat worms until recovery. (b) Fruit are eaten raw and used to make juice. The juice is very popular. Fruits are also squeezed to extract juice, which is sold commercially in the market: 1 kg extract liquid (Juice) + 1.6 kg sugar + 1.4 kg water + 2.4 g potassium meta bisulphate. Marketed as 'Seabuckthorne juice' it is said to be rich in vitamins.

(c) In Manang, half a cup of fruit is boiled on two cups of water and reduced it to a cup and half a cup of decoction is drunk one time a day after meal for the same diseases mentioned above until recovery.

(d) In Mustang, occasionally whole plant is cut and used as fence in the cultivated fields.

(86) Hyoscyamus niger L. (Solanaceae); V 1739, 2801; 'Lantang, Khayalanghlaa' (G, A). **Dist.: Europe, N. Africa, SW & C China, N. America, Nepal** (WC, 2000-3400m), **Ma.** (Manang village, 3450m), **Mu.** (way to Muktinath temple, 3260m).

(a) In Manang and Mustang, about one-forth of a spoonful powder of flowers is put on fire coal and the smoke is given to the affected part of the teeth for gingivitis and to relief pain in teeth 2-3 times a day until recovery. (b) One-eight of a spoonful of powder of flowers is put on infected teeth once a day at night until recovery. (c) The dried fresh seeds are mixed with tobacco and smoked for gingivitis and to relief pain in teeth once a day until recovery. (d) Flowers and seeds are smoked for psychoactive properties. A cigarette is made by mixing the flowers and seeds with tobacco. (e) Seeds are also said poisonous and if eaten/taken in excess by man or cow dies.

(87) Incarvillea arguta (Royle) Royle (Bignoniaceae); V 4406; 'Tonghsheel' (A). **Dist.: Punjab, Himalaya** (Uttar Pradesh to Nepal), **NE India, W. China, Nepal** (WC, 1800-3500m), **Mu.** (way to Kobang pasture, 2820m).

(a) About one-fourth of a spoonful of leaf, stem and flower paste is boiled in two cups of water and reduced to a cup. Half a cup of decoction is drunk once a day for gastritis and high blood pressure until recovered. (b) Used as fodder in lower Mustang. This is considered in taking out more milk from the cattles.

(88) *__Isodon rugosus__ (Wall. ex Benth.) Codd (Lamiaceae); V 4540. **Dist.: Afghanistan, Pakistan (Chitral), Himalaya (Kashmir to Bhutan), China (Yunnan). Nepal** (WC, 1200-3100m), **Mu.** (way to Chele from Samar village, 3310m).

(a) About one-forth of a spoonful of whole plant powder is put in teeth for gingivitis and to relieve tooth pain once a day until recovery. (b) Half a spoonful of powder from whole plant is taken with a cup of hot water or milk for sinusitis once a day until recovery.

(89) Juglans regia L. (Juglandaceae); V 241, 5403; 'Katutun' (G). **Dist.: Himalaya** (Kashmir to Bhutan), **NE India** (Meghalaya), **China** (Xizang), **Nepal** (WCE, 1200-2100m), **Ma.** (way to Dharapani from Chame, 2525m), **Mu.** (way to Larjung, 2510m).

(a) In Manang, one-forth of the ground fruit (walnut) powder is taken with a cup of hot water one time a day after meal for stomachache by mixing with other medicine (confidential mixture) until recovery.

(b) In Manang and Mustang, occasionally wood is used as a source of fuelwood, if there is a scarcity of other fuelwood. (c) The walnuts are eaten once ripe, usually in the month of

September-October. The ripe fruits are also collected and stored for later use or sold in the market.

(d) In Mustang, the walnuts are eaten raw for cough, cold and chest pain until recovered. It is also taken as a vitamin supplement. (e) Cut branches are used as fence in the cultivated field.

(90) Juniperus communis L. (Cupressaceae); V 864, 3324; 'Phar, Chhukshar' (G, A). **Dist.: Arctic** and **Alpine** region of **N. Hemisphere**; **Nepal** (WC 2700-3200m), **Ma.** (way to Manang yakkharka, 4005m), **Mu.** (way to Tsarang pasture, 3665m).

(a) In Manang, fruits are eaten (approx. 5-10 pieces, fresh or dried) to relieve respiratory complaints, chest pains, lung infection, bronchitis and other infections of upper respiratory tract once a day until recovery. (b) About 5-10 pieces of dried fruits are ground to make powder and taken with a cup of hot water once a day for the same diseases listed above until recovery.

(c) In Mustang, one spoonful of leaf and fruit paste mixture is taken with a cup of hot water or milk for 'kidney diseases' three times a day until recovery.

(d) In Manang and Mustang, small cut branches with leaves and fruits are used as a decorating material by displaying them inside a pot on the table in Manang and Mustang. (e) Occasionally, the stem is used as fuelwood at higher altitudes when there is a scarcity of other fuelwood. (f) Small cut branches are used as fence in the crop fields. (g) Leaves with small branches are used to make manure as described in *Juniperus indica* below. (h) Mature small branches are burned as incense in the same manner as previously described in *Ajania nubigena* previously and *Juniperus indica* below. Small branches are stored for future use by the local people. They are stored in the rafters of the roof after being dried in the sun. The branches are stored for short durations (anywhere from one week to six months) because they are found throughout the year in most of the villages of upper Manang and Mustang. *Juniperus communis* is thought to produce incense of inferior quality to *Juniperus indica*, and therefore is used only when *Juniperus indica* is not available, even though it is readily obtained.

(91) Juniperus indica Bertol. (Cupressaceae); V 309, 3589; 'For, Chhukphha' (G, A). **Dist.: Karakoram**; **Himalaya**; **W. China**; **Nepal** (WCE, 3700-4100m), **Ma.** (near Khangshar village, 3835m), **Mu.** (near Jharkot village, 3270m).

(a) In Manang, leaves and fruits are ground to make powder. Half a spoonful of powder is mixed with a cup of milk and drunk two times a day after meal for cough, cold, tonsillitis, headache, malarial fever, neck pain and to reduce blood pressure (defined in appendix VII). (b) The *amchi* puts half a spoonful of powder of leaves and fruits on a glowing red fire coal and the scent is smelt by the patient one time a day for the same diseases listed above until recovered. (c) The wood also has ritual significance and is used to fuel the cremation pyre if *B. utilis* is not available.

(d) In Mustang, about half a spoonful powder of cones is mixed with half a spoonful fruit of *Juniperus indica* and ground to make powder. The mixture is taken early in the morning on an empty stomach with a cup of hot water for tuberculosis (TB) once a day until recovery.

(e) In Manang and Mustang, leaves with small branches are used to make manure. The plant material is spread in the cow/goat shed as bedding and mixed with livestocks dungs and sheep/goat pellets for about three months. After that, it is taken out from the shed and left to stand near the crop fields for about one month. After decaying completely it is used as manure. (f) Mature small branches are used as the most popular source of incense. *Juniperus indica* is almost

always available near the village and can be stored in the rafters of the roof after drying in the sun. It is only stored for a short duration (one week to six months) because it is so widely available. As described previously, when used as incense, two to five small branches are placed on a glowing ember. Sometimes '*ghee*' (cow's butter) may be added separately. Most often an elder member but sometimes the children of the family will conduct this ritual and say the *mantra* that goes along with it. This plant is commonly used because of top ranked category and its availability at any time near the house. (g) The plant is a good source of fuelwood and is said to give good burn. It is ranked first and second by the *Mustangi* and *Manangi* respectively due to its availability and with good burning quality. (h) Small cut branches are used as fence in the cultivated field and leaves with fruits are used as a decorating material by displaying them inside a pot on the table.

(92) Juniperus squamata Buch.-Ham. ex D. Don (Cupressaceae); V 265, 3872; 'Sukri, Chhukshar' (G, A). **Dist.: Afghanistan**; **Himalaya**; **N. Myanmar**; **W. China**; **Nepal** (WCE, 3300-4400m), **Ma.** (way to Ketcho lake, 4100m), **Mu.** (way to Syangbochae pasture, 3890m).

(a) In Manang, plant parts (leaves and stems) are cut into small pieces and put on ground inside the shed when the animals are affected by different kinds of insects, scabies and wounds.

(b) In Mustang, one spoonful of leaf and fruit paste is taken with a cup of hot water or milk for 'kidney diseases' two times a day until recovery.

(c) In Manang and Mustang, stem is used as fuelwood in higher altitudes in the absence of other fuelwood. Small cut branches are used as fence in the cultivated field. (d) Leaves with small branches are used to make manure. The method of manure preparation is same as described above in *J. indica*. (e) Mature small branches are used as the most popular source of incense as described above in *J. indica* but local people use only during the shortage of *J. indica*. This is commonly used after *J. indica* because of top ranked category and its availability at any time near the house. (f) Small cut branches are used as decoration materials by putting it inside the pot.

(93) Lancea tibetica Hook. f. & Thoms. in Hook. (Scrophulariaceae), V 2994; 'Payag Tsawa' (A). **Dist.: Himalaya** (Kashmir to Bhutan), **W. China, Nepal** (WCE, 3300-4400m), **Mu.** (way to Chhuksang pasture, 3210m).

(a) Half spoonful of whole plant paste is mixed with half spoonful of confidential mixtures and taken with a cup of hot water once a day before going to bed for heart diseases, lung diseases, anthelmintic, gastritis until recovery.

(94) *Leontopodium monocephalum Edgew. (Asteraceae); V 3113; 'Kothha' (T). **Dist.: Karakoram, Himalaya** (Kashmir to Sikkim), **Nepal** (CE, 4600-5600m), **Mu.** (near the Larjung village, 2560m).

(a) Whole plant parts paste is applied around boils once a day until recovery.

(95) Lilium nepalense D. Don (Liliaceae); V 2449; 'Pana, Rakshimalmall' (D, T). **Dist.: Himalaya** (Uttar Pradesh to Arunachal Pradesh), **Nepal** (WCE, 2300-3400m), **Mu.** (Way to Kalopani village, 2510m).

(a) About, one-fourth of a spoonful of whole plant paste is taken with a cup of hot water once a day for fever until recovery. (b) Small cut branches are used as decoration materials by putting it over the pot.

(96) Lindelofia longiflora (Benth.) Baill. (Boraginaceae); V 3864; 'Bhadhakuro' (D). **Dist.: Himalaya** (Kashmir to Nepal), **Nepal** (W, 3300-4600m), **Mu.** (near the Kagbeni village, 2800m).

(a) The paste of root is applied around boils for quickening the healing process once a day until recovery. Iron rust is also mixed with plant paste and applied around boils which is said to quicken the healing process.

(97) *Lonicera myrtillus Hook. f. & Thomson (Caprifoliaceae); V 3892; 'Phanghamaa' (A). **Dist.: Himalaya** (Kashmir to Bhutan), **Myanmar, W. China, Nepal** (WCE, 2200- 4200m), **Mu.** (way to Lomanthang village, 3690m).

(a) About, one spoonful mixture of leaf, stem, flower and fruit paste is taken with a cup of hot water to purify impure blood and overflow of blood during menstrual disorder two times a day until recovery. (b) Fruits are eaten raw. (c) Cut branches are used to fence the cultivated fields by spreading over a stone or wood wall. (d) Sometime dried branches are used as fuelwood in the periods of scarcity of other fuelwood.

(98) *Lonicera rupicola Hook. f. & Thomson (Caprifoliaceae); V 3875; 'Phanghamaa' (A). **Dist.: Himalaya** (Uttar Pradesh to bhutan), **W. China, Nepal** (WCE, 3800-4600m), **Mu.** (way to Tamagaon, 3460m).

(a) About, one spoonful mixture of leaf, stem, flower and fruit paste is taken with a cup of hot water to purify impure blood and overflow of blood during menstrual disorders two times a day until recovery. (b) Fruits are eaten raw. (c) Cut whole plant is used to fence the cultivated field by spreading over a stone or wood wall. (d) Sometime dried branches are used as fuelwood in the periods of scarcity of other fuelwood.

(99) *Maharanga bicolor (Wall. ex G. Don) A. DC. (Boraginaceae); V 263; 'Maharangi' (N). **Dist.: Himalaya** (Nepal to Bhutan), **China** (Xizang), **Nepal** (WC, 2100-3000m), **Ma.** (way to Thorang Phedi, 3850m).

(a) The root is pounded on a stone slab and put on clean cloth and squeezed to take out liquid. One spoonful of liquid is mixed with two spoonfuls of boiled mustard oil. About 1-5 drops of the infusion (liquid) were put on ear 2-3 times a day for ear pain until recovery. (b) Half a cup of squeezed root liquid is mixed with a half cup of oil. This is spread on the hair to colour it red or brown (hair dye). (c) The root is dried and ground to make powder. The powder is colourful (red) and is used in religious ceremonies.

(100) Maharanga emodi (Wall.) A. DC. (Boraginaceae); V 1619, 2298; 'Maharangi, Dimock' (N, A). **Dist.: Himalaya** (Uttar Pradesh to Bhutan), **China** (Xizang), **Nepal** (WCE 2200-4500), **Ma.** (in the way to Hongde from Braka, 3300m), **Mu.** (way to Tuckhe village, 2890m).

(a) In Manang, root is pounded on stone slab. About 2-3 drops of the juice are mixed with one spoonful of mustard oil and 1-5 drops of infusion were put on ear 2-3 times a day for ear pain until recovery.

(b) In Mustang, one-forth of a spoonful of whole plant paste is taken with a cup of hot water for high blood pressure two to three times a day until recovered.

(c) In Manang and Mustang, the root is ground to powder and its color is used in rituals and religious ceremonies. (d) Half a cup of squeezed root liquid is mixed with half a cup of oil. This is spread on the hair to colour it red or brown (hair dye).

(101) Malva verticillata L. (Malvaceae); V 211, 4188; 'Tangshang, Chhembaa/ChyaphaKhhamo' (G, A). **Dist.: Europe, Egypt, Himalaya**, (Kashmir to Bhutan), **India, China, NE Asia**, **Nepal**

(WCE, 2100-3000m), **Ma.** (Kanglapass to Ngawal, 3825m), **Mu.** (way to Chhuksang village, 2910m).

(a) In Manang, the flowers of *M. verticillata* (Tangshang) are ground to make powder and half a spoonful powder of *M. verticillata* is mixed with half a spoonful powder of flowers of 'langtang' (*Anisodus luridus*). Then, the mixture is mixed with a cup of milk and taken two times a day for cough, cold, tonsillitis and headache until recovery.

(b) In Mustang, root and stem paste is applied on bone fractures, hand and leg fractures once a day until recovery. It helps to join fractured bones. The paste can be changed once after a week. (c) One spoonful of whole plant powder is taken with a cup of boiled water for 'kidney disease' once a day before going to bed until recovery. (c) Occasionally whole plant parts are used as manure by mixing with cattle dung.

(102) *Meconopsis staintonii Grey-Wilson (Papaveraceae); V 3829; 'Upal serpo' (A). **Dist.: Himalaya** (Nepal to Bhutan), **W. China, Nepal** (WCE, 270-5200m), **Mu.** (Kalopani to Kolapani yakshed, 3429m).

(a) About, one spoonful of root powder is taken with a cup of boiled water for stomachache, gastritis, diarrhea and pain near the side of heart once a day until recovered. If the pain from the side of the heart moves upward then the pain cause vomiting but if pain goes downward then it cause diarrhea.

(103) *Mentha longifolia (L.) Huds. (Lamiaceae); V 275; 'Patina' (N). **Dist.: Europe, Africa, most of Asia, N. America, Nepal** (WC, 1600-2700m), **Ma.** (Khuli goatshed, 3855m).

(a) About 10g leaves are boiled in two cups of water. One cup of decoction is drunk in the morning for cough, cold, tonsillitis and headache until recovery. (b) Leaves are used in home-made pickle/relish regularly to increase and purify the blood. (c) The leaves are pickled (*achar*) alone or mixed with salt, chilli and other common pickle or vegetables such as radish.

(104) *Mirabilis himalaica (Edgew.) Heimerl (Nyctaginaceae); V 410, 4361; 'Nigghibulung, Khembha/Bhhatuu' (G, A). **Dist.: Himalaya to SE China**; **Nepal** (WC, 2300-4000m), **Ma.** (near the goatshed of Khangshar village, 4220m), **Mu.** (way to Kobang pasture, 3010m).

(a) In Manang, about 25g of leaves and flowers are crushed on stone slab and paste is applied around the fractured part of the body once a day until recovery.

(b) In Mustang, one spoonful of whole plant paste is taken with a cup of hot water as a vitamin supplement or to treat edema and other diseases by cold (no detailed symptoms or ailments is given by the *amchi*) once a day until recovery.

(105) *Morchella conica Pers. ex Fr. (Morchellaceae); V 331; 'Guchhichaue' (G). **Dist.: Europe, Japan, China, India, America and Nepal, Ma.** (near the Tilicho Base Came, 4305m).

(a) Whole plant parts of mushroom is eaten as a vegetable for stomachache, wound healing and as a general health tonic once a day until recovery. (b) About 10g powder of the dried mushroom is boiled with a cup of water and taken as soup once a day to treat the diseases mentioned above. (c) Mixed with different vegetables dishes is delicious in taste. It is said to be highly nutritious. When use freshly it is washed with cold water and once dried it is put at first in hot water for five minutes and washed with cold water. The detail methods of preperation of vegetables are same as described above in *Allium carolianum*.

(106) *Morchella esculenta L. (Morchellaceae); V 3310; 'Guchhichaue' (G). **Dist.: Europe, Japan, China, India, America, Australia, Nepal, Mu.** (*P. wallichiana* forest of Marpha, 3205m).

(a) *Amchi* use whole plant parts of mushroom with different confidential mixtures to make medicines to treat heart disease but no details are given. (b) Mixed with different vegetables dishes is delicious in taste. The detail methods of preperation of vegetables are same as described above in *Morchella conica* and *Allium carolianum.*

(107) Morina polyphylla Wall. ex DC. (Dipsacaceae); V 1719; 'Changshar' (G). **Dist.: Himalaya** (Uttar Pradesh to Bhutan), **Nepal** (WCE, 3000-4300m), **Ma.** (way to Ngawal to Ghyaru, 3410m).

(a) Half a spoonful of ground root powder is taken with a cup of hot water two times a day after meal for edema (swelling of the body), stomachache, headache, diarrhoea, dysentery, to stop bleeding during child birth, body pain and numbness of limbs until recovery. (b) Half a spoonful of pounded root is boiled with two cups of water until becoming one cup. One-forth of a cup of decoction is drunk one time a day at night after meal for the same diseases mentioned above until recovery.

