INTRODUCTION

IMPORTANCE OF MEDICINAL PLANTS

Plants have been the most important source of medicines for human health right from the dawn of civilization. The herbal traditions carried out through generations have always served a dual function of curing physical ailments as well as serving as a means of sustainable livelihood by the meaningful exploitation of natural resources. For a while the synthetic products of the modern age surpassed the importance of herbal products. But the safety and efficacy of the herbs over synthetics that are regarded as unsafe to human and environment, the development of drug resistance in many pathogens, the rising cost of synthetic drugs, population rise, inadequate supply of drugs and side effects of several allopathic drugs have all led to the people returning to the naturals with hope of safety and security.

The World Health Organization (WHO) estimates that 80% of about 4 billion population can not afford the products of the Western Pharmaceutical Industry and have to rely upon the use of traditional medicines for their primary health care which are mainly derived from plant material. This fact is well documented in the inventory of medicinal plants listing over 20,000 species. In India, millions of rural household use around 8000 species of the medicinal plants in self-help system. It is estimated that around a million folk practitioners all over India, midwives, bonesetters, visha vaidyas, herbal healers use medicinal plants. The traditional health care systems of India-Ayurveda, Unani and Siddha have 60,000 registered practitioners whose practice depends on the use of medicinal plants. There are over 6000 manufacturing units in the country with a turnover of around Rs.2300 crores per year. Modern medicines also use nearly 25% of their material based on plant or plant-derived drugs (Fransworth and Soejarto, 1991). The world trade on herbal medicine is now estimated at US $ 70 billion with an annual growth rate of 7% (Gera *et al.,* 2003). The trade in medicinal plant extracts promises new opportunities that could lead to employment generation in medicinal plant sector (Bhattacharya and Mitra, 2002).

In spite of the overwhelming influences and our dependence on modern medicine and tremendous advances in synthetic drugs, large segments of the world population still like drugs from plants. Over three-quarters of the world population relies mainly on plants

and plant extracts for health care because modern life saving drugs are beyond reach, although many such countries spend 40-50% of their total wealth on drugs and health care. As a part of the strategy to reduce the financial burden on developing countries, it is obvious that an increased use of plant drugs will be followed in the future. More than 30% of the entire plant species, at one time or other was used for medicinal purposes. In developed countries such as United States plant drugs constitute as much as 25% of the total drugs, while in fast developing countries such as China and India, the contribution is as much as 80%. Thus, the economic importance of medicinal plants is much more to countries such as India than to rest of the world.

Increasing demand of herbal products has led to excessive collection or exploitation of medicinal plants and has put a tremendous pressure on plant resources resulting in substantial loss of their habitats and population decline of many high value medicinal plant species over the years (Planning Commission, 2000: Kala and Sajwan, 2007)**.** More than 90% of medicinal plant raw material for herbal industries in India and also for export is drawn from natural habitats which has threatened the natural populations of medicinal plants (Dhar *et al*., 2002). While over 800 species are used in production by industry, less than 20 species of plants are under commercial cultivation. Over 70% of the plant collections involve destructive harvesting because of the use of parts like roots, bark, wood, stem and the whole plant in case of herbs. This poses a definite threat to the genetic stocks and to the diversity of medicinal plants. Effect on bio-diversity, habitat specificity, narrow range of distribution, land use disturbance, introduction of non-natives, habitat alteration, climatic changes, heavy livestock grazing, explosion of human population, fragmentation and degradation of population, population bottleneck and genetic drift are the potential causes and threat to medicinal plants (Rao *et al.,* 2004; Kala, 2005; Kala, 2000; Weekley and Race, 2001; Oostermeijer *et al.,* 2003).

There are about 400 families in the world of flowering plants; at least 315 are represented in India. Plants provide the predominant ingredients of medicines in most medical traditions. The use of plants as medicines represents by far the biggest human use of the natural world in terms of the number of species individually targeted. There is no reliable figure for the total number of medicinal plants on Earth, and numbers and percentages for countries and regions vary greatly (Schippmann *et al.,* 2002). Of the 2, 50, 000 higher plant species on earth, more than 80,000 are medicinal. Very small proportions of the medicinal plants are lichens, ferns, algae etc; the majority of the medicinal plants

are higher plants. Estimates for the numbers of species used medicinally include: 35,000-70,000 or 53,000 worldwide (Schippmann *et al.,* 2002); 10,000- 11,250 in China (He and Gu, 1997; Pei, 2002; Xiao and Yong, 1998); 7500 in India (Shiva, 1996); 2237 in Mexico (Toledo, 1995); and 2572 traditionally by North American Indians (Moerman, 1998).

