IMPORTANT MEDICINAL AND AROMATIC PLANTS – NEPAL

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Contents

Summary

Medicinal and aromatic plants (MAPs) are deeply rooted into Nepalese culture and play major role in the subsistence of rural people in Nepal. These are reputed in Ayurvedic medicine across Indian sub-continent since prehistoric times. Nepal has been considered one of the biodiversity rich countries in the world. It is estimated that Nepal harbors more than 8,000 species of flowering plants, of which about 20-25% are recorded with medicinal and aromatic properties. Among them, about 10 % have commercial value but most of them are traded in market without processing. The Government of Nepal

has identified 148 major MAPs species and put royalty rate for each species for trade. However, a total 179 MAPs are found with high commercial importance based on their trade value, price, volume of collection and pharmaceutical use. Although a large amount of MAPs from Nepal is supplied all across the world, about 90 % of it is exported to India alone. MAP species represent diverse life forms; 49% herbs, shrubs 14% shrubs 29% trees, and 8% vines. MAPs are found from low land (Terai) to high mountains of the Himalayas in Nepal. A hump-shaped pattern of MAP distribution is found along the elevation gradient of Nepal, with maximum number of MAP species around 1000m elevation.

Mostly, the collection of MAPs comes from the natural population, so domestication of MAPs has been receiving much more attention in Nepal due to higher demand as industrial raw materials as well as to reduce dependency on natural habitats. Knowledge of species distribution, germination and propagation techniques, lifecycles traits and quality of medicinal plants would be very important factors for domestication and sustainable management for future. Although, the collection and trade of MAPs have been a source of income for Nepal, their sustainable harvesting measures are not well addressed. There is a lack of quantitative assessment of their natural population and association with socio-political and climatic factors. There is an urgent need to assess their natural habitats and populations, and find out factors affecting in their existence, so that effective conservation and sustainable harvesting measures can be implemented.

1. Historical Perspective of Medicinal Plants

Medicinal plants have been used to treat for various ailments since beginning of human civilization. The earliest records of the use of medicinal plants were found from the Sumerian civilization, approximately 5,000 years ago (Petrovska, 2012). It comprised 12 recipes for drug preparation referring to over 250 different plant species such as poppy, henbane and mandrake (Kelly, 2009). The Chinese Emperor Shen Nung wrote a book about medicinal plants in ca. 2500 B.C. in which he mentioned about 365 drugs of plant products, such as Gentian, Ginseng, Jimson weed, Cinnamon bark, and Ephedra plants (Bottcher, 1965; Wiart, 2006). The oldest text of Hinduism, derived from the ancient Indo-Aryan culture of the Indian subcontinent written between 1500 and 500 B.C., has mentioned about medicinal plants' use in healing of diseases (Tucakov, 1971). Written as a book in 1550 B.C., the Ebers Papyrus has mentioned 700 medicinal plant species such as pomegranate, castor oil plant, aloe, senna, garlic, onion, fig, willow, etc. (Glesinger, 1954; Tucakov, 1964).

In general, development and advancement in medicinal plants can be divided into five different periods: prehistoric, ancient, middle age, early modern age, and modern age (Kelly, 2009; Petrovska, 2012). The use of medicinal plants has been traced to prehistoric times when many plants were used for treatments various diseases (Teixeira-Santos et al., 2015). Spices were also used as food preservative against food spoilage bacteria in the tropical climate in prehistoric period (Gottardi et. al., 2015). The evidence of medicinal plants found in the prehistoric burial sites has been reported (Teixeira-Santos et. al., 2015). Hundreds of medicinal plants were also used during the earliest Sumerian civilization of Mesopotamia in the ancient times (Petrovska, 2012). The use of medicinal plants has been documented in the Atharvaveda, the Rig Veda and