(108) Myricaria rosea W.W. Sm. (Tamaricaceae); V 345, 3527; 'Angmeo' (G). **Dist.: Himalaya** (Kumaun to Bhutan), **S. Tibet, W. China, Nepal** (CE, 3300-4500m), **Ma.** (way to Pisang from Hongde, 3070m), **Mu.** (way to Chhuksang from Chele, 3600m).

(a) In Manang, about 20 g of pounded mixture of leaves, stems and flowers are boiled with 2 cups of water. About 2-5 spoonfuls of decoction is drunk with one cup of milk, 2-3 times a day after meal for respiratory diseases such as asthma (defined in appendix VII), until recovery. (b) Half a spoonful powder of leaves, stems and flowers is mixed with a cup of boiled water and drunk 2-3 times a day after meal for respiratory diseases mentioned above until recovery. (c) Half a kg of leaves, stems and flowers are cut into small pieces and cooked it with 10L of water, one kg of wheat flour and some salt for half an hour. This is given once a day to the animals for respiratory diseases mentioned above. (d) Mature small branches of this shrub are infrequently used as incense when other incense plants are not available. The method of use is same as described above in *A. nubigenum* and *A. caruifolia*.

(e) In Mustang, half spoonful of leaves stems and flowers mixtures are boiled with a cup of water and half cup of decoction is drunk once a day after meal for lungs diseases and asthma (defined in appendix VII), until recovery.

(109) Nardostachys grandiflora DC. (Valerianaceae); V 296, 4589; 'Panghphoie' (G). **Dist.: Himalaya** (Garhwal to Bhutan), **Tibet, W. China, Nepal** (WCE, 3200-5000 m), **Ma.** (way to TilichoLake, 4370m), **Mu.** (way to Chele pasture from Chele village, 3520m).

(a) In Manang, the root of the plant is ground to make powder. Half a spoonful of powder is mixed with half a spoonfuls of *Aconitum naviculare* root powder and *Betula utilis* fruit powder and mixed with three spoonful of 'chauri ghee' (butter from a female yak). Then the mixture is taken two times a day with a cup of boiled water for diarrhoea and fever until recovery. (b) One spoonful of root powder is put on red fire coal and the scent is used for conjunctivitis (eye swollen, red and 'dirty') at night until recovery. (c) Half a spoonful of root powder is taken with a cup of hot water two times a day after meal for gastritis, headache, anthelmintic, edema (swelling

of the body), dyspepsia and rib pain until recovered. (d) The whole plant is used as one of the major sources of incense in Manang. It is mixed with several other important incense plants, including lichens either in powder or whole plant form by *lamas*, *amchi* and local villagers. It gives a pleasant smell when it is burnt. It is found in higher altitudes (3200 – 5000 m), and because of this is said to be ritually purer and have a nicer smell. It is ranked top among incense in Manang. About one-forth of a handful at a time is mixed with other incense plants such as *Cassiope fastigiata*, *Valeriana jatamansii* and *Rhododendron anthopogon* and placed on a glowing ember in the morning and in the evening for *puja*. It is also used at the time of ritual and religious ceremonies in Manang as well as in the *gomba* (monastery). The detailed method of use is the same as described above for *Ajania nubigena*. *Nardostachys grandiflora* is also one of the commercially traded medicinal plants of Manang district.

(e) In Mustang, whole plant is ground to make powder and one spoonful of powder is mixed with many confidential medicine mixture of the Himalaya (one spoonful) and taken for diarrhea, fever, gastritis, headache, anthelmintic, swelling of the body and rheumatism until recovery.

(110) Neopicrorhiza scrophulariiflora (Pennell) Hong (Scrophulariaceae); V 404, 4445; 'Kutki' (G). **Dist.: Himalaya** (Uttar Pradesh to Bhutan), **N. Myanmar, China** (Sichuan, Xizang, Yunnan), **Nepal** (WCE, 3500-4800m), **Ma.** (above the goatshed of Gangapurna Glacier, 4320m), **Mu.** (Jharkot shed, 3645m).

(a) In Manang and Mustang, about 10g root is pounded on a stone slab and boiled in a cup of water. Five spoonfuls of this filtered decoction is mixed with a cup of milk 2-3 times a day for fever (typhoid, malarial, and fever with jaundice), diarrhoea, paralysis, stomachache, dyspepsia (indigestion), snake and scorpion sting, cough, cold, headache and heart diseases until recovery. (b) About one-forth of a spoonful of root powder is taken with a cup of water or milk and drunk two times a day after a meal for the same diseases mentioned above. It is necessary to take one spoonful of ghee or sugar after using medicine to sweeten the mouth.

(c) In Manang, half a spoonful of root powder is mixed with two spoonfuls of 'chauri ghee' and taken 2-3 times a day until recovery for the same diseases listed above.

(d) In Mustang, the paste of root is applied on cuts, wounds, boils, scabies, ringworm, snake and scorpion stings until recovery.

(111) *Onopordum acanthium L. (Asteraceae); V 165; 'Mangh' (G). **Dist.: Pakistan, Kashmir, W. Asia, Europe** (1750-3400m), **Nepal** (C), **Ma.** (near the communication office in Manang village, 3505m).

(a) About 15g of root is pounded on stone slab and boiled with two cups of water. Then the half-cup of decoction is drunk two times a day after meal for dysuria and diuretic until recovery. (b) One spoonful root powder is mixed with a cup of boiled water and drunk two times a day after meal for dysuria and diuretic until recovery.

(112) Origanum vulgare L. (Lamiaceae); V 903, 2934; 'Akhebobo, Ghoodhaamarcha' (G, T). **Dist.: Throughout Europe, Asia, and North America, Nepal** (WC, 600-4000m), **Ma.** (way to Hongde from Braka, 3300m), **Mu.** (above the Samar village in the way to pasture, 3920m).

(a) In Manang, about 50g of whole plant is pounded on the stone slab and mixed with two cups of water. Boiled it to reduce to a cup and half a cup of decoction is drunk two times a day for high blood pressure, cough, cold, heart diseases and fever until recovery. (b) One-forth of a spoonful of

whole plant ground powder is taken with a cup of hot water two times a day for the same diseases mentioned above until recovery.

(c) In Mustang, one spoonful of whole plant paste is taken with a cup of hot water for sinusitis once a day until recovered. (d) About 500g of whole plant paste is cooked in three cups of water and the vapor is smelt once a day for sinusitis until recovered. (e) Dried whole plant scent is smelt putting it over the red fire coal once a day for the same diseases mentioned above until recovered.

(f) In Manang and Mustang, the whole plant is used as incense after it has been dried thoroughly in sunlight. The dried plant is stored in the home in bundles hanging from the ceiling for future use. The process of use in incense is same as described above in *A. nubigena*. It is not the most popular incense plant as others are considered to be of higher quality.

(113) Oxyria digyna (L.) Hill (Polygonaceae); V 1720, 3891; 'Youyaha, Yuphha' (G, A). **Dist.: Europe, W. & C. Asia, Himalaya** (Kashmir to Bhutan), **Siberia, W. China, Japan, N. America, Greenland**, **Nepal** (WCE, 2400-5000m), **Ma.** (way to Ngawal from Ghyaru, 3370m), **Mu.** (way to Lomanthang village, 3700m).

(a) In Manang and Mustang, the leaves are collected and washed with water. They are fried in oil with salt and various spices, including chilli. Sometimes boiled potato or boiled tubers of *Arisaema* species are cooked with the mixture. The cooked mixture is then used as pickle (*achar*) and eaten with meals as a condiment. This was mostly used in remote villages including the Nar village of Manang. It is also said to be a diuretic which was experienced during their field visit to Nar village in 2004.

(b) In Mustang, one-fourth of a spoonful of whole plant paste is taken with a cup of hot water for constipation, gastritis, diuretic and cure swelling of the stomach once a day until recovery.

(114) *Oxytropis willamsi Vassilcz (Fabaceae); V 208, 4388; 'Sinshi/Dhanghaar, Thakshhyakarwa' (G/T, A). **Dist.:** Nepal (WC, 2500-4000 m), **Ma.** (way to Ngawal from Nar, 4650m), **Mu.** (way to Tuckhe village, 2910m).

(a) In Manang and Mustang whole plant is used as fodder for horses. The plant is used carefully as it is said that an overdose may make a horse mad.

(b) In Mustang, half a spoonful of whole plant powder is mixed with a cup of hot water and drunk two times a day for allergy, cough, cold and fever until recovery. When mixed with other medicinal additives in a confidential manner, it is considered to be more effective. (c) When used as incense, the method of use is same as *A. nubigena* described above. *O. willIamsii* is not commonly used as incense because it is perceived to be an inferior quality when compared to other incense plants.

(115) Paris polyphylla Sm. (Liliaceae); V 2009; 'Satuwa' (G). Dist.: Himalaya (Uttar Pradesh to Bhutan), NE India, China, Nepal (CE, 1800-3300m), Ma. (way to Chame, 2750m), Mu (way to Kalopani pasture, 2650m).

(a) About one-forth of the ground powder (made from leaves, flowers and stems) is taken with a cup of hot water one time a day before going to bed to treat worms until recovery. It is necessary to use a tonic while taking this medicine regularly.

(116) Pedicularis longiflora Rudolph (Scrophulariaceae); V 3897; 'Langhanasherpo' (A). **Dist.: Himalaya** (Kashmir to Bhutan), **S.E. Tibet, W. China, Nepal** (WCE, 2500-4100m), **Mu.** (way to Tsarang, 3650m).

(a) About, one-fourth of a spoonful paste of whole plant is used for headache from bile disorders two times a day until recovery. *Amchi* also prepares medicinal pills from this plant but the detailed is not provided by the *amchi*.

(117) Pinus wallichiana A.B. Jacks. (Pinaceae); V 113, 3121; 'Thansin' (G). **Dist.: Afganistan**, **Himalaya** (Kashmir to Nepal), **Nepal** (WCE, 1800-4100m), **Ma.** (way to Chame from Bhratang, 2660m), **Mu.** (way to Syangboche village, 3650m).

(a) In Manang, the bark of the plant was cut into pieces and put on the fractured part of the body continuously for about 2-3 months until recovery. (b) Half a spoonful powder of the bark is mixed with a cup of milk and drunk two times a day after meal for tuberculosis (TB) up to 1-2 years regularly (defined in appendix VII). (c) Latex is applied on the abrasion part of the skin in the evening continuously until recovery.

(d) In Mustang, about half a spoonful of cone powder is mixed with half a spoonful fruit powder of *Juniperus indica*. The mixture is taken early in the morning with a cup of hot water once a day in empty stomach for tuberculosis (TB) continuously until recovery. (e) The latex is eaten.

(f) In Manang and Mustang, cones and leaves are one of the important sources of organic fertilizer. The manure is prepared by mixing the plant material with dung collected in goat shed for about three months. It is then left to stand outside for about one month to allow the decaying process to take place and then used in the fields. (g) A small cut branch with cones is used as a decoration material by displaying in the tables. (h) Wood is used for construction of houses, bridges and to make furniture. (i) Plant is used as fuelwood and is ranked third (first *Betula utilis*; second *Juniperus indica* and third *Pinus wallichiana*) by the local people among fuelwood species in Manang. The wood has ritual significance, and is used to fuel the cremation pyre when *Betula utilis* or *Juniperus indica* is not available. Similarly in Mustang, It is ranked second (first *Juniperus indica*, second *Pinus wallichiana* and third *Betula utilis*) after *Juniperus indica* by the local people. Category of ranking is given by the local people according to good burning quality and availability. (j) Cut branches are used as fence the cultivated field.

(118) *Plantago erosa Wall. (Plantaginaceae); V 4530; 'Naram' (A). **Dist.: India, Ceylon, Himalaya** (Kumaun to Bhutan), **Asam, Burma, S.E. Tibet, W. China, Nepal** (WCE, 900-4100m), **Mu.** (Larjung to Marpha village, 2620m).

(a) About 20g of whole plant is boiled in a cup of water and half a cup filtrate is drunk two times a day for diarrhea and constipation until recovery.

(119) Polygonatum cirrhifolium (Wall.) Royle (Liliaceae); V 235; 'Gomesha' (G). **Dist.: Himalaya** (Punjab to Bhutan), **NE India** (Manipur), **W. China, Nepal** (WCE, 1700-4600m**), Ma.** (way to Khuli goatshed, 4070m).

(a) About 10g of pounded whole plant parts is mixed with two cups of water and boiled until the volume is reduced to one cup. Half a cup of decoction is drunk 2-3 times a day, for cough, cold and fever until recovery. (b) Half a spoonful of powder of whole plant is taken with a cup of milk or boiled water to increase sexual power one time a day before going to bed until recovery.

(120) *Prunella vulgaris L. (Lamiaceae); V 2896; 'Balbhuti' (D). **Dist.: Throughout Europe and temperate Asia, Nepal** (WCE, 1200-3800m), **Mu.** (way to Chele village, 3020m).

(a) Whole plant is pounded in stone slab and one spoonful of paste is taken with milk or hot water for small children affected by Pneumonia (defined in appendix VII) once a day until recovery. (b)

The whole plant paste is used in leg, hand and rib for the same time and same diseases mentioned above. (c) The root is tye in neck to treat disease mentioned above until recovery. It is considered that tyeing the root around the neck in a ritual performed by a *Dhami* lessens the disease.

(121) Prunus armeniaca L. (Rosaceae); V 4532; 'Khurpani, Khambu/Bhala' (G/T, A). **Dist.: China, Nepal** (C, 2900-3500m), **Mu.** (Marpha village, 2640m).

(a) Ripe fruits are eaten raw, said to be rich in vitamin and also used as a substitute of sauce in noodles and soup. (b) In past *Mustangi* use the seeds to extract oil. The oil is used to make hair dye (blacking the hair). (c) Plant is used as an excellent quality of fuelwood.

(122) Prunus himalaica Kitam. (Rosaceae); V 3870; 'Khambhu' (A); **Dist.: Nepal** (C, 3900m), **Mu.** (way to Syangboche, 3800m).

(a) Fruits are eaten raw for sinusitis and said to be rich in vitamin. It is also used as a substitute of sauce in noodles and soup. (b) In the past *Mustangi* used the seeds to extract oil. The oil is used to make hair dye (blacking the hair). (c) Occasionally wood is used as fuelwood.

(123) *Ranunculus laetus Wall.ex D. Don. (Ranunculaceae); V 4536; 'Khangkhar' (A). **Dist.: C. Asia, Afghanistan, Himalaya** (Kashmir, Uttar Pradesh to Arunachal Pradesh), **China** (W. China, Xizang), **Nepal** (W, 1900-2700m), **Mu.** (way to Chele from Jomsom village, 3020m).

(a) The paste of whole plant is applied to the affected part of the body for sinusitis, bodyache and backbone pain once a day until recovery. (b) Half a spoonful of the powder of whole plant is taken with a cup of hot water for the same diseases mentioned above once a day until recovery. (c) Whole plant is used as fodder.

(124) Rheum australe D. Don (Polygonaceae); V 3267; 'Khajo' (G). **Dist.: Himalaya** (Himachal Pradesh to Nepal, Bhutan), **China** (Xizang), **Nepal** (CE, 3200-4200m), **Mu.** (Tsarang pasture, 3820m).

(a) Half a spoonful of root powder is drunk with a cup of milk or hot water for malarial fever two times a day until recovery. (b) Stems are made into a pickle (*achar*). At first they are softened by pounding on a stone slab. *Achar* is prepared by mixing it with chilli, salt and spices. It is made with mustard oil so that it can be stored for longer periods of time. The pickle can be stored for 1-2 years submerged in oil inside the glass bottles. This is made by the villagers and also by the herders. Pickled is considered tasty in comparison to Manang pickle of *R. moorcroftianum*.

(125) *Rhodiola quadrifida (Pallas) Fischer & C.A. Meyer (Crassulaceae); V 4593; 'Chengchungh' (A). **Dist.: C. Asia, Himalaya**, (Kashmir, Uttar Pradesh, Bhutan**), N. & W. China, Mongolia, Siberia, Nepal** (WCE, 3000-4200m), **Mu.** (way to Jomsom from Chele pasture, 3360m).

(a) Half a spoonful of root powder is taken with one cup of hot water for asthma, lungs diseases, kidney diseases, skin diseases, jaundice, wound diseases and as an anti-poison once a day until recovery.

(126) Rhododendron anthopogon D. Don (Ericaceae); V 234, 2864; 'Palu, Sangalin' (G, A). **Dist.: Himalaya** (Punjab to Bhutan), **Tibet, Nepal** (WCE, 3300-5100m), **Ma.** (above the Khuli goatshed, 4400m), **Mu.** (way to Chhuksang pasture, 3210m).

(a) In Manang, plant parts (leaves and flowers) are ground to make powder. Half a spoonful of powder is drunk with a cup of milk or hot water two times a day after meal to reduce blood pressure, paralysis, pains in limbs and waist and inflammation of limbs and fever. (b) Half a

spoonful mixture of leaves and flowers powder is put on red fire coal and the scent is smelt by the patient in the evening for paralysis, pains in limbs and waist and inflammation of limbs until recovery.

(c) In Mustang, half a spoonful of mixture of flower, stem and leaf is taken with a cup of hot water two times a day to 'sweeten the mouth' when appetite is lost from stomach diseases, liver diseases or vomiting, until recovered.

(d) In Manang and Mustang, leaves, flowers and stems are used as incense by mixing them with other aromatic plants such as *Cassiope fastigiata*, *Valeriana jatamansii* and *Nardostachys grandiflora*. This mixture is very popular and while in season (September to October) is collected in large amounts for future use by the members of the family. People from Manang who now live in one of the larger cities carry the plants back to their new homes for personal religious use. About half a handful plants are used for incense as described above in *Ajania nubigena* and *Artemisia caruifolia*.

(127) *Rhododendron campanulatum Sm. (Ericaceae); V 2589; 'Gurans' (N). **Dist.: Himalaya** (Kashmir to Arunachal Pradesh), **China** (Xizang), **NE India, Myanmar, Nepal** (1500-3300m), **Mu.** (above the Kalopani village in the way to goatshed, 2690m).