India is proud to be rich in biological diversity and tenth among the plant rich countries of Asia, sixth as far as centres of diversity especially agrodiversity are concerned. India possesses almost 8% of the estimated biodiversity of the world and is one of the world's 12 biodiversity centres with the presence of over 45,000 different plant species and 2 hot spots of biodiversity in Western Ghats and North-Eastern region. Of these, about 15,000-20,000 plants have good medicinal value. However, only 7000-7500 species are used for their medicinal values by traditional communities. Nearly three-fourth of the drugs and perfumery products used in the world are available in natural state in the country.

In India, traditional systems of medicines have used drugs of herbal origin since ancient times. The *Ayurveda* system of medicine uses about 700 species, *Unani* 700, *Siddha* 600, *Amchi* (the Tibetan system) 600 and modern medicine around 30 species. The drugs are derived either from the whole plant or from different organs, like leaves, stem, bark, root, flower, seed, etc. Some drugs are prepared from excretory plant product such as gum, resins and latex. Even the Allopathic system of medicine has adopted a number of plant-derived drugs which form an important segment of the modern pharmacopoeia. Some important chemical intermediates needed for manufacturing the modern drugs are also obtained from plants (e.g. diosgenin, solasodine, β-ionone). Plant-derived drug not only offers a stable market world wide, but they also continue to be an important source for new drugs.

Among ancient civilizations, India has been known to be rich repository of medicinal plants. Raw materials for manufacture of drugs and perfumery products are collected from the forest which acts as the principal repository of large number of medicinal and aromatic plants. About 8,000 herbal remedies have been codified in Ayurveda. The *Rig-Veda* (5000 BC) has recorded 67 medicinal plants, *Yajurveda* 81 species, *Atharvaveda* (4500-2500 BC) 290 species, *Charak Samhita* (700 BC) and *Sushrut Samhita* (200 BC) had described properties and uses of 1100 and 1270 species respectively, in compounding of drugs and these are still used in the classical

formulations, in the Ayurvedic system of medicine. Unfortunately, much of the ancient knowledge and many valuable plants are being lost at an alarming rate. With the rapid depletion of forests, impairing the availability of raw drugs, Ayurveda, like other systems of herbal medicines has reached a very critical phase.

A number of well established indigenous or traditional systems, including Unani, Siddha, Homoeopathy, Tibetan, Amchi, Yoga and Naturopathy are practised along with modern medicine for the management of total health care system. In all these systems a large number of plant drugs are used, although there may be some common plants. Inventorisation of these plant drugs is, indeed, a colossal task. Moreover the plant drugs in those systems of medicine are known by their classical or vernacular names which creates problem in correct identification of plants.

Ayurveda, dating back to 1500-800 BC, is most developed and widely practiced in India and has been an integral part of Indian culture. It has more than 8000 plant remedies and uses around 35,000-70,000 plant species. Ayurveda is gaining prominence as the natural system of health care all over the world. Today this system of medicine is being practiced in countries like Nepal, Bhutan, Sri Lanka, Bangladesh and Pakistan, while the traditional system of medicine in the other countries like Tibet, Mongolia and Thailand appear to be derived from Ayurveda. Phytomedicines are also being used increasingly in Western Europe and US. China has pharmacologically validated and improved many traditional herbal medicines and eventually integrated them in formal health care system.

Secondary metabolites of plants have commercial importance and are used in a number of pharmaceutical compounds. In addition to that, a variety of biochemical products and biologically active molecules are synthesized and preserved by green plants which can be extracted and used as chemical feed stocks or as raw materials for various scientific investigations. After extraction they can be modified for enhanced activity and /or reduced toxicity. However, a sustained supply of the source material often becomes difficult due to the factors like environmental changes, cultural practices, diverse geographical distribution, labour cost, selection of the superior plant stock and over exploitation by pharmaceutical industry.

About 120 therapeutic agents of known structure from about 90 species of plants have been isolated from the small fraction of flowering plants. Some of the useful plant drugs include vinblastine, vincristine, taxol, podophyllotoxin, camptothecin, digitoxigenin,

gitoxigenin, digoxigenin, tubocurarine, morphine, codeine, aspirin, atropine, pilocarpine, capscicine, allicin, curcumin, artemesinin and ephedrine among others. In some cases, the crude extract of medicinal plants may be used as medicaments. On the other hand, the isolation and identification of the active principles and elucidation of the mechanism of action of a drug is of paramount importance. Hence, works in both mixture of traditional medicine and single active compounds are very important. The active molecule that cannot be synthesized economically can be obtained from the cultivation of plant material. About 121 (45 tropical and 76 subtropical) major plant drugs have been identified for which no synthetic one is currently available (Table 1.1). The scientific study of traditional medicines, derivation of drugs through bioprospecting and systematic conservation of the concerned medicinal plants are thus of great importance.