the Sushrutasamhita and these lead to development of Ayurveda in Southeast Asia around 3,000 years before now (Pandey et al., 2013). In around 60 A.D., a Greek physician had documented over 600 medicinal plants in De Materia Medica (Nutton, 2012). From the Middle Ages (between 5th and late 15th centuries), information on medicinal plants based on traditional knowledge and herbal gardens has been started to be documented (Petrovska, 2012). Herbal medicines were started to flourish as Ayurveda, Siddha, Amchi, Chinese, and Tibetan system of medicines in various parts of world during this time. However, knowledge of medicinal plants became more utilized in modern age (between 19thand 20th centuries) with the application of chemistry and pharmaceutical methods and tools, mainly in extraction of plant metabolites and formulation of medicines (Kelly, 2009).

1.1. Overview of Medicinal and Aromatic Plants in Nepal

The MAPs are deeply rooted into Nepalese culture and they play major role in the subsistence of rural people in Nepal. The wealth of Himalayan herbs from Nepal has been reputed in Ayurvedic medicine across the Indian sub-continent since prehistoric times. Nepal which is located between India and China (Figure 1) has a long tradition of using MAPs to treat various ailments. The evidence of medicinal plants can be traced before 7,000 years from today. For example, according to Hindu mythology, Hanuman, the obedient soldier of Ram (the Hindu god) brought medicinal herbs from Indian Mountains (Vindhyachal Parbat) to treat Ram's brother Laxman, who was gravely wounded during the war (Acharya, 1887).

Figure 1. Geographical location of Nepal and its districts

Many important traditional practices of medicine including Ayurveda, Unani, Siddha and Tibetan (Sowa Rigpa) have been practiced in Nepal (Phoboo et al., 2008). Beside

these, there are local medical practices prevailing among the different tribes of Nepal. However, the dominant practice in Nepal is Ayurvedic system which has three principles, namely, "VATA" "PITTA" and "KAPHA (COUGH". Human health is an optimal state of harmonious balance among these three elements. The Ayurveda (Ayurvedic system) is a treatment system that is rooted in the ancient Hindu culture which has developed in connection to Veda and Hindus civilization (Kunwar, 2017).

Besides, Ayurvedic practitioners, Amchi (Tibetan practitioners), Siddha and Unani also utilize the medicinal plants for treatments in Nepal (Ghimire et al., 2016). Many MAPs are exported to neighboring countries and overseas, including India, China, European countries and America (Bhattarai and Ghimire, 2006). The high demand of MAPs of Nepal in the international market is attributed to their unique bioactive compounds and medical efficiency (Phoboo et al., 2008).

2. Definition of Medicinal and Aromatic Plants

Plants with medicinal and/or aromatic uses are called medicinal and aromatic plants, abbreviated as MAPs. Plants with specific properties with proven health benefits are defined as medicinal plants (Taylor, 1996), also called herbal drugs. They are used to treat aliments in traditional and modern medical systems throughout the world. Medicinal plants are used as raw, processed or semi-processed forms, often in combination with multiple plants or ingredients (Bhattarai and Ghimire, 2006). Many medicinal plants are sources for the extraction of important chemical compounds which are used for the production of drugs.

Aromatic plants contain aromatic compounds which are usually extracted in the form of essential oils, concentrated hydrophobic liquids, also known as volatile oils, ethereal oils, aetheroleum or plant oils (Gyawali et al., 2008). Generally, essential oils are extracted by distillation from leaves, barks, buds, whole plants, flowers, fruits and seeds. These oils are useful also in the production of various cosmetic products, perfumes, medicines, toiletry and for aromatherapy (Ghimire, 2008). Plant oils have various health benefits as they are often used to ease stress, boost mood, relieve pain from headaches and migraines, get a better sleep during night, and quell nausea. Most of the essential oils have antiseptic properties as well (Chouhan et al., 2017). Common essential oils in Nepal are Basil, Calendula, Cinnamon, Citronella, Eucalyptus, Lemongrass and Peppermint (Gyawali et al., 2008).