(a) About one–two flowers are eaten raw for bronchitis once a day until recovery. (b) Sometimes fish throns remain lodged in the mouth when eating meat of fish. One spoonful of flowers powder is chewed raw to remove these fish thron. (c) Two–three flowers are boiled in two cups of water and one cup of decoction is drunk for bronchitis once a day until recovery. (d) Leaves, flowers and stems are used as incense by mixing them with other incense plants such as *V. jatamansii* and *N. grandiflora*. This mixture is very popular and while in season (September to October) is collected in large amounts for future use by members of the family. People from Mustang who now live in one of the larger cities carry the plants back to their new homes for personal religious use. About half handful plants are used for incense as described above in *A. nubigena* and *A. caruifolia*. (e) It is used as fuelwood in the lower Mustang.

(128) Rhododendron lepidotum Wall. ex G. Don (Ericaceae); V 1722, 3797; 'Bhaiunakpo' (A). **Dis.: Himalaya** (Kashmir to Aurnanchal Pradesh), **N. Myanmar, W & S China, Nepal** (WCE, 2100-4700m), **Ma.** (near Milireppa cave, 3750m), **Mu.** (way to Kalopani yakshed, 2870m).

(a) In Manang, half a spoonful of paste (made from fresh leaves and flowers) is taken with a cup of hot water two times a day for purifying the blood until recovery. (b) The plant part (dried leaves and flowers) are ground to make powder. Half a spoonful of powder is taken with a cup of hot water 1-2 times a day for fever, cough, cold, tonsillitis by mixing with other different medicinal plants of the Himalaya (confidential mixture) until recovery.

(c) In Manang and Mustang, leaves, flowers and stems are used as incense by mixing them with other incense plants. This mixture is very popular and while in season (September to October) is collected in large amounts for future use by members of the family. About half a spoonful plants are used for incense as described above in *A. nubigena* and *A. caruifolia*. This plant is used less frequently than *R. anthopogon* because it is felt to be of lower quality than *R. anthopogon*.

(129) Rosa macrophylla Lindl. (Rosaceae); V 353, 3591; 'Seghu' (G). **Dist.: Bhutan, India, Kashmir, Sikkim, Nepal** (WCE, 2100-3800m), **Ma.** (way to Pisang from Hongde, 2990m), **Mu.** (way to Eklebhatti from Kagbeni, 2720m).

(a) In Manang, half a spoonful of fruit powder is taken with a cup of hot water two times a day for fever, diarrhoea, dysentery, cough and cold until recovery. (b) The paste of the fruit pulp is applied on the infected part for boils two times a day until recovery. (c) Sometimes the flowers are worn as decoration in the hair (for both men and women).

(d) In Mustang, about three to four flowers are boiled in a cup of hot water. Half a cup of decoction is drunk for fever, diarrhea and bile disorders once a day until recovery.

(e) In Manang and Mustang, the fruits are eaten raw and although larger, are said to be of inferior quality in comparison to *R. sericea* in taste. (f) Due to its thorny nature it is used as non living fence in Mustang and living and or non-living fence in Manang in the cultivated fields. (g) Used as fuelwood in the higher altitudes where fuel wood is rare.

(130) Rosa sericea Lindl. (Rosaceae); V 121, 3597; 'Sewa/Saibhamathi, Songhthakpha/Chhewa' (G, A). **Dist.: Himalaya** (Chamba to Bhutan), **China, India, Myanmar, Sikkim, Nepal** (WCE, 2200-4600m), **Ma.** (Chame to Phoo village, 2925m), **Mu.** (Eklebhatti to Jomsom, 2690m).

(a) In Manang, half a spoonful of fruit powder is drunk with a cup of hot water three times a day for diarrhoea, dysentery, stomachache, dyspepsia and bile disorders until recovery. (b) Two fresh or air dried petals are mixed with a cup of hot water and given 2-3 times a day as a substitute of tea to reduce blood pressure (defined in appendix VII). (c) The fruit pulp is separated, dried in sunlight; ground to make fine powder and the powder is put on infected teeth once a day after meal for gingivitis (toothache) until recovery.

(d) In Manang and Mustang, due to its thorny nature the plant is used as living and non living fence and is also used as fuelwood in the higher altitudes where the fuelwood is rare. (e) The fruits are eaten raw. Compared to *Rosa macrophylla*, these fruits are sweeter in taste and therefore are much preferred.

(f) In Mustang, about 20g of fruit is boiled in a cup of water. Half a cup of decoction is drunk for cough and cold once a day until recovery. (g) Flowers are pounded in stone slab and about 20g paste is taken with a cup of hot water to relieve fatigue twice a day until recovery. Effectiveness of the medicine increases when mixed with other medicinal plants and additives. (h) About 5-10 fruits are mixed with 5-10 flowers and powder. Half a spoonful of powder is drunk with a cup of hot water for fever (any kinds of fever), to lower blood pressure recommended for old men, headache, numbness of limbs, vertigo/dizziness, poor vision, liver disease, bile disorder and 'air or wind disease' two to three times a day until recovery. Sometimes *amchi* mixed confidential mixtures and prepare pills medicine to the patients but no details about the confidential mixture were shared by the *amchi*.

(131) Rubus foliolosus D. Don (Rosaceae); V 1516, 3567; 'Mapalan, Kathandakhari, Gatha' (G, T, A). **Dist.: Himalaya** (Himachal Pradesh to Nepal), **NE India, W. China, Nepal** (WC, 2100-2900m), **Ma.** (near Manang village, 3505m), **Mu.** (way to Jharkot from Kagbeni, 2820m).

(a) In Manang, about 50g of pounded root is boiled on two cups of water and reduced to one cup. Half a cup of decoction is drunk for fever, dyspepsia (indigestion), cough, cold, headache, tonsillitis, vertigo/dizziness, enervates periods (weakness periods) and those diseases which are not easily cured by other medicine until recovery. (b) One-forth spoonful of root powder is taken with a cup of hot water 2-3 times a day for the same diseases mentioned above until recovery.

(c) In Manang and Mustang, pink, fruits are sweet when ripe and are eaten raw.

(d) In Mustang, half a cup of fruit juice is taken by the children for Pneumonia once a day until recovery. (e) Half a spoonful of stem paste is taken with a cup of hot water for fever once a day until recovery. (f) Cut thorny branches are used as fence in the cultivated fields.

(132) Rumex nepalensis Spreng. (Polygonaceae); V 313, 3873; 'Hali, Lungsho/Somangh' (G, A). **Dist.: SW Europe, W. Asia, Himalaya, India, East to W. & C. China; Nepal** (WCE, 1200-4200m), **Ma.** (near Khangshar village, 3700m), **Mu.** (near Syangbochae village, 3800m).

(a) In Manang, about 10g of pounded root is boiled in a cup of hot water and ten spoonfuls of decoction is drunk 2-3 times a day after meal for fever.

(b) In Manang and Mustang, one-forth of a spoonful of ground root powder is taken with a cup of hot water two times a day after meal for fever, lung diseases, liver diseases, joint pain, vomiting, gingivitis, joint pain, stomachache, 'air or wind diseases', cough and cold until recovery. (c) The roots are used for dyeing (yellow color). They are dried, pounded and boiled with the clothes (e.g. a monk's belt). About two kg of root is needed for one belt. Alcohol '*raksi*' is added as fixative. (d) Leaves, after washing in fresh water, can be used as a vegetable at the time of scarcity of other vegetables. This was more common in the past, but these days more vegetables are being produced in kitchen gardens. The detailed method of cooking vegetable is same for *A. carolinianum* as mentioned above. This plant is not dried or stored for future use because of its perceived of inferior quality.

(e) In Mustang, root paste is applied on bone fractures and edema once a day until recovered. (f) One spoonful of root paste is drunk with a cup of hot water for lung diseases, liver diseases, joint pain, vomiting and 'air or wind diseases' until recovery. (g) Half a spoonful of whole plant powder is taken with a cup of boiled water/milk to treat dehydration feeling inside the body (Patients drink more water during this disease) once a day until recovery. Effectiveness of medicine increases when it is mixed with other confidential medicines of the Himalaya.

(133) *Salix babylonica L. (Salicaceae); V 4001; 'Jankchhar, Chyanghhama' (T, A). **Dist.: Native of China, cultivated in temperate regions, Nepal** (WCE, 1400-3650m), **Mu.** (way to Tsarang village, 3610m).

(a) The parts between bark and stem are taken. About half a spoonful of paste is taken with a cup of hot water once a day before going to bed for body pain until recovery. This is often used by day labourers. (b) About two spoonfuls of parts between bark and stem are mixed with a cup of water and boiled. Half a cup of decoction is drunk once a day for body pain and excessive menstrual bleeding until recovery. (c) Leaves are taken by goat and sheep as fodder. (d) Cut small wood (1/4 meter) is used for ritual and religious ceremony to worship goddess. The detailed method of use of wood and worship is same as described above in *A. cissifolius* and *Cotoneaster* species. (e) Used as living and non-living fence (cut branches) in upper and lower Mustang. The plants cultivated in the sloppy areas help to check soil erosion. (f) Wood is used as fuelwood and households construction materials.

(134) *Salix lindleyana Wall. (Salicaceae); V 779; 'Langmanackpo' (G). **Dist.: Himalaya** (Kumaun to Sikkim), **W. China**; **Nepal** (CE, 3000-4600m), **Ma.** (way to TankiManang from Yakkharka, 3910m).

(a) Half a spoonful of ground powder (made from leaves and stems) is taken with a cup of hot water once a day after meal for stomachache, diarrhoea and dysentery by mixing with different kinds of medicinal plants (confidential mixture, no details given) until recovery.

(135) *Salvia castanea Diels (Lamiaceae); V 4592; 'Dhursho' (N). **Dist.: Himalaya** (Nepal to Bhutan), **Tibet, China, Nepal** (CE, 1800-4100m), **Mu.** (way to Jomsom from Chele, 3010m).

(a) About, two spoonful of dried stem bark are pounded on stone slab and mixed with other medicines i.e. two spoonfuls of the root of *Boehmeria platyphylla*; special type of cloth called *Banad* (one spoonful the ashes of *Banad* after being heated in the fire). This is in total now became five spoonfuls. Five spoonful of this mixture (medicine) is taken once a day for excessive menstrual bleeding during child birth and hemorrhage. Over dosage taken for above diseases is dangerous becaues over dosage cause over flow of blood.

(136) *Saussurea strahceyana (Kuntze) Lipsch. (Asteraceae); V 517; 'Ta' (G). **Dist.: Himalaya** (Kashmir to Nepal), **Nepal** (WC, 2600-3800m), **Ma.** (way to Pisang from Hongde, 3100m).

(a) About 10g of leaves and stems are collected and pounded on stone slab. The pounded mixture is used as paste on infected part where blood circulation stops and the paste (on the body) is slightly heated by a source of heat. It helps in blood circulation in cold weather and is used especially for older people.

(137) *Saussurea fastuosa (Decne.) Sch. Bip. (Asteraceae); V 415; 'Singamindro' (G). **Dist.: Himalaya** (Uttar Pradesh to Sikkim), **N. Myanmar, S. & W. China, Nepal** (WC, 2900-3800m), **Ma.** (near the agriculture field in Khangshar, 4080m).

(a) About 10 drops of juice is applied in minor cuts to stop bleeding.

(138) *Saussurea graminifolia Wall. ex Dc. (Asteraceae); V 3867; 'Kanglamathoo' (A). **Dist.: Himalaya** (Uttar Pradesh to Bhutan), **China** (Xizang, Yunnan), **Nepal** (CE, 3500-5700m)**, Mu.** (way to Thorang Phedi, 3867m).

(a) About, one spoonful paste of whole plant is taken with a cup of milk/hot water for female diseases (menstrual disorders, menstrual problems, and excessive menstrual bleeding), sinusitis and bone fractures two times a day until recovery. (b) Half a spoonful of whole plant powder is taken with a cup of hot water for wounds, nose bleeds and stomachache two times a day until recovery.

(139) Selinum wallichianum (DC.) Raizada & Saxena (Apiaceae); V 404, 3119; 'Bhutkesh, Tanak' (G, A). **Dist.:** Himalaya (Kashmir, Bhutan), NE India, China, Nepal (WCE, 2700-4800m), **Ma.** (agriculture field of Gangapurna Glacier, 3595m), **Mu.** (way to syangboche village, 3800m),

(a) In Manang, half a spoonful of powder (made from leaves and flowers) is taken with a cup of hot water two times a day after meal for stomachache until recovery. (b) The paste (made from leaves and flowers) is applied on cuts and wounds two times a day until recovery.

(c) In Manang and Mustang, whole plant is dried in sunlight and ground to make powder. The *lama* and/or *amchi* puts half a spoonful of powder on a glowing ember and the scent is inhaled at night by the person who has been affected by a ghost until the person has recovered from the ghost attack. The person affected by the ghost attack becomes sick and needs the healing ritual/ceremony which is done by the *lama* or *amchi*. The local name of the plant '*bhutkesh*' tells of its use against ghost attacks in the community. *Bhut* means 'ghost' in the local language.

(140) *Senecio chrysanthemoides DC. (Asteraceae); V 3819; 'Mara' (G). **Dist.: Pakistan** (Chitral), **Himalaya** (Kashmir to Arunachal Pradesh), **NE India** (Meghalaya), **S. China, Nepal** (WCE, 1400-4000m), **Mu.** (way to Kalopani village, 2500m).

(a) Root is pounded on stone slab. About three spoonfuls is mixed with a cup of hot or cold water and the filtrate (five-six spoonfuls) is drunk three times a day after having meals or breakfast for fever until recovery. The patient will need to drink more water as this treatment increases thirst. The dose is increased according to the condition of patient.

(141) Solanum nigrum L. (Solanaceae); V 3117; 'Jangali vihi' (N). **Dist.: Almost cosmopolitan, Nepal** (WCE, 900-2900m), **Mu.** (near the Chele village, 3025m).

(a) About, one spoonful of fruits paste is mixed with half a spoonful of neer color, ¼ spoonful of '*Banadh*' (cloth ash), ¼ spoonful of *Areca catechu*. Half a spoonful mixture is taken once a day for Pneumonia until recovery. (b) The paste of above mixture is applied on joints of children for Pneumonia once a day until recovery.

(142) Sonchus wightianus DC. (Asteraceae); V 4282; 'Nonnechhar, Nochharee' (G, A). **Dist.: Afghanistan, Pakistan, Himalaya, India, Sri Lanka, Myanmar, China, Malaysia, Nepal** (WCE, 600-2500m), **Mu.** (way to Thini village, 2780m).

(a) About, half a spoonful of whole plant is taken with a cup of hot water once a day for bile disorders until recovery. (b) Leaves are cooked as a vegetable after rinsing with clean water. The method of cooking this vegetable is same as described for *Arisaema flavum* and *Allium* species above. The plant is said to be of inferior quality due to its taste.

(143) Stellera chamaejasme L. (Thymelaeaceae); V 366, 3124; 'Rekemukta, Rechakpa' (G, A). **Dist.: C. Asia, Himalaya** (Garhwal to Bhutan), **Mongolia, S. Siberia, N. China, Nepal** (WC, 2700-4200m), **Ma.** (Chame pasture, 3220m), **Mu.** (way to Tamagaoun from Lomanthang, 3650m).

(a) In Manang, about one-forth of a spoonful of dried root powder with a cup of hot water is used to make a drink to treat infectious diseases (no other detail is given by the healer). (b) The paste of the root is applied to treat pain from swelling due to fractured bone and used as an antiseptic for open wounds until recovery. (c) Half a spoonful of fresh root is boiled with two cups of water and reduced it to a cup. Half a cup of decoction is drunk two times a day for fractured bones and edema (swelling of the body) until recovery. (d) Bark of the stem and root is used to make paper.

(e) In Mustang, about ¼ spoonfuls mixture of root, leaf and flower is taken with a cup of hot water for hand and leg swelling once a day until recovery. (f) The paste of root, leaf and flower is applied on the affected part two times a day until recovery. (g) The paste of root is applied on edema and bone fractures once a day until recovery. (h) Half a spoonful of root powder is drunk with a cup of milk/water once a day for edema and bone fractures until recovery.

(144) Swertia ciliata (D. Don ex G. Don) B.L. Burtt (Gentianaceae); V 199; 'Tiktha' (G). **Dist.: Afghanistan, Himalaya** (Kashmir to Sikkim), **Nepal** (WCE, 2800-4000m), **Ma.** (way to Nar from Phoo village, 4020m).

(a) Whole plant is ground to make powder. Half a spoonful of powder is mixed with a cup of milk or hot water, 2-3 times a day for fever, jaundice, malarial fever, diabetes, cough, cold and headache until recovery. (b) About 5g of pounded whole plant is mixed with two cups of water

and half a cup of decoction is drunk two times a day for fever, jaundice, malarial fever, diabetes, wounds, cough, cold and headache until recovery.

(145) *Swertia racemosa (Griseb.) C.B. Clarke (Gentianaceae); V 861; 'Lakhetiktha' (G). **Dist.: Himalaya** (Nepal to Bhutan), **NE India, China** (Xizang), **Nepal** (WCE, 3000-5000m), **Ma.** (way to Khangshar Yakkharka, 4570m).

(a) Whole plant is ground to make powder. Half a spoonful of powder is mixed with a cup of milk or hot water and drunk 2-3 times a day for fever, jaundice, malarial fever, diabetes, cough, cold and headache until recovery. (b) About 5g of whole plant is pounded and mixed with two cups of water and half a cup of decoction is drunk two times a day for fever, jaundice, malarial fever, diabetes, wounds, cough, cold and headache until recovery.

(146) *Swertia macrosperma (C.B. Clarke) C.B. Clarke (Gentianaceae); V 3898; 'Tithee' (N). **Dist.: Himalaya** (Nepal to Bhutan), **Khasia, Burma**, **Nepal** (CE, 2000-3200m), **Mu.** (way to Kagbeni from Chhuksang, 2900m).

(a) Whole plant is chewed raw for cough and cold until recovery. (b) About two cups of water is mixed with a spoonful paste of whole plant and boiled until it reduces to a cup. One cup of decoction is drunk for cough, cold and fever two times a day until recovery.

(147) *Taraxacum eriopodum DC. (Asteraceae); V 4012. 'Chhayathii/Khurmangh' (A). **Dist.: Himalaya** (Kashmir to Bhutan), **North-East India, Western China, Nepal** (WCE, 3000-4250), **Mu.** (way to Samar from Chele, 3280m).

(a) About, one spoonful of whole plant powder is used for fever from bile disorders and dry mouth at the time of fever once a day until recovery.