TABLE 1.1 MAJOR PLANT DRUGS FOR WHICH NO SYNTHETIC ONE IS AVAILABLE (Kumar *et al.*, 1997).

DRUG	PLANT	USE
Vinblastine	***Catharanthus roseus***	**Anticancer**
Ajmalacine	*Catharanthus roseus*	Anticancer, hypotensive
Rescinnamine, Reserpine	*Rauvolfia serpentine*	Tranquilizer
Quinine	*Cinchona sp.*	Antimalarial, amoebic dysentery
Pilocarpine	*Pilocarpus jaborandi*	Antiglucoma
Cocaine	*Erythroxylum coca*	Topical anaesthetic
Morphine	*Papaver somniferum*	Painkiller
Codeine	*Papaver somniferum*	Anticough
Atropine	*Atropa belladonna*	Spasmolytic, cold
Atropine	*Hyoscyamus niger*	Spasmolytic, cold
Cardiac glycosides	*Digitalis sp.*	For congestive heart failure
Artemesinin	*Artemisia annua*	Antimalarial
Taxol	*Taxus baccata*	Breast and ovary cancer, antitumour
Berberine	*Berberis*	For leishmaniasis
Pristimerin	*Celastrus paniculata*	Antimalarial
Quassinoids	*Ailanthus*	Antiprotozoal
Plumbagin	*Plumbago indica*	Antibacterial, antifungal
Diospyrin	*Diospyros montana*	
Gossypol	*Gossypium sp.*	Antispermatogenic
Allicin	*Allium sativum*	Antifungal, amoebiasis
Ricin	*Ricinus communis*	

Emetine	*Cephaelis ipecacuanha*	Amoebiasis
Glycyrrhizin	*Glycyrrhizia glabra*	Antiulcer
Nimbidin	*Azadirachta indica*	Antiulcer
Catechin	*Acacia catechu*	Antiulcer
Sophoradin	*Sophora subprostrata*	Antiulcer
Magnolol	*Magnolia bark*	Peptic ulcer
Forskolin	*Coleus forskohlii*	Hypotensive, cardiotonic
Digitoxin, Digoxin	*Digitalis, Thevetia*	Cardio tonic
Thevenerin	*Thevetia*	Cardio tonic
Nerrifolin	*Thevetia*	Cardio tonic
Podophyllin	*Podophyllum emodi*	Anticancer
Indicine N-oxide	*Heliotropium indicum*	Anticancer
Elipticine	*Ochrosia*	Anticancer
Homoharringtonine	*Cephalotaxus*	Anticancer
Camptothecine	*Camptotheca acuminata*	Anticancer

Studies have shown that Ayurvedic medications can reduce the toxic effects of radiations and chemotherapy in cancer treatment or even accelerate surgical wound healing. Hence a combination therapy integrating Ayurveda and allopathy can be used to control the side effects and undesirable reactions. Modern science and technology have an essential role to play in the process. An integrated approach for the cultivation, conservation and preservation of important plant species through plant molecular biology, plant tissue culture; research on the rationale and methodology of Ayurvedic medical practice; isolation of active constituents and their development into new therapeutics; standardisation and validation of known herbal medicines and other related aspects need to be focused upon (Roy *et al*., 1998).

Medicinal principles are present in different parts of the plant like root, stem, bark, heartwood, leaf, flower, fruit or plant exudates. These medicinal principles are separated by different processes; the most common being extraction. Extraction is the separation of the required constituents from plant materials using a solvent. The promotion and development of processing of medicinal and aromatic plants have gained momentum recently in many developing countries. Increasing awareness about biodiversity conservation and sustainable use of natural resources coupled with poor socio-economic conditions of native populations are ground realities for planning and harnessing the low-cost and purpose oriented process technologies.

Medicinal plants are used as raw materials for extraction of active constituents in pure form (e.g. alkaloids like quinine and quinidine from cinchona bark, emetine from ipecacuanha root, glycosides from digitalis leaves, sennosides from senna leaves), as precursors for synthetic vitamins or steroids, and as preparations for herbal and indigenous medicines. Products such as ginseng, valerian and liquorice roots are part of the herbal and health food market, as well as the food flavours, fragrance and cosmetic industries. A large quantity of medicinal plant material is used in the preparation of herbal and medicinal teas, e.g. chamomile. Hundreds of medicinal plants are items of commerce, however relatively small quantities are used in formulated herbal remedies. Several formulations like herbal teas, extracts, decoctions, infusions, tinctures, macerates etc are prepared from medicinal plants (Kraisintu, 1997).

There are some problems concerning the proper identity of a number of drug species. In many cases, a single plant species has several different commercial or medicinal names in different regions. Several distinct species are often used under the same drug name. Another problem relates to adulteration in the market samples. In other words, authentication of the botanical identity and ascertaining the genuineness of drug is of great concern in practical situations.