2.1. Traditional Use of MAPs in Nepal

In Nepal, about 80% of the people live in rural areas, of which a majority of them rely on traditional remedies that involve the use of MAPs for their health problems (Bhattarai et. al., 2012). The use of herbal medicine has been considered safe and reliable which is economically affordable for those poor people in rural areas (Ambu et al., 2020). In Nepal, several medicinal plants have been used as various traditional medicine system practices, such as Ayurveda, Siddha, Unani, Tibetan, and Chinese (Bhattarai and Ghimire 2006). In the northern part of Nepal, their use is mainly influenced by Tibetan culture and practice of Tibetan medicine system (Sowa Rigpa), whereas, in the southern part of Nepal i.e., border to India, primarily three systems i.e.,

Ayurveda, Siddha and Unani have been in practice. In the mid-hill areas including Kathmandu (a capital city of Nepal), various types of traditional systems are in practice. Because of a high diversity in ethnicity and culture, the use of MAPs also varies across the country. Major ethnic groups in Nepal are Newar, Braman, Chhetri, Tharu, Chepang, Danuwar, Rai, Limbu, Gurung, Magar, Tamang, Jirel, and Muslim. The tradition of using MAPs varies among these groups. Among them, primarily Tharu, Danuwar, Tamang, Chepang and Rai are more dependent on traditional healing system in comparison to other ethnic groups (Kunwar, 2017).

Modern era of using MAPs in Nepal started after establishment of Herbs production and Processing Company (HPPCL), which is one of the oldest companies in Nepal and established in 1981 to extract essential oils from different indigenous Himalayan herbs as well as exotic plants. This company is a pioneer which created positive impacts on essential oil production as an industry in Nepal. Nowadays, various enterprises in Nepal are involved in essential oil extraction from plants such as

- *Mentha*,
- *Matricaria chamomilla*,
- *Lemongrass*,
- *Jatamansi,*
- *Eucalyptus* spp.,
- *Zanthoxylum armatum,*
- *Gaultheria fragrantissima,*
- Lichen.

These enterprise export essential oil and items with similar properties aboard, which is a major source of foreign currency in Nepal. According to United Nation COMTRADE data base, Nepal exported essentials, perfumes, and toiletries of $ 14.95 million in 2021.

3. Diversity of MAPs in General

Royal Botanical Garden, Kew has reported about 391,000 species of vascular plant species globally. Experts estimate that about 5-10% of total plant species have been investigated for their pharmaceutical activity. According to an estimate made by Schipmannent et al. (2006), globally, there are total 72,000 plant species used for medicinal purposes. China is a country with a long history of use of medicinal plants and there are about 11,000 medicinal plants (Pie and Huai, 2007). India alone has about 8000 plants that are considered to have medicinal value. Generally tropical countries are richer in plant diversity as well as in medicinal plants. Due to advancement of phytochemistry and pharmaceutical research every year new medical compounds are being identified from the plants and so the number of MAPs is being increased. However, sources of a majority of MAPs are wild areas from their natural habitats so research on domestication of MAPs should be given a priority.

3.1. Diversity of MAPs in Nepal

Due to diverse and extreme physio-climatic variation in Nepal, it harbors diverse ecosystems from tropical to temperate to alpine (Figure 2). Owing to its diverse climatic conditions some of the most unique and economically valuable MAPs are found in

Nepal. The Himalayan elevation gradient is the longest bioclimatic gradient in the world extending from c. 60 to more than 8000 m within 150–200 km, south to north transect, and comprises tropical/subtropical, temperate, sub-alpine and alpine climatic zones. Nepal has been considered one of the biodiversity rich countries in the world. It is estimated that Nepal has more than 8,000 species of flowering plants, of which about 20-25% are recorded with medicinal and aromatic properties (Bhattarai and Ghimire, 2006). Regarding the number of MAPs in Nepal, different authors have reported different numbers. However, the number of MAPS may depend on the frequency of their use and type of traditional medical system practice. In Nepal, a maximum of 1,950 species of MAPs are reported (Ghimire, 2008); Tiwari et al. (2004) reported 1,700 MAPs; Baral and Kurmi (2006) reported 1,792 species. Only 143 species are found as commercial highly valuable medicinal plants which account for a significant amount of trade in the export (Bhattarai and Ghimire, 2006).