(148) *Taraxacum tibetanum Hand.-Mazz. (Asteraceae); V 362, 4421; 'Khurmang, Bhaghaamugphochoo, Khurmoo, Chhayathii/Dhunghiiphool' (G, T, A, N). **Dist.: Himalaya** (Nepal to Bhutan), **Tibet, W. China, Nepal** (C, 4000-4300m), **Ma.** (Chame pasture, 3530m), **Mu.** (way to Eklebhatti from Kagbeni, 2760m).

(a) In Manang, about half a spoonful of powder (made from leaves, stems and flowers) is taken with a cup of hot water two times a day for jaundice fever, fever which comes from inner bone mostly, gastritis and vertigo/dizziness until recovery.

(b) In Mustang, about 100g of root is boiled in two cups of water and half a cup of the decoction is drunk once a day for fever (fever from bile disorder), cough and cold until recovery. (c) Half a spoonful of root paste is drunk with a cup of hot water for gastritis, old fever (fever remaining in the body of the patient without cure since 1-2 month), eyes diseases, decreased vision, infections, bile diseases, headache, bitter mouth taste, loss of appetite, diarrhea and dysentery once a day until recovery.

(149) *Taxus baccata subsp. wallichiana Zucc. (Taxaceae); V 1725, 2489; 'Silingi, Jhamarshine' (G, T). **Dist.**: **Afghanistan, Himalaya** (Kashmir to Bhutan), **NE India, N. Myanmar, Indo-China, W. China, Malaysia; Nepal** (WCE, 2300-3400m), **Mu.** (way to Kalopani forest, 2640m), **Ma.** (way to Chame from Pisang, 2880m).

(a) In Manang and Mustang, about 20 fruits are boiled in two cups of water and half a cup of decoction is drunk once a day after meal for cancer until recovered. (b) Wood is used as fuelwood and furniture. (c) Small cut branches are put as decoration materials by displaying them on the table. (d) Cut small branches are used as fence in the cultivated field.

(e) In Manang, the plant powder (made from leaves and stems) is taken with a cup of hot water two times a day after meal for cancer until recovery. The healers (*amchis*) treatment is confidential (no detailed given by the healers).

(150) *Thalictrum cultratum Wall. (Ranunculaceae); V 801; 'Nagghunensa, Aotin chauque' (G, A). **Dist.: Himalaya** (Kashmir, Uttar Pradesh to Bhutan), **China; Nepal** (WCE, 2400-4200m), **Ma.** (near Manang village, 3500m).

(a) About 10g of leaves and flowers are boiled on two cups of water and half a cup of decoction is drunk two times a day after meal for fever. (b) About half a kg of leaves and flowers are mixed with one kg of wheat flour and for 20L of water, cooked for half an hour and given to animals (horse, yak, and mule) for diarrhoea. (c) The paste of leaves and flowers is applied for boils, wounds and other skin diseases (ringworm and blister) two times a day until recovery.

(151) *Thalictrum alpinum L. (Ranunculaceae); V 3552; 'Chakchha/Jackhhu' (A). **Dist.: N. America, Arctic and Apine Europe and Asia; Nepal** (WCE, 2800-5000m), **Mu.** (way to Chele pasture from Chele village, 3350m).

(a) About, one spoonful of whole plant paste is taken with a cup of hot water for cough, cold, fever, food poisoning, hand and leg pain, joint swelling, joint pain and backbone pain two times a day until recovery. (b) The paste of whole plant is applied in hand, leg and joint to reduce pain once a day until recovery.

(152) Thymus linearis Benth. (Lamiaceae); V 202, 3893; 'Akhino, Macto' (G, A). **Dist.: Afghanistan, Chitral, Pakistan, Himalaya** (Kashmir to Nepal), **Tibet India**, **China, Japan, Nepal** (CW, 2400-4500m), **Ma.** (near Nar village, 4040m), **Mu.** (near Lomanthang village, 3710m).

(a) In Manang, about 10g of leaves, stems and flowers are boiled in two cups of water and half a cup of decoction is drunk at night for eye infection i.e., eye pain and conjunctivitis (eye swollen, red and 'dirty'), gingivitis, to increase blood (during weakness periods) and dyspepsia until recovery.

(b) In Mustang, one spoonful of root is pounded on stone slab and boiled with a cup of water. Half a cup of decoction is drunk three times a day for fever (any kind of fever) until recovery. (c) Half a spoonful of whole plant powder is drunk with a cup of hot water for toothache (tooth pain) once a day until recovery.

(d) In Manang and Mustang, dried plant parts i.e., leaves, stems and flowers are ground to make powder and half a spoonful of powder is drunk with a cup of boiled water two times a day after meal for eye infection i.e., eye pain, conjunctivitis (eye swollen, red and 'dirty'), gingivitis, to increase blood (during weakness periods), stomachache, anthelmintic and dyspepsia until recovery. It helps older people to improve eye sight. (e) Whole plant is first softened by pounding on a stone slab. It is then mixed with chilli and salt powder. This is then used as pickle. Often older people use this pickle because they believe by eating it their eyesight will be improved. It is eaten with food (rice or any dishes) by making '*Chop* in Nepali' (especial kind of pickle in Mustang). *Chop* is prepared by the powder of *Thymus linearis* by mixing with chilly, salt, and *Z. armatum* powder. This mixture is tasty and makes anyone free from loss of appetite.

(153) Urtica dioica L. (Urticaceae); V 364, 3877; 'Sishnoo, Polo/Shaa' (N, G). **Dist.: Europe, Himalaya, W. China, Nepal** (WC, 3000-4500m), **Ma.** (Chame pasture, 3500m), **Mu.** (way to Jhaite village, 3550m).

(a) In Mustang, it is said that if once a year this vegetable (from leaves and stem) is eaten, then any diseases that had remained with the person over a long time would be cured. (b) The vegetable is used to lower blood pressure and to increase blood. *Amchi* prepares medicine by mixing with other confidential medicinal plants. (c) About a kg leaves is mixed with 10-20 cups of water and boiled for sometimes by adding a spoonful powder of *Z. armatum* and a spoonful of salt. The vapor is then sniffed as the patient and the bowl of aromatic water are covered a cotton cloth for ten minutes. This is used to treat edema and urine stopping problems (problems when people are not able to pass urine). It is used because the *amchi* believes that if the swelling of the body extends from the legs up to the neck and reaches the heart, then this water from the legs will enter the heart, resulting in the death of the patient.

(d) In Manang and Mustang, leaves and stems are collected carefully with the helps of wooden forceps and boiled in water for about 5-10 minutes. Additives like salt and chilli powder are added and the mixture is fried in oil/fat (of yak) or *ghee* (clarified butter obtained from milk of Himalayan cow). Spices (*Allium* species and *Z. armatum*) are mixed to flavor the dish. This dish is used as a substitute for lentils/pulse and/or as a vegetable. The plant is also dried in sunlight and stored for future use. One cup of *U. dioica* soup is enough for the single men but additional cups will cause diarrhea because of it is rich in vitamin E. Therefore it is not necessary to use more oil or fat during cooking. (e) Local people said that if birth day of a people uprooting *U. dioica* and germination day meets same than *U. dioica* will not burn that people when touched.

(154) Valeriana jatamansii Jones (Valerianaceae); V 1711, 2389; 'Nappu, Ghyapoo' (G, A). **Dist.: Afghanista, Himalaya** (Kashmir to Bhutan), **NE India, Myanmar, W. & C. China, Nepal** (WCE, 1500-3300m), **Ma.** (way to Bagarchap, 2250m), **Mu.** (way to Larjung village, 2535m).

(a) In Manang, half a spoonful of root powder is taken with a cup of boiled water two times a day after meal for eye pain, conjunctivitis (defined in appendix VII), headache, infected wounds, stomachache, cough, cold and tonsillitis until recovery.

(b) In Mustang, one-forth of a spoonful of root is boiled in a cup of water and reduced to half cup and filter. The filtrate half cup decoction is drunk for headache, cut, wounds and eye diseases once a day until recovery. (c) The paste of root is applied on wounds and boils once a day until recovery. (d) About 100g leaf, is boiled in two cups of water for sometime and one cup of decoction is drunk two times a day for fever (any kinds of fever) until recovery.

(e) In Manang and Mustang, the whole plant is used as incense by mixing with other aromatic plants of that area. It has pleasant smell in both the fresh and dried forms. Five to ten plants are placed on a glowing ember and used as incense in the manner as described above in *Ajania nubigena* and *Nardostachys grandiflora*.

(155) Verbascum thapsus L. (Scrophulariaceae); V 888, 3122; 'Yugisingh, Dhumaserchee' (G, A). **Dist.: Himalaya** (Kashmir to Bhutan), **W. & C. China, Nepal** (WCE, 1800-4000m), **Ma.** (in the way to Brakha from Manang, 3410m), **Mu.** (way to Lomanthang village, 3700m).

(a) In Manang, half a spoonful of flower and leaves powder is taken two times a day after meal with a cup of hot water for cuts, wounds, urinary diseases (diuretic, and dysuria) and edema (swelling of the body) until recovery.

(b) In Mustang, half a spoonful of pounded root is taken with a cup of boiled water to dry wounds, anthelmintic and pain in stomach two-three times a day until recovery. (c) The paste of root is use to dry wounds once a day until recovery. (d) Half a spoonful mixture of flower and seed powder is taken with a cup of hot water for inability to urinate, over bleeding and infection diseases once a day until recovery. The quality of the medicine increased when mixed with 8-16 confidential mixture of the Himalaya. (e) Half a spoonful of whole plant powder is taken with a cup of hot water one-three times a day (according to the condition of patient) for edema and to stop excessive urination. If this disease is known in time and treatment is done by the *amchi* then no side effect will occur to the patients. (f) About two spoonfuls of seeds were boiled in a cup of water and drunk three times a day for stomachache until recovery. (g) One spoonful of flower is dried in a fire and pounded. It is then mixed with mustard oil. This paste is applied on burns once a day until recovery.

(156) Viola biflora L. (Violaceae); V 2297; 'Tamick/Makdhawaa' (A). **Dist.: Europe, Siberia, C. Asia, Himalaya** (Kashmir to Arunachal Pradesh), **W. & N. China, N. Korea, Japan, W. N. America**, Nepal (WCE, 2100-4500m), **Mu.** (4210m, above Lomanthang village i.e., in the pasture).

(a) About half a spoonful of whole plant paste is taken with a cup of hot water three times a day for boils, wounds, bone fractures and headache until recovery. Patients have no side effect when using the medicine and the quality increases when mixed with other confidential mixtures of the Himalaya. (b) Used as a vitamin during loss of appetite by mixing with soup, chili, etc.

(157) Zanthoxylum armatum DC. (Rutaceae); V 1729; 'Prumo' (G). **Dist.: Himalaya** (Kashmir to Bhutan), **N. India**, **East to China**, **Taiwan**, **Philippines**, **Lesser Sunda Islands**, Nepal (WCE, 1100-2500m), **Ma.** (way to Bhratang, 2870m).

(a) The fruits are made into a pickle and eaten to treat cough, cold, tonsillitis, headache, fever, high altitude sickness, numbness of limbs, vertigo/dizziness, diarrhoea and dysentery two times a day until recovery. (b) Dried fruits are powdered and one-forth spoonful of powder is taken with a cup of boiled water for diarrhoea, dysentery and stomachache until recovery. (c) The fruits are chewed and put between teeth for gingivitis and to relieve tooth pain. (d) It is used as the most important pickle in Manang because of its high medicinal value. Powder of seeds of *Z. armatum* is made into a pickle by mixing it with salt and chilli powder. Almost all people eat this kind of mixture pickle with rice, noodle soup, home made bread or other food items.

Key: V: Voucher; G: Gurung; T: Thakali; A: *Amchi*; N: Nepali; D: *Dhami*; J: *Jhakris*; L: *Lama*; Ti: Tibetan; W: West; C: Central; E: East; Ma.: Manang; Mu.: Mustang; Dist.: Distribution.

Appendix VI - List of ailments treated by local traditional healers of Manang and Mustang districts, Nepal grouped by body system	
Body System (Categories)	**Ailments treated by the local traditional healers**
Skin	Warts, wound diseases, wounds on skin, wounds, to dry wounds, wound problems (infections), skin diseases, skin swelling, abrasions, boils, scabies, cuts, burns, ringworm, blisters and allergy.
Cardiovascular	Heart diseases, heart pain and pain near the side of heart.
Respiratory	Shortness of breath, sore throat, chest pain, asthma, bronchitis, reduce sound production (wheezes or stridor) during breathing, difficulty in breathing, increased rate of breathing, tuberculosis, lung diseases and respiratory diseases.
Neurological	Numbness of limbs, paralysis, pulse pain, vein pain, nerve diseases, nerve dispersed conditions and nerve pulse.
Reproductive	Infertility, wounds in vagina, quicken labour and delivery, stop bleeding during child birth, breaks bloods during child birth and pregnant mother.
Gastointestinal	Diarrhoea, dysentery, vomiting, stomachache, stomach diseases, stomach swelling, gastritis, to treat worms (white intestinal worms), anthelmintic, bile disorders, constipation, liver diseases, haemorrhoides, digestive and bile diseases.
Orthopaedic	Heal broken bones, bone fracture, bone pain, bone diseases, back pain, backbone pain, legs pain, fracture of hand and leg, joint pain, to reduce collection of water in joints, extra bone appeared part of the body and swelling (joints and body swelling).
Blood	Blood deficiency, purification of blood, menstrual disorders (heavy flow), over flow of blood during child birth, menstrual problems, high blood pressure, blood circulation, blood diseases, blood filtrate, to clear impure blood, reduce fat in blood and blood coagulating periods (for thinning the blood).
Renal/Urological	Kidney diseases, urinary tract infection, diuretic, dysuria, red urination, diseases from urine, not urine in time and difficulty in passing urine.
Muscular	Increase body size, body massage, waist pain, inflammation of body, rheumatism, neck pain and limbs pain.
ENT	Conjunctivitis, pain in nose (internal or external), nose swelling, stop bleeding from nose, mouth swelling, eye pain, eye diseases, blindness, defects in visions, ear pain, gingivitis, relief tooth pain, worms in teeth, cough, cold, tonsillitis and sinusitis.
Paediatric	Massage the head of children and children diseases.
Other/ Whole body/ Systemic	Fever (any kind of fever i.e., typhoid fever, malaria, blood fever, lungs fever, fever from bile disorders), jaundice, headache, high altitude sickness, vertigo/dizziness, stop sweating, diabetes, cancer, snake bite, scorpion sting, vitamin, nutritious, tonic (to treat weakness), infectious diseases, edema (swelling of the body), body pain, pain from swelling, antipoison, feeling higher level of heat inside the body, to increase sexual desire, to reduce the effect of false medicine, those diseases which are not cured by other medicines, enervate periods, unmanaged body, pain in upper part of the body, to increase hair long and black, to clear hair from face, diseases of elephant and goat, communicable diseases, hand, leg and rib pain, to absorbe water from swelling part of the body, diseases from air/wind, diseases by cold, appetite, to remove fish bone which remains lodged in the throat, feeling of deficient of water inside the body, food poisoning and pneumonia.

Appendix VII – Selected terminology of ailments and their symptoms provided by the healrs of Manang and Mustang.	
Ailments	**Symptoms**
Air/Wind	**Symptoms:** body color blue and thin, hair brown, patient angry while talking, weak, more air comes from mouth, and may get faint due to weakness.
Bile	It is the fluid secreted by the liver and poured into the duodenum as an aid to the digestive process. It is bitter, yellowish or green in colour, and of complex structure. [**Symptoms:** headache (a continuous pain the cranial region of the head), bitter mouth, vomiting, loss of appetite, fever, sleepy and eyes, nail and skin color yellow].
Blood	**Symptoms:** more amount of blood or less amount of blood inside the body, dismatched blood circulation, high blood pressure [Symptoms of high blood pressure often appear after eating too much salt, angry, vertigo/dizziness, headache, urine becomes red in colour with very bad smell), low blood pressure, blood deficiency (white face with white nose and lips, low pulse impulse, low amount of blood in the tongue and urine yellow)].
Boils	A hard inflamed suppurating (forming or secreting pus), tumor (swelling).
Diuretic	**Symptoms:** yellow eyes, hands and legs, and patient cannot sit in direct sun.
Edema	**Symptoms:** body swelling due to cold.
Eye	**Symptoms:** eye becomes red, pain in eyes, vision difficulties, and other diseases associated with eye, conjunctivities (**Symptoms** of conjunctivitis are: eye swollen, red and become dirty).
Fever	Abnormal increase in the body temperature (**symptoms:** any disease having high temperature, Sleepy, thirsty, tongue bitter, typhoid fever (no more interest to talk, loss of appetite and continuous fever).
Gastritis	Stomachache [pain in the stomach or abdomens], loss of appetite, constipation, air remains inside the stomach, citrus water come from mouth and brown color vomit called **ulcer** (an erosive solution of contyinuity in any externalor internal surface of the body, forming a purulent open sore.
Haemorr-hoides	A disease characterized by tumors on the veins about the anus, [**Symptoms: blood comes in stool, pain in the anus]**.
Heart	Continuous pain in the chest and heart, increase heart beat and difficulty in breathing.
High altitude sickness	Vomiting (**symptoms:** citrus water comes from the mouth and loss of appetite), **vertigo/dizziness** [having a sensation of vertigo in the head with proneness to fall], headache, eyes become red and blue due to extreme cold, and shortness of breath.
Jaundice	A morbid condition caused by obstruction of the bile [**Symptoms:** yellowness of the conjunctiva, skin, fluid, and tissues, and by constipation, loss of appetite, weakness, continuous fever, absence of water in the mouth so patient fell thirsty and drinks a lot of water, feet cold, eyes, hands, legs, nail, urine and stool become yellow and difficult or painful urination (dysuria)].
Kidney	**Symptoms:** pain around ribs, backache and pain moves towards thigh and knees from ribs; low listening power; telephone like voice come from the ear and menstrual periods becomes unusal.
Leg pain	Painful part of the legs cannot be straightened by the patient.
Liver	**Symptoms:** stomachache, pain in left part of the stomach and upper part of the body, upper and lower lips black, high fever, loss of appetite, bitter mouth, red face, red eyes and **pus** (a yellowish-white, opaque, somewhat viscid matter, produced by suppuration; it consists of a colourless fluid in which white corpuscles are suspended) inside liver.

Lungs	**Symptoms:** asthma, bloody cough, pus from lungs in cough, and shape of nose irregular in right and left side.
Mad	Person without functioning of the sensory organs and becomes without sense.
Pneumonia	Inflammation of the lings from infection of viruses or bacteria (**symptoms:** patients cannot speak properly, nose becomes dry, children feel sleepy, close his/her eyes and ribs become weak).
Respiratory	**Symptoms:** asthma (a chronic, paroxysmal disorder of respiratation, characterized by difficulty in breathing), more sound production (wheezes or stridor) during breathing and walking, and bronchitis (inflammation of the air-passages in the lungs, either acute or chronic).
Sinusitis	**Symptoms:** headache, cough stops, vertigo or dizziness, continuous pain in nose and eyes and loss of appetite.
Skin wounds	Smalls wounds appear in the body and wounds are rubbed by the hands.
Snake	**Symptoms:** body swelling, hands and legs, cannot work, become serious and patient feels snake running in their body.
Tuberculosis (TB)	**Symptoms:** [continuous body pain, color of cough (a diseased condition of the respiratory organs manifesting itself in fits of coughing] turns from white to brown, sound production (wheezes or stridor) during breathing and this happened when a lung is not properly working, patients become thin, blood in vomit, vertigo/dizziness and headache].
Urinary tract infection	**Symptoms:** [urine yellow to red and with a bad smell, increased volume of the blood in the body].
Urine	**Symptoms:** patients become weak; urine may stop by high fever or by more cold.
Water deficient	**Symptoms:** mouth becomes dry, thirsty and loss of appetite.

Source: Information compiled of the interviewees of the field visits.

Appendix VIII – Ethnobotanical Uses of Medicinal Plants of Manang and Mustang Districts, Nepal	
Use Category	**Plant Species**
Medicinal (157 spp)	*Abies spectabilis, Acanthopanax cissifolius, Aconitum naviculare, Aconitum orochryseum, Aconitum spicatum, Allium carolinianum, Allium fasciculatum, Allium oreoprasum, Allium prattii, Allium wallichii, Alnus nepalensis, Amaranthus lividus, Anaphalis nepalensis, Anaphalis triplinervis, Androsace robusta, Androsace muscoidea, Androsace strigillosa, Androsace tapete, Anemone rivularis, Anisodus luridus, Arabidopsis himalaica, Arctium lappa, Argyrolobium roseum, Arisaema flavum, Arisaema jacquemontii, Arnebia benthamii, Artemisia biennis, Artemisia caruifolia, Artemisia dubia, Artemisia gmelinii, Artemisia indica, Asparagus filicinus, Aster diplostephioides, Aster stracheyi, Astilbe rivularis, Berberis angulosa, Berberis aristata, Berberis ceratophylla, Berberis koehneana, Berberis lycium, Berberis mucrifolia, Bergenia ciliata, Betula utilis, Bistorta affinis, Bistorta macrophylla, Bupleurum longicaule, Cannabis sativa, Caragana brevispina, Caragana gerardiana, Caragana jubata, Carum carvi, Chenopodium foliolosum, Cicerbita macrorhiza, Cirsium wallichii, Cissampelos pareira, Clematis barbellata, Clematis tibetana, Clematis vernayi, Clinopodium umbrosum, Convolvulus arvensis, Cordyceps sinensis, Corydalis govaniana, Cupressus torulosa,Cynanchum canescens, Cynoglossum zeylanicum, Dactylorhiza hatagirea,Datura stramonium,Delphinium brunonianum, Delphinium stapeliosum,Descurainia Sophia, Dicranostigma lactucoides, Elsholtzia eriostachya,Ephedra gerardiana, Erysimum hieraciifolium, Euphorbia longifolia, Fragaria nubicola,Galium boreale, Gentiana robusta, Geranium donianum, Gynura nepalensis, Halenia elliptica, Hedychium ellipticum, Heracleum candicans, Hippophae salicifolia, Hippophae tibetana, Hyoscyamus niger, Incarvillea arguta, Isodon rugosus, Juglans regia, Juniperus communis, Juniperus indica, Juniperus squamata, Lancea tibetica, Leontopodium monocephalum, Lilium nepalense, Lindelofia longiflora, Lonicera myrtillus, Lonicera rupicola, Maharanga bicolor, Maharanga emodi, Malva verticillata, Meconopsis napaulensis, Mentha longifolia, Mirabilis himalaica, Morchella conica, Morchella esculenta, Morina polyphylla, Myricaria rosea,Nardostachys grandiflora, Neopicrorhiza scrophulariiflora, Onopordum acanthium,Origanum vulgare, Oxyria digyna, Oxytropis willamsi, Paris polyphylla, Pedicularis longiflora, Pinus wallichiana, Plantago erosa, Polygonatum cirrhifolium, Populus ciliata, Prunella vulgaris, Ranunculus laetus, Rheum australe, Rheum moorcroftianum, Rhodiola quadrifida, Rhododendron anthopogon, Rhododendron campanulatum, Rhododendron lepidotum, Rosa macrophylla, Rosa sericea, Rubus foliolosus, Rumex nepalensis, Salix babylonica, Salix lindleyana, Salvia castanea, Saussurea strahceyana, Saussurea fastuosa, Saussurea graminifolia, Selinum wallichianum, Senecio chrysanthemoides, Solanum nigrum, Sonchus wightianus, Stellera chamaejasme, Swertia ciliata, Swertia racemosa, Swertia macrosperma, Taraxacum eriopodum, Taraxacum tibetanum, Taxus baccata* subsp. *wallichiana, Thalictrum cultratum, Thalictrum alpinum, Thymus linearis, Urtica dioica, Valeriana jatamansii, Verbascum thapsus, Viola biflora and Zanthoxylum armatum.*
Cooked as a vegetable (14 spp)	*Allium carolinianum, Allium fasciculatum, Allium oreoprasum, Allium prattii, Allium wallichii, Amaranthus lividus, Arisaema flavum, Arisaema jacquemontii, Chenopodium foliolosum, Morchella conica, Morchella esculenta, Rumex nepalensis, Sonchus wightianus* and *Urtica dioica.*

Eaten raw as fruit or a snake (19 spp)	*Berberis angulosa*, *Berberis aristata*, *Berberis koehneana*, *Berberis mucrifolia*, *Berberis ceratophylla*¸ *Berberis lycium*, *Caragana brevispina*, *Caragana jubata*, *Caragana gerardiana*, *Chenopodium foliolosum*, *Fragaria nubicola*, *Hippophae salicifolia*, *Hippophae tibetana*, *Juglans regia*, *Lonicera myrtillus*, *Lonicera rupicola*, *Rosa macrophylla*, *Rosa sericea*, and *Rubus foliolosus*.
Processed and drunk as juice (3 spp)	*Fragaria nubicola*, *Hippophae salicifolia* and *Hippophae tibetana*.
Spices (6 spp)	*Allium carolinianum*, *Allium fasciculatum*, *Allium oreoprasum*, *Allium prattii*, *Allium wallichii* and *Zanthoxylum armatum*.
Achar (12 spp)	*Allium carolinianum*, *Allium fasciculatum*, *Allium oreoprasum*, *Allium prattii*, *Allium wallichii*, *Asparagus filicinus*, *Cannabis sativa*, *Hippophae salicifolia*, *Mentha longifolia*, *Rheum australe*, *Thymus linearis* and *Zanthoxylum armatum*.
Used as living fence (9 spp)	*Berberis aristata*, *Berberis angulosa*, *Berberis ceratophylla*¸ *Berberis lycium*, *Hippophae salicifolia*, *Rosa macrophylla*, *Rosa sericea*, *Salix babylonica*, and *Populus ciliata*.
Cut for fence (30 spp)	*Abies spectabilis*, *Acanthopanax cissifolius*, *Alnus nepalensis*, *Berberis angulosa*, *Berberis aristata*, *Berberis ceratophylla*¸ *Berberis koehneana*, *Berberis lycium*, *Berberis mucrifolia*, *Betula utilis*, *Caragana brevispina*, *Caragana jubata*, *Caragana gerardiana*, *Cupressus torulosa*, *Hippophae salicifolia*, *Hippophae tibetana*, *Juglans regia*, *Juniperus communis*, *Juniperus indica*, *Juniperus squamata*, *Lonicera myrtillus*, *Lonicera rupicola*, *Pinus wallichiana*, *Populus ciliata*, *Rosa macrophylla*, *Rosa sericea*, *Rubus foliolosus*, *Rhododendron campanulatum*, *Salix babylonica*, and *Taxus baccata* subsp. *wallichiana*.
Fuelwood (29 spp)	*Abies spectabilis*, *Acanthopanax cissifolius*, *Alnus nepalensis*, *Berberis aristata*, *Berberis koehneana*, *Berberis angulosa*, *Berberis mucrifolia*, *Berberis ceratophylla*, *Berberis lycium*, *Betula utilis*, *Caragana brevispina*, *Caragana jubata*, *Caragana gerardiana*, *Cupressus torulosa*, *Ephedra gerardiana*, *Hippophae salicifolia*, *Juglans regia*, *Juniperus communis*, *Juniperus indica*, *Juniperus squamata*, *Lonicera myrtillus*, *Lonicera rupicola*, *Pinus wallichiana*, *Populus ciliata*, *Rosa macrophylla*, *Rosa sericea*, *Rhododendron campanulatum*, *Salix babylonica*, and *Taxus baccata subsp. wallichiana*.
Incense (19 spp)	*Anaphalis nepalensis*, *Anaphalis triplinervis*, *Artemisia biennis*, *Artemisia caruifolia*, *Artemisia dubia*, *Artemisia gmelinii*, *Artemisia indica*, *Cupressus torulosa*, *Juniperus indica*, *Juniperus squamata*, *Juniperus communis*, *Myricaria rosea*, *Nardostachys grandiflora*, *Origanum vulgare*, *Oxytropis willamsii*, *Rhododendron anthopogon*, *Rhododendron campanulatum*, *Rhododendron lepidotum* and *Valeriana jatamansii*.
Ritual and Religious plants (27 spp)	*Acanthopanax cissifolius*, *Aconitum spicatum*, *Anaphalis nepalensis*, *Anaphalis triplinervis*, *Artemisia biennis*, *Artemisia caruifolia*, *Artemisia dubia*, *Artemisia gmelinii*, *Artemisia indica*, *Betula utilis*, *Cupressus torulosa*, *Juniperus communis*, *Juniperus indica*, *Juniperus squamata*, *Maharanga bicolor*, *Maharanga emodi*, *Myricaria rosea*, *Nardostachys grandiflora*, *Origanum vulgare*, *Oxytropis willamsii*, *Pinus wallichiana*, *Rhododendron anthopogon*, *Rhododendron campanulatum*, *Rhododendron lepidotum*, *Salix babylonica*, *Selinum wallichianum*, and *Valeriana jatamansii*.

Construction materials (5 spp)	*Abies spectabilis*, *Betula utilis*, *Pinus wallichiana*, *Populus ciliata*, and *Salix babylonica*.
Decoration materials (11 spp)	*Abies spectabilis*, *Anaphalis nepalensis*, *Cupressus torulosa*, *Gentiana robusta*, *Juniperus communis*, *Juniperus indica*, *Juniperus squamata*, *Lilium nepalense*, *Pinus wallichiana*, *Rosa macrophylla*, and *Taxus baccata* subsp. *wallichiana*.
Dye and soap (5 spp)	*Arnebia benthamii*, *Asparagus filicinus*, *Maharanga bicolor*, *Maharanga emodi* and *Rumex nepalensis*.
Fodder (19 spp)	*Alnus nepalensis*, *Arnebia benthamii*, *Artemisia biennis*, *Artemisia caruifolia*, *Artemisia dubia*, *Artemisia gmelinii*, *Artemisia indica*, *Caragana brevispina*, *Caragana jubata*, *Caragana gerardiana*, *Clematis barbellata*, *Clematis tibetana*, *Clematis vernayi*, *Ephedra gerardiana*, *Incarvillea arguta*, *Convolvulus arvensis***,** *Oxytropis willamsii*, *Ranunculus laetus***,** and *Salix babylonica*.
House hold articles (4 spp)	*Abies spectabilis*, *Betula utilis*, *Pinus wallichiana* and *Taxus baccata* subsp. *wallichiana*.
Manure (9 spp)	*Alnus nepalensis*, *Amaranthus lividus*, *Anisodus luridus*, *Cupressus torulosa*, *Juniperus communis*, *Juniperus indica*, *Juniperus squamata*, *Malva verticillata* and *Pinus wallichiana*.
Paper (2 spp)	*Betula utilis* and *Stellera chamaejasme*.
Recreational drug (4 spp)	*Anisodus luridus*, *Cannabis sativa*, *Datura stramonium* and *Hyoscyamus niger*.
Others (2 spp)	*Arctium lappa* and *Mirabilis himalaica*.

Appendix IX - Activities of some Nepalese ethnomedicinal plant extracts, against a variety of both Gram-positive and Gram-negative bacteria							
Scientific name (Family), V number	**Parts used**	**Results of antibacterial testing**					
		S.t.	**S.a.**	**P.a**	**S.f.**	**E.c.**	**B.s.**
Tetracycline (Positive control)		+	+	+	+	+	+
Ciprofloxacin (Positive control)		+	+	+	+	+	+
Erythromycin (Positive control)		+	+	+	+	+	+
Methanol (Negative control)		-	-	-	-	-	-
Abies spectabilis (Pinaceae), V 342.	L & C	nt	+	-	nt	+	+
Aconitum naviculare (Ranunculaceae), V 295.	Wp	-	-	-	-	+	nt
Aconitum spicatum (Ranunculaceae), V 3457.	Rt	nt	-	-	nt	-	-
Androsace strigillosa (Primulaceae), V 169.	Wp	nt	+	-	nt	+	-
Anemone rivularis (Ranunculaceae), V 492.	Wp	nt	+	+	nt	+	+
Anisodus luridus (Solanaceae), V 3111.	Fl	-	-	-	-	-	nt
Arisaema jacquemontii (Araceae), V 4333.	Rt	nt	+	+	nt	+	+
Arnebia benthamii (Boraginaceae), V 3102.	Wp	nt	+	+	nt	+	+
Artemisia caruifolia (Asteraceae), V 4003.	Wp	nt	+	+	nt	+	+
Artemisia gmelinii (Asteraceae), V 4004.	L, S & Fl	-	-	-	-	+	nt
Artemesia gmelinii (Asteraceae), V 4004.	Wp	nt	+	+	nt	+	-
Artemisia indica (Asteraceae), V 4005.	Wp	nt	+	-	nt	+	+
Asparagus filicinus (Liliaceae), V 2125.	St	nt	+	+	nt	+	+
Asparagus racemosus (Liliaceae), V 2406.	Rt	nt	+	+	nt	+	+
Aster diplostephioides (Asteraceae), V 3092.	Fl	+	+	+	+	+	nt
Astilbe rivularis (Saxifragaceae), V 3076.	Rt	nt	+	+	nt	+	+
Berberis angulosa (Berberidaceae), V 3557.	Rt	+	+	+	+	+	nt
Berberis aristata (Berberidaceae), V 4567.	Br	nt	+	+	nt	+	+
Berberis ceratophylla (Berberidaceae), V 4334.	Br	-	+	-	-	-	nt
Berberis mucrifolia (Berberidaceae), V 4010.	Br	nt	+	+	nt	+	+
Bergenia ciliata (Saxifragaceae), V 3052.	Rt	nt	+	+	nt	+	+
Betula utilis (Betulaceae), V 201.	L & B	+	-	-	-	-	nt
Bistorta affinis (Polygonaceae), V 3083.	R	-	-	-	-	-	nt
Bistorta affinis (Polygonaceae), V 3083.	Wp	nt	+	+	nt	+	+
Bistorta macrophylla (Polygonaceae), V 132.	R	-	+	-	-	+	nt
Caragana brevispina (Fabaceae), V 5432.	Sd	nt	+	-	nt	+	-
Caragana gerardiana (Fabaceae), V 4006.	Fl	nt	+	+	nt	-	-
Cissampelos pareira (Menispermaceae), V 2435.	Rt & L	nt	+	+	nt	+	+
Clematis barbellata (Ranunculaceae), V 3097.	L & Fl	+	-	-	+	+	nt
Cupressus torulosa (Cupressaceae), V 4017.	Sd	nt	+	+	nt	+	+
Cynoglossum zeylanicum (Boraginaceae), V 145.	Fl	-	-	-	-	-	nt
Dactylorhiza hatagirea (Orchidaceae), V 3028.	Rt	+	+	+	+	+	nt
Delphinium brunonianum (Ranunculaceae), V 261.	Wp	+	+	+	+	+	nt