Figure 2. Photo shows a complex landscape of Nepal from low valleys to higher Himalayan landscape.

MAPs distribution is not uniform across the country in both directions, from south to north (latitude) and east to west (longitude) of Nepal. Lower sub-tropical region of Nepal (1000-1500m) harbors the maximum number of medicinal plants, about 700 species. The lowest number of MAPs are found in the higher elevation but the percentage of commercially important is greater in higher elevation than in the lower elevation. MAPs in Nepal also vary in their size and life forms. They are annuals (live only one year or less), biennials (life cycle between one year and two years) and perennial (life cycle more than three years). Similarly, they represent various plant life forms such as trees, shrubs, climbers, and herbs (Bhattarai and Ghimire, 2006). Some of the unique and valuable MAPs found in Nepal are

- *Yarchagumba,*

- *Kutki,*
- *Jatamasi,*
- *Nirmasi,*
- *Bishma,*
- *Chiraito.*

The list of important MAPs are given in the Appendices 1.01-1-07

SN	Scientific name	Local name	Value of MAPs	Elevation range m asl
1	*Cuscuta reflexa*	Akasebeli	Medium	200-2200
2	*Amomum subulatum*	Alainchi	High	1000-2000
3	*Phyllanthus emblica*	Amala	High	150-1400
4	*Psidium guajava*	Amba	Medium	100-1500
5	*Ricinus communis*	Arandi	Medium	150-2400
6	*Terminalia arjuna*	Arjunchhal	High	100-500
7	*Justicaadhatoda*	Ashuro	Medium	500-1600
8	*Withaniasomnifera*	Aswagandha	High	100-500
9	*Aconilumheterophyllum*	Attish	High	3200-3700
10	*Aegle marmelos*	Bael	Medium	300-1100
11	*Polenlillafulgense*	Bajradanti	Medium	1600-4800
12	*Melia azedarach*	Bakaino	Medium	700-1100
13	*Sidacordilolia*	Balujhar	Medium	500-1400
14	*Ocimumbasilicum*	Bamari	High	300-1500
15	*Lilium nepalense*	Ban lasun	High	2300-3400
16	*Terminalia bellirica*	Barro	Medium	300-1100
17	*Cissampelos pareira*	Batupate	Medium	150-2299
18	*Ziziphus mauritiana*	Bayer	High	200-1200
19	*Semecarpus anacardium*	Bhalayao	Medium	200-1200
20	*Cannabis sativa*	Bhanga/ganja	High	200-2700
21	*Betula utilis*	Bhojpatra	High	2700-4300
22	*Ecliptaprostrata*	Bhringaraj	High	200-1200
23	*Phyllanlhusamarus*	Bhui Amala	High	800-900
24	*Phyllanthus niruri*	Bhuiamala	High	100-1500
25	*Selinumcandolli*	Bhutkesh	Medium	3000-3800

Appendix 1.01. Important Medicinal and aromatic plants of Nepal and their distribution range. Scientific name and corresponding local name (Nepali) are provided. Species are categorized into medium and high value based on their trade value, price, volume of collection and pharmaceutical use (IUCN, 2000; Bhattarai and Ghimire, 2006) (Page 1/7)