Delphinium brunonianum (Ranunculaceae), V 261.	Wp	nt	+	+	nt	+	-
Delphinium stapeliosum (Ranunculaceae), V 255.	Wp	+	-	-	-	-	nt
Dicranostigma lactucoides (Papaveraceae), V 4105.	Wp	nt	+	+	nt	+	+
Ephedra gerardiana (Ephedraceae), V 4008.	R	+	+	-	+	-	nt
Ephedra gerardiana (Ephedraceae), V 4008.	Wp	nt	+	+	nt	+	+
Ephedra gerardiana (Ephedraceae), V 4008.	L	nt	+	+	nt	-	+
Euphorbia longifolia (Euphorbiaceae), V 2018.	Rt	nt	+	+	nt	+	+
Galium boreale (Rubiaceae), V 123.	Wp	-	-	-	-	-	nt
Gentiana robusta (Gentianaceae), V 170.	Wp	nt	+	+	nt	+	+
Geranium donianum (Geraniaceae), V 153.	L, & Fl	nt	+	+	nt	+	+
Heracleum candicans (Apiaceae), V 2972.	R	nt	+	+	nt	+	+
Hippophae salicifolia (Elaeagnaceae), V 2246.	Fr	nt	+	+	nt	+	+
Hippophae tibetana (Eleagnaceae), V 3082.	Sd	nt	+	+	nt	+	+
Hyoscyamus niger (Solanaceae), V 2236.	Sd	nt	+	+	nt	+	+
Juglans regia (Juglandaceae), V 2135.	Fr	nt	+	-	nt	+	+
Juniperus indica (Cupressaceae), V 277.	L & Br	+	+	+	+	+	nt
Juniperus indica (Cupressaceae), V 277.	Sd	+	+	+	+	+	nt
Lancea tibetica (Scrophulariaceae), V 2994.	Wp	nt	+	+	nt	+	+
Lonicera rupicola (Caprifoliaceae), V 3550.	L, St, Fl	nt	+	+	nt	+	+
Lonicera myrtillus (Caprifoliaceae), V 3562.	L, St, Fl	nt	+	+	nt	-	-
Maharanga bicolor (Boraginaceae), V 255.	Rt	nt	+	+	nt	+	+
Maharanga emodi (Boraginaceae), V 2071.	Rt	nt	+	+	nt	+	+
Malva verticillata (Malvaceae), V 156.	L, Fl, S	+	-	-	+	-	nt
Malva verticillata (Malvaceae), V 156.	Rt	nt	-	-	nt	+	+
Mentha longifolia (Lamiaceae), V 275.	L, & St	-	-	-	-	-	nt
Mirabilis himalaica (Nyctaginaceae), V 4035.	L & Fl	-	-	-	-	+	nt
Mirabilis himalaica (Nyctaginaceae), V 4035.	Wp	nt	-	+	nt	-	-
Morina polyphylla (Dipsacaceae), V 2079.	Rt	nt	+	+	nt	+	+
Myricaria rosea (Tamaricaceae), V 320.	L & S	+	+	-	+	+	nt
Nardostachys grandiflora (Valerianaceae), V 256.	Wp	+	+	+	+	+	nt
*Neopicrorhiza scrophulariiflo*ra (Scrophulariaceae), V 431.	Rt	+	+	+	+	+	nt
*Neopicrorhiza scrophulariiflo*ra (Scrophulariaceae), V 431.	Rt	nt	+	+	nt	+	+
Onopordum acanthium (Asteraceae), V 165.	Rt	-	+	+	+	-	nt
Origanum vulgare (Lamiaceae), V 2224.	Wp	nt	+	-	nt	+	+
Oxyria digyna (Polygonaceae), V 3561.	Wp	nt	-	+	nt	+	+
Pinus wallichiana (Pinaceae), V 276.	Br	+	+	+	+	+	nt
Pinus wallichiana (Pinaceae), V 276.	Lx	+	+	+	+	+	nt
Polygonatum cirrhifolium (Liliaceae), V 238.	Wp	+	+	+	+	+	nt
Pterocephalus hookeri (Dipsacaceae), V. 4089.	Wp	nt	-	+	nt	+	-

Ranunculus laetus (Ranunculaceae), V 4001.	Wp	nt	+	+	nt	-	+
Rheum australe (Polygonaceae), V 3085.	Rt	nt	+	+	nt	+	+
Rhododendron anthopogon (Ericaceae), V 210.	L, S, Fl	+	-	-	-	-	nt
Rhododendron anthopogon (Ericaceae), V 210.	L, & Fl	nt	+	+	nt	+	+
Rhododendron lepidotum (Ericaceae), V 2122.	L, & Fl	nt	+	+	nt	+	+
Rosa macrophylla (Rosaceae), V 345.	Fr	nt	+	-	nt	+	+
Rosa sericea (Rosaceae), V 102.	Fr	nt	+	+	nt	+	+
Rubus foliolosus (Rosaceae), V 2019.	Rt	nt	+	+	nt	+	+
Rumex nepalensis (Polygonaceae), V 284.	Rt	+	+	+	+	+	nt
Salix babylonica (Salicaceae), V 4002.	Br	nt	-	+	nt	-	-
Salix serpyllum (Salicaceae), V 2015.	L, & S	nt	+	+	nt	+	+
Selinum wallichianum (Apiaceae), V 435.	Rt	nt	+	+	nt	+	+
Selinum wallichianum (Apiaceae), V 435.	L & Fl	nt	+	+	nt	+	+
Stellera chamaejasme (Thymelaeaceae), V 3072.	Rt	nt	+	+	nt	+	+
Swertia ciliata (Gentianaceae), V 311.	Wp	+	+	+	+	+	nt
Thalictrum cultratum (Ranunculaceae), V 121.	L, Rt, Fl	-	+	-	-	-	nt
Thalictrum cultratum (Ranunculaceae), V 121.	L, & Fl	nt	+	+	nt	+	+
Thymus linearis Benth. (Lamiaceae), V 126.	Wp	nt	+	+	nt	+	+
Urtica dioica (Urticaceae), V 3553.	L & St	nt	+	+	nt	-	-
Valeriana jatamansii (Valerianaceae), V 2072.	Rt	nt	+	+	nt	+	+

Key: Parts used refers to the part of the plant extracted and tested: L, leaves; Fl, flowers; WP, whole plants; R, roots; S, Stems; B, bark; Lx, latex; Sd, seeds; +: testing resulted in a zone of inhibition, indicating the presence of antibacterial activity, -: testing resulted in no zone of inhibition, indicating the absence of antibacterial activity, Test organisms: *S.a.*: *Staphylococcus aureus*,*P.a.*: *Pseudomonas aeruginosa*, *S.t.*:*Salmonella typhi*, *S.f.*:*Streptococcus faecalis*, *E.c.*: *Escherichia coli*, *B.s.*: *Bacillus subtilis*; nt: not tested; nc: V number not available

Appendix X - Traditional uses of ethnomedicinal plants of Nepal collected from Manang and Mustang districts, including literature uses		
Scientific name	**Parts used**	**Traditional uses**
Abies spectabilis	L, C & N	Broken bones, asthma, bronchitis, cough, cold, rheumatism, haemoptysis, nasal congestion, whooping cough (Bhattarai, 1992; Bhattarai, 1993a; Joshi and Edington, 1990; Manandhar, 2002; Bhattarai *et al*., 2006b).
Aconitum naviculare	Wp & R	Fever, blood fever, headache, bile diseases, cough, poison, wind diseases, kidney diseases, intestines diseases, liver diseases (Bista and Bista, 2005; Bhattarai *et al*., 2006b).
Aconitum spicatum	Wp & R	Poison, antipyretic, analgesic, infected wounds; tonic, to counteract the effects of poison, poisonous animal stings or bites, boils, fever, allergy, edema, cuts, wounds (Rajbhandari *et al*., 1995; Manandhar, 2002).
Allium oreoprasum	Wp	Cough, cold, headache, tonsillitis, stomachache, white intestinal worms, high altitude sickness (Bhattarai *et al*., 2006b).
Allium wallichii	Wp & B	Fever, tonsillitis, cough, cold, loss of appetite, periods of weak or lethargic, cholera, diarrhea, headache, to alleviate altitude sickness (Manandhar, 2002).
Androsace strigillosa	WP, Fl, L & R	Edema, fever, skin swelling, boils on tongue, lymph fluid disorders, wounds (Kletter and Krieckbaum, 2001; Lama *et al*., 2001; Manandhar, 2002; Bhattarai *et al*., 2006b).
Anemone rivularis	Wp, L, Sd, Fr & R	Colds, white intestinal worms, stomachache, edema, cough, fever, sinusitis, restoring body heat, wounds, liver and bile disorders, indigestion, dries lymph fluid, vomiting, improve body heat (Bhattarai, 1992, 1993a, 1993b, 1997; Kletter and Krieckbaum, 2001; Lama *et al*., 2001; Bista and Bista, 2005; Bhattarai *et al*., 2006b).
Anisodus luridus		Teeth affected by worms, gingivitis, to relieve tooth pain (Bhattarai *et al*., 2006b).
Arisaema jacquemontii	R, Fl & Fr	Nose pain, eye pain, warts, stimulates menstruation, treating suffocation, abnormal growth of new bone tissue, worm infestation, chesty infection, stomach pain, toothache, imbalances of menstrual disorders, rheumatisms, bone ache, swelling (Kletter and Krieckbaum, 2001; Lama *et al*., 2001; Bista and Bista, 2005; Bhattarai *et al*., 2006b).
Arnebia benthamii	Wp	Unmanaged pain in upper part of the body, lungs disease, to increase hair, hemorrhoids, to remove facial hair, chronic fever, blood fever, swelling, poisoning (Bista and Bista, 2005).
Artemisia caruifolia	Wp, L, & S	Asthma, cough, cold, fever in the lungs, allergies of the skin (Manandhar 2002).
Artemisia gmelinii	L, S & Fl	Fever, cough, cold, sore throat, nose swelling, ear pain, allergies, skin wounds (Bhattarai *et al*., 2006).
Artemisia indica	Wp & L	Anthelmintic, expectorant, stomachic, antiseptic, emmenagogue, dyspepsia, hemorrhage, menorrhagia, diarrhea, dysentery, abdominal pains, conjunctivitis, wounds, tonic, antispasmodic, asthma, headache, cuts, profuse menstruation, appetite, carminative, diuretic, expectorant, stimulant, abortifacient, anthelmintic, cough, ringworm, sinusitis (Manandhar, 2002).

Asparagus filicinus	R	Menstrual disorders, to increase body size, to stop bleeding from nose, heart diseases, stomach disorders, skin diseases, lactation, weakness, excessive menstrual bleeding, nasal bleeding, diarrhoea, dysentery, diuretic, tonic, urinary-tract infection, and detergent (Kletter and Krieckbaum, 2001; Lama *et al*., 2001; Bhattarai *et al*., 2006b).
Asparagus racemosus	R	Tonic, to increases sperms, to increase lactation, demulcent, diuretic, aphrodisiac, expectorant, galactagogue, cooling, alternative, appetizing, antispasmodic, stomachic, astringent, dysentery, diarrhoea, tumours, inflammations, biliousness diseases of the blood, eye diseases, throat complaints, tuberculosis, leprosy, elilepsy, night blindness, scalding urine, rheumatism, dyspepsia, gonorrhea, refrigerant, antiseptic, flatulence, bile, painful urination, worms, expelling the placenta of animals after delivery, mulching disorders, amenorrhea, kidney and liver troubles, impotency, pimples (Rajbhandari *et al*., 1995; Muller-Boker, 1999; Manandhar, 2002; Bhattarai, 2007).
Aster diplostephioides	Fl	Fever, wounds, chest pain, nerves diseases, anti-poison, stomach diseases, liver diseases (Bhattarai *et al*., 2006b).
Astilbe rivularis	Wp, R & Rh	Fever, vertigo/dizziness, headache, infertility, tonic, pre and post pregnancy, hemorrhage, diarrhoea, dysentery, energetic toothache, sore throat, cough, post natal body-aches, sprains, muscular swellings, prolapse of the uterus, excessive bleeding during menstruation, peptic ulcer, (Bhattarai, 1993b, 1993d; Manandhar, 2002; Oli, 2003; Gurung, 2003; IUCN, 2004; Bhattarai *et al*., 2006b).
Berberis angulosa	Fl, L & R	Cough, cold, fever, dysentery, jaundice, eye pain, kidney diseases, bile disorders, imbalances of dysentery, eye diseases, bile disorders, intestine fever (Bista and Bista, 2005; Bhattarai *et al*., 2006b).
Berberis aristata	Fl, L, R B & Wd	Edema, eyes diseases, vitamins, bile disorders, diarrhea, dysentery, jaundice, skin diseases, hemorrhagic, malarial fever (Rajbhandari *et al*., 1995; Manandhar, 2002; Bhattarai *et al*., 2006b).
Berberis ceratophylla	B, Fl, Fr & S	Fever, vitamins, edema, nerve dispersed conditions (Bhattarai *et al*., 2006b).
Berberis mucrifolia	Fl, Fr & S	Kidney diseases and bile disorders.
Bergenia ciliata	R, Wp, Rh & L	Stomachache, blindness, dysentery, diarrhoea, haemorrhoids, asthma, gout, indigestion, backache, colic, anthelmintic, fever, astringent, diuretic, demulcent, aphrodisiac, pulmonary affections, renal, muscular calculus, ophthalmia, in dissolving kidney stones, boils, urinary troubles, oral inflammation, infection, antipyretic, dislocated bones, sprains, cough, colds, tonic, carminative, strain, blood purifier, pneumonia, sore throat, fractured bones, child birth, body and joint pain, maternity problem, abdominal pain, round worms (Bhattarai, 1992, 1993a, 1993b, 1993c; Edwards, 1996; Rai *et al*., 2000; Manandhar, 2002; Devkota and Karmacharya, 2003; Gurung, 2003; Kunwar and Duwadee, 2003; Oli, 2003; Bhattarai *et al*., 2006b).
Betula utilis	B & L	Carminative, antiseptic, hysteria, cuts, wounds, burns, jaundice,

		relieve earache, boils, fever (Manandhar, 2002; Bhattarai *et al*., 2006b).
Bistorta affinis	R, L, Fl, & Fr	Cough, cold, tonsillitis, fever, diarrhoea, dysentery, to increase blood in the period of blood deficiency (Kletter and Krieckbaum, 2001; Bhattarai *et al*., 2006b).
Bistorta macrophylla	R	Diarrhoea, dysentry, typhoid fever (Manandhar, 2002; Bhattarai *et al*., 2006b).
Caragana brevispina	Fl	Blood diseases (any blood diseases), as a blood purifier, liver diseases, diseases of urine, rib pain, tonic, allergy.
Caragana gerardiana	Fl & Fr	Fever.
Carum carvi	Sd, Wp & Fr	Headache, cough, cold, tonic, carminative, dyspepsia, spasmodic problems, appetite, muscular swellings, stomachic disorder, digestive, stimulant, expectorant, emmenagogue, astringent, antimicrobial, eye diseases, food poisoning, swelling of breast and testicles, gastro-intestinal disorders, flatulence, imbalances of wind fever, poison, eye disease, heart fever (Rajbhandari *et al*., 1995; CSIR, 2000; Joshi and Joshi, 2001; Kletter and Kriechbaum, 2001; Manandhar, 2002; Bista and Bista, 2005; Bhattarai *et al*., 2006b).
Cissampelos pareira	Wp & R	Gastritis, stomachache, headache, diuretic, purgative, dyspepsia, diarrhoea, dropsy, cough, urinary troubles, snake bite, tonic, fever, indigestion, soothe the pain of dislocated bones, skin diseases, gonorrhoea, colic, swelling of gums, peptic ulcers, painful urination, colds, wounds, constipation, urinary-tract infection (Rajbhandari *et al*., 1995; Manandhar, 2002; Bhattarai, 2007).
Clematis barbellata	L & Fl	Boils, scabies, cuts, wounds, fracture of hand, leg, back pain, waist pain, cough, cold, stomachache, diarrhoea, dysentery, sinusitis, headache (Manandhar, 2002; Bhattarai *et al*., 2006b).
Cupressus torulosa	Fr	Body ache, leg pain, sinusitis, gingivitis, mouth swollen.
Cynoglossum zeylanicum	Wp & Fl	Ringworm, indigestion, cuts, wounds, boils, conjunctivitis (Manandhar, 2002; Bhattarai *et al*., 2006b).
Dactylorhiza hatagirea	R	Expectorant, astringent, demulcent, nutritious, wounds, stomach troubles, boils, cuts, burns, scabies, ringworm, snake and scorpion stings, tonic (Manandhar, 2002; Bhattarai *et al*., 2006b).
Delphinium brunonianum	Wp, L, S & Fl	Jaundice fever, appetite, headache, body swellings, wounds to kill fleas and lice, ticks of animals, dysentery (Rajbhandari, 2001; Kletter and Krieckbaum, 2002; Lama *et al*., 2001; Manandhar, 2002; IUCN, 2004; Bhattarai *et al*., 2006b).
Delphinium stapeliosum	Wp	Fever (typhoid, malaria), jaundice (Bhattarai *et al*., 2006b).
Dicranostigma lactucoides	Wp, Fl & L	To expel the placenta after child birth, bile disorder, headache, diuretic, to reduce fat in blood, for thinning the blood (Manandhar, 2002).
Ephedra gerardiana	Wp, R & S	Controlling asthmatic paroxysm, cardiac and circulatory stimulant, rheumatism, syphilis, blood pressure, bronchitis, chest pain, vertigo/dizziness, headache, respiratory diseases, cuts, wounds, gastritis, skin diseases, stimulant, asthma, hay fever, respiratory infections, to control bed wetting, imbalance of maturation, excessive bleeding, kidney fever, cough, heart diseases, (Rajbhandari *et al*., 1995; Manandhar, 2002; Bista and

		Bista, 2005; Bhattarai *et al*., 2006b).
Euphorbia longifolia	R	Cough, cold, fever, sinusitis, constipation, hot and cold diseases, bacterial infections, skin diseases (Kletter and Kriechbaum, 2001; Bhattarai *et al*., 2006b).
Galium boreale	Wp	Boils (Bhattarai *et al*., 2006b).
Gentiana robusta	L & Fl	Stomachache, fever, edema, cuts, wounds, boils, cooling (Kletter and Kriechbaum, 2001; Bhattarai *et al*., 2006b).
Geranium donianum	L, R & Fl	Gingivitis, toothache, pain in the teeth, fever, bile disorders, cough, intestinal disorders, joint pain, antihelmintic (Kletter and Kriechbaum, 2001; Bhattarai *et al*., 2006b).
Heracleum candicans	R, Fr & Sd	Cough, cold, bone diseases, stomachache, diarrhoea, dysentery, joint pain, wounds, boils, skin diseases, blisters, phlegm, wind disorders, earache, stomach disorders, infection, bleeding, leprosy, fever due to wounds, joint pain, intestinal parasites, blood pressure (Kletter and Kriechbaum, 2001; Bhattarai *et al*., 2006b).
Hippophae salicifolia	Fr	Cough, cold, chest pain, stomachache, diarrhoea, worms, rheumatism, gastritis, menstrual disorders, liver, lung, phlegm diseases, blood disorders, dysentery, joint pain, gum infection, toothache, diabetes, intestinal parasites, enervate period, to be in fresh mode (Kletter and Kriechbaum, 2001; Bhattarai *et al*., 2006b).
Hippophae tibetana	Fr	Enervate period, worms appetizer, blood disorders, stimulant, antihelmintic, tonic, cough, cold, diuretic, tonic, to treat worm (Kletter and Kriechbaum, 2001; Bhattarai *et al*., 2006b, 2008).
Hyoscyamus niger	Sd	Asthma, whooping cough, gingivitis, 'unbalanced swelling diseases' and tooth pain (Manandhar, 2002; Bista and Bista, 2005; Bhattarai *et al*., 2006b).
Juglans regia	Fr, No, Tw, Sd, R & B	Stomachache, antihelmintic property, astringent, tonic, headaches, detergent, rheumatism, skin diseases, discharge of blood from the gums, wind diseases, shrunken limbs, mouth sores, antihistaminic, dental diseases, paralysis, cough, cold, chest pain, vitamin (Bhattarai, 1992; Kletter and Kriechbaum, 2001; Manandhar, 2002; Devkota and Karmachraya, 2003; Kunwar and Duwadee, 2003; IUCN, 2004; Bhattarai *et al*., 2006b).
Juniperus indica	Fr & L	Fever, headache, tuberculosis, cough, cold, tonsillitis, malarial fever, neck pain, to reduce blood pressure (Bhattarai *et al*., 2006b; Manandhar, 2002).
Lancea tibetica	Wp, Fr	Heal wounds, lung diseases, heart diseases, imbalances of lung infections, intestinal diseases, constipation (Kletter and Krieckbaum, 2001; Bista and Bista, 2005).
Lonicera rupicola	L, S & Fl	To purify the impure blood, overflow of blood during menstrual disorders.
Lonicera myrtillus	L, S & Fl	To purify impure blood, overflow of blood during menstrual disorder.
Maharanga bicolor	Rh	Hair tonic (Manandhar, 2002).

Maharanga emodi	R & Rh	Ear pain, cooling, laxative, antihelmintic, alexipharmic, eye disease, derangements of the blood, bronchitis, abdominal pain, fever, wounds, piles, hair tonic, blood pressure (Manandhar, 2002; IUCN, 2004; Bhattarai *et al*., 2006b).
Malva verticillata	R, S, L & Fl	Bone fractures (to join the fractures bones), kidney diseases, cough, cold, tonsillitis, headache, imbalances of diarrhoea, wound, urinary diseases, kidney fever (Bista and Bista, 2005; Bhattarai *et al*., 2006b).
Mentha longifolia	Wp & L	Astringent, cough, cold, tonsillitis, headache, to increase and purify the blood (Kletter and Krieckbaum, 2001).
Mirabilis himalaica	R, L & Fl	Kidney problems, fractured part of the body (Kletter and Kriechbaum, 2001; Bhattarai *et al*., 2006b).
Morina polyphylla	R	Stomachache, headache, diarrhoea, dysentery, child birth, body pain, numbness of limbs, edema, gastritis, painful joints (Kletter and Kriechbaum, 2001; Lama *et al*., 2001; Bhattarai *et al*., 2006b).
Myricaria rosea	Wp, L, S & Fl	Colds, backache, asthma, imbalances of flesh poisoning, bile fever, massage therapy (Manandhar, 2002; Bista and Bista, 2005; Bhattarai *et al*., 2006b).
Nardostachys grandiflora	R	Haemorrhoids, diarrhoea, fever, conjunctivitis, gastritis, headache, antihelmintic, edema, dyspepsia, imbalances of chronic fever, fever of poisoning, ribs pain (Manandhar, 2002; Bista and Bista, 2005; Bhattarai *et al*., 2006).
*Neopicrorhiza scrophulariiflor*a	R, & Wp	Paralysis, indigestion, snake bite, heart diseases, cuts, wounds, boils, scabies, ringworm, cough, colds, dropsy, stomachache, purgative, cathartic, scorpion sting, (diseases of blood, nerves, veins, vessels, the large intestine and in the vital organs), especially the lungs, inflammation, reducing impure blood, laxative, liver problems, hypertension, jaundice, expectorant, antipyretic, appetizer, anorexia, fever, typhoid, tonic, bile diseases, intestinal pain, blood and lung fever, gastritis, diarrhoea, sore throat, eye diseases, bitter, cathartic, dyspepsia, veins, neurological disorders, vomiting (Bhattarai, 1992, 1993a, 1993b, 1997; Rajbhandari *et al*., 1995; Kletter and Krieckbahum, 2001; Lama *et al*., 2001; Manandhar, 2002; Oli, 2003; IUCN, 2004; Bista and Bista, 2005; Bhattarai *et al*., 2006b).
Onopordum acanthium	R	Dysuria, diuretic, urinary-tract infection (Bhattarai *et al*., 2006b).
Origanum vulgare	Wp, R, B & L	Blood pressure, cough, cold, heart diseases, fever, colic, diarrhoea, hysteria, rheumatism, toothaches, earaches, promote menstrual flow, wounds, tooth decay, sinusitis (Manandhar, 2002; Bhattarai *et al*., 2006b).
Oxyria digyna	Wp	Constipation, gastritis, diuretic, swollen of stomach (Bhattarai, 2007).
Pinus wallichiana	C, B, Lx	Fractured part of the body, tuberculosis, abrasion (Bhattarai *et al*., 2006).
Polygonatum cirrhifolium	Wp	Cough, cold, to increase sexual power (Bhattarai *et al*., 2006b).

Pterocephalus hookeri	Wp	Chronic diseases, (blood, veins and arteries diseases), fever, urinary bladder diseases, cough, cold, poison fever, gout, arthritis, lymph fluid, intestinal pain, blood disorders (Kletter and Kriechbaum, 2001; Manandhar, 2002; Bista and Bista, 2005).
Ranunculus laetus	Wp & R	Cuts, wounds, stomachache, sinusitis, body ache, backbone pain (Manandhar, 2002).
Rheum australe	R	Purgative, astringent, tonic, stomachic, malarial fever (Manandhar, 2002).
Rhododendron anthopogon	L & Fl	Blood pressure, paralysis, pains in limbs, waist, inflammation of limbs, fever, to produce sneezing, indigestion, stomach, liver and lungs diseases, sore throat, phlegm diseases, appetizer, diuretic, allergy, vomiting, aromatic, stimulant, cough, colds (Rajbhandari *et al*., 1995; Lama *et al*., 2001; Manandhar, 2002; Bhattarai *et al*., 2006b).
Rhododendron lepidotum	L, Wp & Fl	Fever, cough, cold, tonsillitis, to kill bugs, promote digestive heat, stimulates appetite, bile and lung diseases, back pain, blood disorders, bone diseases, purifies the blood (Lama *et al*., 2001; Manandhar, 2002; Bhattarai *et al*., 2006b).
Rosa macrophylla	Fr	Eyesight, dysentery, cough, cold, boils, bile disorders fever, diarrhoea, imbalances of poison-fever, kidney fever (Lama *et al*., 2001; Manandhar, 2002; Bista and Bista, 2005; Bhattarai *et al*., 2006b).
Rosa sericea	Fr, Sp, B & Fl	Diarrhoea, dysentery, stomachache, dyspepsia, bile disorders, blood pressure, gingivitis, headaches, liver complaints, opthalmia, eye infection, liver, bile, wind and lung diseases, menstrual disorders, poisoning and lymph fluid disorders, imbalance of bile, wind disorders, swelling of stomach, intestine disorders (Bhattarai, 1992; Lama *et al*., 2001; Manandhar, 2002; Gurung, 2003; Bista and Bista, 2005; Bhattarai *et al*., 2006b).
Rubus foliolosus	R, Sp & Fr	Fever, indigestion, tonsillitis, vertigo/dizziness, energy, diseases which are not easily cured by other medicine, headaches, lung diseases, wind fever, cough, cold (Lama *et al*., 2001; Manandhar, 2002; Bhattarai *et al*., 2006b).
Rumex nepalensis	Wp, R & L	Body pain, purgative, antidote, dislocated bone, eye trouble, diarrhoea, antihelmintic, cough, colds, swollen gums, headaches, skin diseases, kidney fever, cough, nasal bleeding, constipation (Manandhar, 2002; Bista and Bista, 2005).
Salix babylonica	B & S	Body pain, over flow of blood during menstrual periods.
Salix serpyllum	L & S	Stomachache, diarrhoea, dysentery (Bhattarai *et al*., 2006b).
Selinum wallichianum	L, R, Fr & Fl	Stomachache, cuts, wounds, cough, cold, antiseptic, bleeding, colic, gastritis, intestinal pain, body pain, fever (Lama *et al*., 2001; Manandhar, 2002; Devkota and Karmacharya, 2003; IUCN, 2004; Bhattarai *et al*., 2006b).
Stellera chamaejasme	R & B	Skin diseases, aching joints, sprains (Kletter and Krieckbaum, 2001; Manandhar, 2002).
Swertia ciliata	Wp	Headache, fever, jaundice, malarial fever, diabetes, cough, cold, wounds (Kletter and Krieckbaum, 2001; Bhattarai *et al*., 2006b).

Thalictrum cultratum	L & Fl	Fever, diarrhoea, boils, wounds, skin diseases (ringworm, and blister) (Bhattarai *et al*., 2006b).
Thymus linearis	L, S, Wp, & Fl	Eye pain, conjunctivitis, gingivitis, to increase blood, indigestion, stomach and liver complaints, body pains, antihelmintic, cough, cold, gastric complaints, appetite, stimulant, blood purifier, digestive, gum and tooth problems (Bhattarai, 1992; Lama *et al*., 2001; Manandhar, 2002; Bhattarai *et al*., 2006b).
Urtica dioica	R, S, L & Fr	Cough, cold, asthma, dental caries, dog bites, cuts, wounds, dislocated bones, bile diseases, fever, antihelmintic, boils, menstrual disorders, jaundice, diarrhoea, dysentery (Rajbhandari *et al*., 1995).
Valeriana jatamansii	R, Wp & Rh	Eye pain, conjunctivitis, infected wounds, stomachache, cough, cold, tonsillitis, boils, insomnia, pimples, rheumatism, eye troubles, antispasmodic, neurosis, sedative, nausea, cholera, carminative, stimulant, hysteria, hypochondriasis, nervous unrest, emotional trouble, analgesic, expectorant, diuretic, aphrodisiac, dislocation of joints, eye infection, sore throat, indigestion, wounds, burns, paralysis, common cold, abdominal pain, asthma, headache, epilepsy (Joshi and Edington, 1990; Bhattarai, 1992; Rajbhandari *et al*., 1995; Taylor *et al*., 1996a; Lama *et al*., 2001; Manandhar, 2002; Devkota and Karmacharya, 2003; IUCN, 2004; Bhattarai *et al*., 2006b)
Zanthoxylum armatum	Fr, R, Bh, L, Sd, & B	Tonsillitis, high altitude sickness, numbness of limbs, vertigo/dizziness, gingivitis, tooth pain, toothache, leukoderma, stomach troubles, carminative, stomachic, analgesic, expectorant, diuretic, diaphoretic, antipyretic, dental troubles, scabies, insect repellent, tonic, deodorant, antiseptic properties, antifungal activity, pyorrhea, dysentery, abdominal pains, constipation, cholera, gastritis, appetizer, worm, cough, cold, headache, fever, diarrhoea, antihelmintic, cuts, wounds, indigestion, roundworms, dyspepsia (Bhattarai, 1992, 1993a; Joshi and Edington, 1990; Rajbhandari *et al*., 1995; Edwards, 1996; Joshi and Joshi, 2000; Manandhar, 2002; Devkota and Karmacharya, 2003; Gurung, 2003; Kunwar and Duwadee, 2003; Oli, 2003; Bhattarai *et al*., 2006b).

Keys: L: leaves; Fl: flowers; Wp: whole plant; R: roots; S: stems; B: bark; Fr: fruits; Sd: seeds; Rt: root tubers; C: cones; No: oil of nut; Bh: branches; Rh: rhizome; Pt: petals; Tw: twigs; N: needles; Sp: Stem pith; Wd: wood; Lx: Latex;

Appendix XI - Minimum inhibitory concentrations (MIC) of 33 medicinal plant species with methanol, dichloromethane and hexane extracts against *Staphylococcus aureus*, Bacillus *subtilis*, *Escherichia coli* and *Pseudomonas aeruginosa*

Plant Scientific Name (Part tested)[1]	**MIC[2] (mg/disc) *S. aureus*[3,4]**			**MIC (mg/disc) *B. subtilis***			**MIC (mg/disc) *E. coli***			**MIC (mg/disc) *P. aeruginosa***		
	M	**D**	**H**	**M**	**D**	**H**	**M**	**D**	**H**	**M**	**D**	**H**
Abies spectabilis (L & C)	0.125	0.031	0.500	1.0	0.250	0.500	0.250	0.062	0.125	-	-	0.500
Allium oreoprasum (WP)	0.125	-	0.500	-	1.0	0.250	0.031	-	0.500	-	-	0.500
Androsace strigillosa (WP)	0.125	0.250	0.250	-	-	0.500	0.250	0.500	-	-	0.500	-
Anemone rivularis (WP)	0.062	0.002	1.0	0.250	0.500	0.500	0.031	0.500	-	0.500	1.0	1.0
Arisaema jacquemontii (Rt)	0.062	-	-	0.250	-	-	0.031	-	0.500	0.500	0.250	1.0
Asparagus filicinus (R)	0.250	1.0	-	0.125	-	0.500	0.250	0.062	-	0.500	0.250	-
Astilbe rivularis (R)	0.125	-	0.062	0.062	-	0.062	0.250	-	0.062	0.250	-	0.015
Bergenia ciliata (R)	0.125	-	0.250	0.250	-	0.500	0.500	-	0.250	0.250	1.0	-
Bistorta affinis (R)	0.250	-	-	0.250	-	-	0.250	-	-	0.500	1.0	-
Carum carvi (Sd)	-	0.125	-	-	0.500	0.500	-	0.500	0.250	-	-	-
Delphinium brunonianum (WP)	0.125	0.250	-	0.250	0.500	-	0.125	0.500	-	-	0.500	0.500
Euphorbia longifolia (R)	0.125	0.062	-	0.125	0.250	0.250	0.500	-	-	0.500	-	1.0
Geranium donianum (L, & Fl)	0.062	0.002	1.0	0.250	0.500	1.0	0.500	0.500	0.500	0.250	0.500	1.0
Heracleum candicans (R)	0.125	0.125	0.500	0.500	0.250	0.500	0.250	0.016	0.125	1.0	0.500	-
Hippophae salicifolia (Sd)	0.125	1.0	-	1.0	0.250	1.0	0.125	0.500	-	0.500	0.250	1.0
Hippophae tibetana (Sd)	0.500	0.500	-	0.250	0.250	0.500	0.125	0.031	-	0.500	-	-
Juglans regia (Fr)	0.500	-	1.0	0.250	-	0.500	0.250	-	-	-	1.0	1.0
Maharanga bicolor (R)	0.250	0.125	0.0009	0.500	0.016	0.007	0.500	0.016	0.062	0.500	0.250	0.007
Maharanga emodi (R)	0.250	0.062	0.001	1.0	0.016	0.001	0.125	0.500	0.016	0.500	0.250	0.007
Morina polyphylla (R)	0.250	1.0	1.0	1.0	-	0.250	0.125	0.125	0.125	0.500	1.0	0.500
Neopicrorhiza scrophulariiflora (R)	0.125	1.0	0.250	0.125	-	0.250	0.062	0.250	0.500	1.0	0.500	1.0
Origanum vulgare (WP)	0.250	0.500	0.500	0.125	0.500	0.250	0.250	0.062	0.500	-	-	0.500
Rhododendron anthopogon	0.062	0.015	0.062	0.250	0.016	0.062	0.250	0.016	0.062	0.500	0.250	0.031

(L, & Fl)												
Rhododendron lepidotum (L, & Fl)	0.500	0.250	0.125	0.125	0.625	0.125	0.500	0.250	0.062	0.500	-	0.125
Rosa macrophylla (Fr)	0.125	-	-	0.500	1.0	0.500	0.500	-	-	-	0.250	1.0
Rosa sericea (Fr)	0.500	-	0.500	0.250	0.500	0.250	0.031	0.250	0.250	0.500	0.500	0.500
Rubus foliolosus (R)	0.500	0.500	-	0.500	0.500	0.250	0.250	0.500	-	0.500	-	-
Salix serpyllum (L, & S)	0.500	1.0	-	0.500	0.250	-	0.031	0.062	-	0.500	-	1.0
Selinum wallichianum (L & Fl)	0.125	1.0	-	1.0	-	0.500	0.250	-	-	1.0	0.500	-
Thalictrum cultratum (L, & Fl)	1.0	0.500	-	0.250	0.250	1.0	0.031	0.500	-	0.500	0.500	1.0
Thymus linearis (L, S, & Fl)	0.250	0.062	0.250	0.500	0.500	0.250	0.500	0.031	0.500	1.0	1.0	0.500
Valeriana jatamansii (R)	0.062	0.015	0.001	0.031	0.016	0.003	0.500	0.016	0.003	0.500	0.250	0.007
Zanthoxylum armatum (Fr)	0.250	0.250	-	-	1.0	0.500	-	-	-	-	-	1.0

[1]Part tested for antibacterial activity; L: leaves; Fl: flowers; WP: whole plant; R: roots; S: stems; Fr: fruits; Sd: seeds; Rt: root tubers; C: cones; [2]MIC: Minimum inhibitory concentrations in microgram per disc; '-' indicated no zone of inhibition. [3]Bacteria tested: *S. aureus*: *Staphylococcus aureus*; *B. subtilis*: *Bacillus subtilis*; *E. coli*: *Escherichia coli*; and *P. aeruginosa*: *Pseudomona aeruginosa*; [4]Solvent used for extraction: M: methanol; D: dichloromethane; H: hexane; All solvent controls (MeOH, CH_2Cl_2 and hexane) were negative, producing no zone of inhibition. Positive controls were erythromycin for Gram-positive and ciprofloxacin for Gram-negative bacteria, diluted in MeOH (0.25mg/mL); MIC for antibiotics: *Staphylococcus aureus:* 0.019µg/disc*; Bacillus subtilis*: 0.0095µg/disc; *Escherichia coli*: 0.039µg/disc; *Pseudomonas aeruginosa*:0.078µg/disc.

Appendix XII - Ranking of Mustang and Manang districts within Nepal (75 districts). Ranking category: Most developed (1-25); Intermediate (26-50); Least developed (51-75).		
Subject of Ranking	**Manang**	**Mustang**
Overall Composite Index	10	19
Poverty and Deprivation Index	25	33
Socio-economic and Infrastructural Development Index	10	17
Per Capita Food Production (PCFP)	61 (2194 Kilo calories)	60 (2196 Kilo calories)
Health and Development Index	7	22
Drinking Water Coverage	9 (93.51 %)	28 (84.67 %)
Toilet Facilities	45 (35.95 %)	40 (40.78 %)
Broad Occupational Structure	24	21
Overall Literacy Rate	18 (60.45 %)	57 (52.08 %)
Health Institutions Density	28	42
Livestock (number) Per Farm Household	2 (20.05)	1 (20.19)

Source: ICIMOD (2003). Districts of Nepal Indicators of Development.