SN	Scientific name	Local name	Value of MAPs	Elevation range m asl
26	*Selinumtenifolium*	Bhutkesh	Medium	2700-4801
27	*Solanum indicum*	Bihi	High	200-1400
28	*Aconitum ferox*	Bikha	High	2100-3800
29	*Aconitum heterophyllum*	Bikha	High	3200-3700
30	*Aconitum spicatum*	Bikha	High	1800-4200
31	*Aconitum bisma*	Bikhma	High	1800-4201
32	*Maesa chisia*	Bilaune	Medium	1200-2600
33	*Pueraria tuberosa*	Biralikanda	High	300-1500
34	*Acoros calamus*	Bojho	High	1700-2300
35	*Micheliachampaca*	Chanp	Medium	600-1300
36	*Alstoniascholaris*	Chhatiwan	High	100-800
37	*Swertia alata*	Chiraito	High	2000-3600
38	*Swertia angustifolia*	Chiraito	High	600-2600
39	*Swertia bimacudata*	Chiraito	High	900-2700
40	*Swertia chirayita*	Chiraito	High	1500-2500
41	*Swertia ciliata*	Chiraito	High	2800-4000
42	*Swertia paniculata*	Chiraito	High	1500-3000
43	*Swertia multicaulis*	Chiraito	High	4000-4900
44	*Plumbago zeylanica*	Chitu	High	100-1300
45	*Smilax aspera*	Chopchini	Medium	1200-2600
46	*Berberis aristata*	Chutro	High	1800-3000
47	*Berberis asiatica*	Chutro	High	1200-2500
48	*Aesandrabutyracea*	Chyuri	High	300-800
49	*Cymbopogon nardus*	Citronella	High	100-1000
50	*Prinsepia utilis*	Datelo	Medium	1500-2900

Appendix 1.02. Important Medicinal and aromatic plants of Nepal and their distribution range. Scientific name and corresponding local name (Nepali) are provided. Species are categorized into medium and high value based on their trade value, price, volume of collection and pharmaceutical use (IUCN, 2000; Bhattarai and Ghimire, 2006) (Page 2/7)

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Biographical Sketches

Dr. Khem Raj Bhattarai has over 30 years' experience in exploration and documentation of flora, domestication of medicinal plants, conservation and management of biodiversity. He received his MSc degree in Botany in 1991 with top first class from Tribhuvan University, Nepal. His carrier was started from 1992 as a Botanist/Scientist in the National Herbarium and Plan Laboratories, under the Ministry of Forests, Nepal. He holds MPhil in Ecology and PhD in Biodiversity from the University of Bergen, Norway where he studied from 1999 to 2004. After few years of his active work in Himalayan botany, he deserved the Senior Scientific Officer and became the director of National Herbarium of Nepal. During 2013-2015 he served as a Joint Secretary (gazetted first class officer) in the Ministry of Forests, Government of Nepal. He has extensively published on relationship between biodiversity and climate, medicinal plants, conservation and ecology in peer review journals. He has published three books on medicinal plants and two book chapters on ecology and vegetation. He has served board of directors from 2009 to 2015 in the Herbs Production and Processing Company Limited, Kathmandu, Nepal. During his tenure in the government, he has served as a chairperson, coordinator and member in the different committees formed for management of medicinal plants by the Government of Nepal. He has established

a Gorkha Organic Herbal farm in 2018 in Gorkha, Nepal, where 30 different tropical and subtropical herbal crops are under cultivation. Currently he is vice president of Nepal Ayurvedic Medicine Producers Association and President of Nepal Herbal and Agricultural Grower Association. He has received award "Mahendra Bidhya Bhusan" from the government and BD Pandey Award from Association of Plant Physiologists of SAARC countries.

Dr. Subedi Subedi grew up in rural centeral-west Nepal where he developed an interest in plant science. He received a bachelor's degree in biology from Tribhuvan University. Then, he became interested in the plants in high mountains and studied the effects of climate change on high mountain plants for his master's degree at Tribhuvan University. Dr. Subedi's Ph.D. dissertation at Florida International University focused on a functional trait approach to examine plant community dynamics in tropical hardwood hammock forests. Currently, Dr. Suresh Subedi is an Assistant Professor in Department of Biological Sciences at Arkansas Tech University, continues his research on plant biology at different biological scales- organismal to community to ecosystem and their response to environmental change, using an integrative approach combining observational, experimental, and modeling techniques. He has published several research papers in peer review journals.