Appendix XIII - Classification, usage and market price of prioritized medicinal plants in Manang and Mustang districts, Nepal. (Usage: 1 - primary health care; 2 - treatment of common ailments; 3 - treatment of broad range of ailments; 4 - usage by *Amchis*; 5 - economic value).			
Prioritized species in Manang	**Plant parts in Trade**	**Prioritized species in Mustang**	**Traded price (NRs.)**
High priority			
Aconitum naviculare (1, 2, 3, 4, 5)	Rt		1 kg @ 700- 1000
Aconitum orochryseum (1, 2, 3, 4, 5)	Rt	*Aconitum orochryseum* (1, 2, 3, 4, 5)	1kg @. 450-2000
Allium oreoprasum (1, 2, 3, 4, 5)	Wp		1 Kg @ 300- 1000
Dactylorhiza hatagirea (1, 2, 3, 4, 5)	Rt	*Dactylorhiza hatagirea* (1, 2, 3, 4, 5)	1 kg @ 800-2200.
	Ju	*Hippophae salicifolia* (1, 2, 3, 4, 5)	1 liter @ 400-500.
	L	*Juniperus indica* (1, 2, 3, 4, 5)	1 kg @ 100-150.
Neopicrorhiza scrophulariiflora (1, 2, 3, 4,5)	Rt	*Neopicrorhiza scrophulariiflora* (1, 2, 3, 4, 5)	1 kg @ 300-800.
Zanthoxylum armatum (1, 2, 3, 4, 5)	Fr	*Zanthoxylum armatum* (1, 2, 3, 4, 5)	1 kg @ 80-300.
Moderate priority			
	Rt	*Aconitum naviculare* (1, 4, 5)	1 kg @ 700- 1000
		Aconitum spicatum (1, 3, 4)	
	Wp	*Allium wallichii* (1, 2, 4, 5)	1 kg @ 250-1200
		Artemisia caruifolia (1, 2, 4)	
Astilbe rivularis (4, 5)	Rt	*Astilbe rivularis* (1, 4, 5)	1 kg @ 150-200.
		Berberis aristata (1, 3, 4)	
Bergenia ciliata (4, 5)	Rt	*Bergenia ciliata* (1, 3, 4, 5)	1 kg @ 80-150.
	Br	*Betula utilis* (1, 4)	1/4th of a meter @ 10-15.
Carum carvi (1, 2, 4)		*Bistorta affinis* (1, 2, 4)	
		Clinopodium umbrosum (1, 3, 4)	
Cordyceps sinensis (4, 5)	Wp	*Cordyceps sinensis* (1, 4, 5)	1kg @ 200000-250000.
Fritillaria cirrhosa (4, 5)	Bu		1 Kg @ 2200-7000
	Ju	*Hippophae tibetana* (1, 2, 4, 5)	1 liter @ 400-500.
		Juglans regia (1, 5)	
	Rt	*Maharanga bicolor* (1, 4,	1 kg @ 500-800.

		5)	
	Wp	*Morchella esculenta* (1, 4, 5)	1 kg @ 4000-6000.
	Rt	*Nardostachys grandiflora* (1, 3, 4, 5)	1 kg @ 800-1000.
	Rt	*Paris polyphylla* (1, 4, 5)	1 kg @ 25-350.
	Rt	*Rheum australe* (1, 4, 5)	1 kg @ 500-650.
Rheum moorcroftianum (4, 5)	Rt		1 kg @ 500-650
Rubus foliolosus (1, 2, 4)		*Rubus foliolosus* (1, 2, 3)	
		Rumex nepalensis (1, 2, 3, 4)	
	Rt	*Selinum wallichianum* (1, 4, 5)	1 kg @ 200-250.
	Wp	*Swertia chirayita* (1, 2, 4, 5)	1 kg @ 300-700.
Swertia ciliata (1, 4)	Wp		1 kg @ 300-700.
Taxus baccata subsp. *wallichiana* (4, 5)		*Verbascum thapsus* (1, 2, 3, 4)	
	Rt	*Valeriana jatamansii* (1, 4, 5)	1 kg @ 125-200.
LOW PRIORITY			
Beberis aristata (1)		*Taxus baccata* subsp. *wallichiana* (1)	
Bistorta macrophylla (1)		*Urtica dioica* (1)	
Clinopodium umbrosum (1)			
Paris polyphylla (1)			
Rumex nepalensis (1)			
Keys: Rt: root; Wp: whole plant; Ju: juice; L: leaves; Bu: bulbs; Br: bark; Fr: Fruit;			

Appendix XIV - Medicinal Plants Sold Legally During the Year 1994-2004 From Manang District, Nepal

Plant Species	Amount	Royalty paid in NRs.	Year
Neopicrorhiza scrophulariiflora, *Rheum* species and *Swertia* species	856 kg	2,185/-	1994-1995
Aconitum orochryseum, *Neopicrorhiza scrophulariiflora*, *Rheum* species and *Swertia* species	5,763 kg	74,000/-	1998-1999
Aconitum orochryseum, *Neopicrorhiza scrophulariiflora*, *Paris polyphylla*, *Rheum* species and *Swertia* species	5,615 kg	55,835/-	1999-2000

Medicinal Plants Sold Legally During the Year 2001-2004 from the Community Forests of Lower Manang

Plant Species	Amount	Royalty paid in NRs.	Year	Name of Community Forest
Taxus baccata subsp. *wallichiana*	89,800 kg	221445	2001-2004	Tilche Community Forest, Tilche
Aconitum orochryseum and *Neopicrorhiza scrophulariiflora*	7,975 kg	92.6	2005-2007	Tilche Community Forest, Tilche
Taxus baccata subsp. *wallichiana*	740 kg	185.05	2000-2003	Taal Community Forest, Taal
Bergenia ciliata, *Rheum* species, *Swertia* species and *Taxus baccata* subsp.*wallichiana*	22,920 kg	554	2001-2003	Nacha Community Forest, Nacha
Aconitum orochryseum, *Neopicrorhiza scrophulariiflor* and *Paris polyphylla*	960 kg	15.3	2005-2006	Nacha Community Forest, Nacha
Taxus baccata subsp. *wallichiana*	5,938 kg	148.45	2002-2003	Thocha Community Forest, Thocha

Source: Anonymous (2003-2004). NTFP Data Base in Manang and File Report of District Forest Office, Chame, Manang

Appendix XV - Prioritization of Ethnomedicinal Plants

Prioritization of Ethnomedicinal Plants in ten Village Development Committee of Manang district

Braka	Dhukur Pokhari	Ghyaru	Hongde	Khangshar	Manang	Nar	Ngawal	Phoo	Pisang
A. n.	*N. s.*	*A. n.*	*A. n.*	*A. n.*	*A. n.*	*C. s.*	*A. n.*	*C. s.*	*A. n.*
N. s.	*A. n.*	*D. h.*	*N. s.*	*A. o.*	*N. s.*	*D. h.*	*A. o.*	*N. s.*	*R. f.*
D. h.	*D. h.*	*R. f.*	*S. c.*	*N. s.*	*D. h.*	*N. s.*	*D. h.*	*D. h.*	*N. s.*
C. s.	*R. f.*	*S. c.*	*D. h.*	*D. h.*	*C. s.*	*A. n.*	*S. c.*	*A. n.*	*D. h.*
R. m.	*A. o.*	*A. o.*	*A. o.*	*Z. a.*	*S. c.*	*A. or.*	*R. m.*	*R. m.*	*R. m.*
S. c.	*S. c.*	*Z. a.*	*C. s.*	*P. p.*	*R. f.*	*A. r.*	*C. s.*	*A. or.*	*C. s.*
B. c.	*B. c.*	*N. s.*	*B. a.*	*S. c.*	*Z. a.*	*R. m.*	*Z. a.*	*B. c.*	*Z. a.*
A. r.	*R. m.*	*R. m.*	*R. n.*	*R. f.*	*R. m.*	*Z. a.*	*A. r.*	*R. f.*	*A. r.*
R. f.	*C. c.*	*C. s.*	*B. c.*	*C. s.*	*B. c.*	*C. c.*	*B. c.*	*A. r.*	*R. n.*
B. m.	*A. r.*	*B. m.*	*A. r.*	*C. u.*	*C. c.*	*B. c.*	*C. u.*	*Z. a.*	*C. c.*

Prioritization of ethnomedicinal plants in ten Village Development Committee of Mustang District

Lomanthang	Charang	Ghami	Samar	Chaile	Kagbeni	Jharkot	Jomsom	Marpha	Larjung
A. w.	*A. w.*	*A.w.*	*A. w.*	*A. w.*	*A. o.*	*A. o.*	*N. s.*	*M. c.*	*H. s.*
N. s.	*H. t.*	*A. c.*	*U. d.*	*C. s.*	*A. n.*	*R. as.*	*H. s.*	*H. t.*	*M. b.*
V. j.	*Z. a.*	*V. j.*	*A. n.*	*A. o.*	*A. s.*	*D. h.*	*R. as.*	*R. as.*	*D. h.*
A. n.	*D. h.*	*U. d.*	*Z. a.*	*D. h.*	*C. g.*	*R. f.*	*S. ch.*	*A. s.*	*C. s.*
C. s.	*R. as.*	*A. s.*	*A. o.*	*R. as.*	*C.s.*	*R. as.*	*P. p.*	*C. g.*	*B. c.*
D. h.	*U. d.*	*B. c.*	*R. n.*	*B. a.*	*E. g.*	*C. f.*	*A. r.*	*C. t.*	*P. p.*
H. t.	*N. s.*	*Z. a.*	*R. as.*	*N. s.*	*H. t.*	*H. s.*	*N. g.*	*B. c.*	*H. t.*
A. o.	*B. c.*	*A. o.*	*C. c.*	*V. t.*	*O. v.*	*H. t.*	*H. t.*	*P. p.*	*C. u.*
A. s.	*B. a.*	*R. as.*	*A. s.*	*R. as.*	*P. p.*	*S. c.*	*R. n.*	*A. s.*	*S. ch.*
C. u.	*R. f.*	*D. h.*	*J. i.*	*M. b.*	*H. t.*	*Z. a.*	*R. as.*	*S. ch.*	*Z. a.*

Key: *A. n.*: *Aconitum naviculare*; *A. o.*: *Aconitum orochryseum*; *A. s.*: *Aconitum spicatum*; *A. or.*: *Allium oreoprasum*; *A. w.*: *Allium wallichii*; *A. c.*: *Artemisia caruifolia*; *A. r.*: *Astilbe rivularis*; *B. a.*: *Beberis aristata*; *B. c.*: *Bergenia ciliata*; *B. a.*: *Bistorta affinis*; *B. m.*: *Bistorta macrophylla*; *C. g.*: *Caragana gerardiana*; *C. c.*: *Carum carvi*; *C. s.*: *Cordyceps sinensis*; *C. u.*: *Clinopodium umbrosum*; *D. h.*: *Dactylorhiza hatagirea*; *E. g.*: *Ephedra gerardiana*; *H. t.*: *Hippophae tibetana*; *H. s. Hippophae salicifolia*; *J. i.*: *Juniperus indica*; *M. b.*: *Maharanga bicolor*; *N. g.*: *Nardostachys grandiflora*; *N. s.*: *Neopicrorhiza scrophulariiflora*; *O. v.*: *Origanum vulgare*; *P. p.*: *Paris polyphylla*; *R. f.*: *Rubus foliolosus*; *R. as.*: *Rheum australe*; *R. m.*: *Rheum moocroftianum*; *R. n.*: *Rumex nepalensis*; *S. ch.*: *Swertia chirayita*; *S. c.*: *Swertia ciliata*; *U. d.*: *Urtica dioica*; *V. j.*: *Valeriana jatamansii*; *V. t.*: *Verbascum thapsus*; *Z. a.*: *Zanthoxylum armatum*; (*Taxus baccata* subsp. *wallichiana* and *Fritillaria cirrhosa* are prioritized due to the authentic recent information (during the field visit in October 2006) gathered from District Office, Chame as well as with the local villagers of Manang).

Appendix XVI - Priority species of medicinal plants in South Asia						
Plant species	**South Asia**	**Pakistan**	**Sri Lanka**	**Nepal**	**Manang**	**Mustang**
+*Aconitum spicatum*	Yes	No	No	No	No	Yes
Allium wallichii	No	No	No	Yes	No	Yes
*******Berberis aristata*	Yes	No	Yes	No	Yes	Yes
+* *Bergenia ciliata*	No	Yes	No	Yes	Yes	Yes
+ Cordyceps sinensis	No	No	No	Yes	Yes	Yes
+Dactylorhiza hatagirea	No	No	No	Yes	Yes	Yes
+Ephedra gerardiana	No	No	No	No	No	No
+Fritillaria cirrhosa	No	No	No	No	Yes	No
** Juglans regia*	No	No	No	No	No	Yes
**Juniperus indica*	No	No	No	Yes	No	Yes
+ Morchella esculenta	No	No	No	No	No	Yes
*+*Nardostachys grandiflora*	Yes	No	No	No	No	Yes
*+*Neopicrorhiza scrophulariiflora*	Yes	No	No	No	Yes	Yes
+ Paris polyphylla	No	No	No	No	Yes	Yes
+Rheum australe	Yes	No	No	No	No	Yes
*+*Swertia chirayita*	Yes	No	No	No	No	Yes
+Taxus baccata subsp. *wallichiana*	No	No	No	Yes	Yes	Yes
*+*Valeriana jatamansii*	Yes	No	No	No	No	Yes
**Zanthoxylum armatum*	No	No	No	No	Yes	Yes

Key: 9 medicinal plants of Nepal origin (prioritized in Manang and Mustang) being traded in India is given by (*); 14 medicinal plants prioritized from Manang and Mustang were in the preliminary list of widely distributed commercially threatened species of medicinal plants requiring conservation attention in the Himalaya is given by (+) (Hamilton and Radford, 2007); Karki and wiliams (1999); and Rawal (2004).

PHOTOGRAPHS

PLATE I – LANDSCAPES IN MANANG AND MUSTANG DISTRICTS OF NEPAL

Landscape in Mustang

Landscape in Manang

Cultivated fields with Wheat and Barley in Manang

Cultivated fields with Wheat Barley in Mustang

Trans-Himalayan habitat with Bushes

Marsyangdi River, Himalaya

PLATE II - KNOWLEDGEABLE VILLAGERS AND RITUALS AND RELIGIOUS PLACES OF MANANG AN
MUSTANG DISTRICTS OF NEPAL

Amchi Tshampa Ngawan Gurung

Amchi Karma Sonam Lama

Dhami Dhanbir B.K.

Tenzing Gurung (Knowledge

Milereppa *Gomba* of Manang

Prayers flags hanging in the thread

PLATE III- USEFUL PLANTS OF MANANG AND MUSTANG DISTRICTS OF NEPAL

Aconitum orochryseum Stapf

Allium carolinianum DC.

Berberis mucrifolia Ahrendt

Dactylorhiza hatagirea (D. Don) Soo

Dicranostigma lactucoides Hook. f. & Thomson

Hippophae salicifolia D. Don

PLATE IV - USEFUL PLANTS OF MANANG AND MUSTANG DISTRICTS OF NEPAL

Juglans regia L.

Lilium nepalense D. Don

Malva verticillata L.

Mirabilis himalaica (Edgew.) Heimerl

Maharanga emodi (Wall.) A. DC.

Morchella esculenta Pers.

PLATE V - USEFUL PLANTS OF MANANG AND MUSTANG DISTRICTS OF NEPAL

Oxytropis willamsi Vassilcz

Rumex nepalensis Spreng.

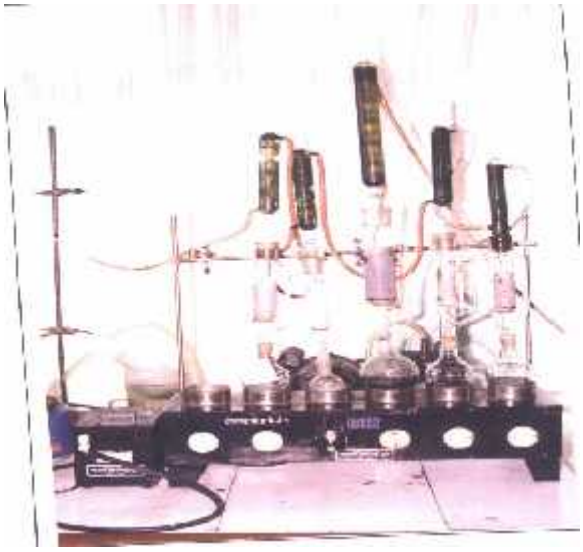
Urtica dioica L.

Hyoscyamus niger L.

Juniperus indica dried over roof for incense

Collection of *Clematis* species for fodder

PLATE VI – BIOASSAY TESTING

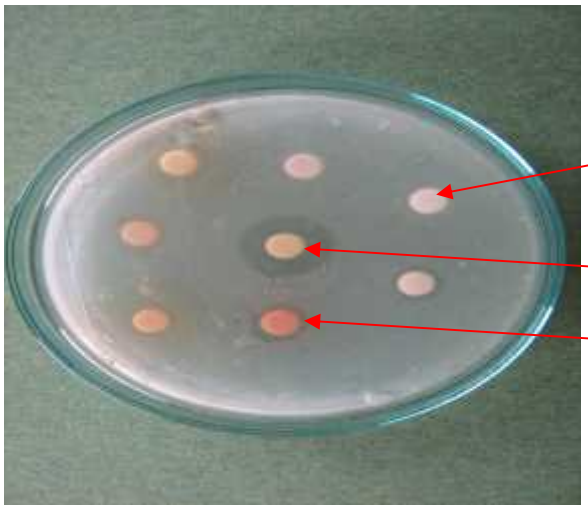


Soxhlet extractor showing extraction of medicinal plants

Plants parts being dried on shade

Observation of the zone of Inhibition

Preparation of extracts



Discs showing zone of inhibition

PLATE VII - TRADERS AND TRADE

Bhuthi Gurung (*Manangi*) packing *Allium wallichii* of Mustang in Narayanghat

Manangi traders in Narayanghat selling medicinal plants

Trader Tirtha Bahadur Lama with bottles of medicinal plants in Pokhara

Trader selling medicinal plants in stall in Parsa District

CONSERVATION AND MANAGEMENT OF MEDICINAL PLANTS

Germination of *Hippophae* seedlings

Dried root of *Rheum moorcroftianum*