Realizing the benefits and essentiality of the herbal drugs, the Government of India has set up the National Medicinal Plants Board which is responsible for co-ordination of all matters relating to medicinal plants, including drawing up of policies and strategies for conservation, proper harvesting, cost-effective cultivation, research and development, processing, marketing of raw materials in order to protect, sustain and develop this sector. Furthermore, in each state and union territory, State Medicinal Plants Board has been set up for the promotion and popularization of the medicinal plants cultivation. West Bengal and Sikkim are two such states, which cover the Sikkim and Darjeeling Himalayas representing one-third of the national total of high value medicinal plants.

Considering the priority list of National Medicinal Plants Board and State Medicinal Plants Board of West Bengal and Sikkim, the following 17 species of medicinal plants have been identified for sustainable commercial cultivation in the Darjeeling and Sikkim Himalayan region (Pradhan S, Lama PC and Chhetri DR. Programmes on Medicinal Plants: The Present Scenario. *Natural Resource Based Economy in the Eastern Himalaya*. 69-86, 2005).

These are:

1. *Aconitum heterophyllum*
2. *Acorus calamus*
3. *Asparagus racemosus*
4. *Datura stramonium*
5. *Digitalis purpurea*
6. *Hippophae rhamnoides*
7. *Hippophae salicifolia*
8. *Nardostchys jatamansi*
9. *Dactylorhiza hatagirea*
10. *Picrorhiza kurrooa*
11. *Piper longum*
12. *Rauvolfia serpentine*
13. *Rhododendron arboreum*
14. *Rubia cordifolia*
15. *Saussurea ovallata*
16. *Swertia chirayita*
17. *Taxus baccata*

Eastern Himalayas, comprising of Darjeeling and Sikkim Himalayas, cover mountainous terrain ranging between 300 meters to more than 6000 meters with perpetual snowy mountain ranges. Diverse climatic conditions comprising from humid subtropical at lower foothills and the valleys to temperate and sub temperate at mid hills and alpine at the high altitudes makes this Himalayas one of the most floristically rich and interesting areas of the country and contains about one-third of the total species of Indian flora. This region, being situated in one of the bio-diversity hot spots of the world, is a virtual gold mine of medicinal plant bio-diversity. Of the 1500 odd medicinal plant species widely used in the country, this region alone is represented by more than 500 species. The figure would go up if other lesser-known plants are included in the list. This vast economic resource of the country has largely gone unnoticed and uncared for.

Fig. 1.2 Map showing the Eastern Himalayan region.

Darjeeling Himalaya is situated between the 27^0 13'- 28^0 31' N and 87^0 59'- $88^0$53' E in the Eastern Himalayan region of India. It is a frontier district running up between Nepal and Bhutan, and stretching from the plains of Bengal in the south to Sikkim in the north. It is bordered by Bhutan in the east and Nepal in the west. The three hill subdivisions of Darjeeling district, Kalimpong, Kurseong and Darjeeling sadar consisting of eight developmental blocks and occupying an area of 2417 sq km comprise the Darjeeling Himalaya. The altitudinal range of this hilly region varies from 130 to 3660 m. Due to their great variation, a wide array of climatic zones are available which varies from tropical in the lower hills to sub-alpine in the high hills. This favours the luxuriant growth of diversified and rich vegetation. This region is also the abode of many endemic elements and a number of species which have become rare, threatened or endangered.

Darjeeling Himalaya along with being a rich repository of medicinal plants has also nurtured several distinct ethnomedicinal systems over a long period of time. Nepali *jaributi*, Lepcha herbal and the Tibetan system, which all rely on the local plant resources, are the most prominent ones. All these systems are inclusive with no clear demarcation between them. Biswas (1956) has described 147 medicinal plants found in the Darjeeling and Sikkim Himalayas. Likewise, Rai and Sharma (1994) described 40 different genera

while detailing the status, uses and potential of medicinal plants of the Sikkim Himalaya, and enumerated 47 species while working on ethnomedicinal plants in the fringe areas of Sikkim and Darjeeling Himalayas (Rai *et al*., 1998)**.**

Works exclusively on the medicinal plants of Darjeeling Himalaya have been few and far between. Yonzone *et al.* (1984) mentioned 75 plants of ethnomedicinal importance from Darjeeling. Rai and Bhujel (1999) have enumerated 18 new plants used in ethnomedicine. They also noted the use of 30 monocot species in traditional medicine of Darjeeling hills (Rai and Bhujel, 2002). Saini (2000) has enlisted 129 medicinal plants studied by the Silviculture Forest Division of Darjeeling. Das and Mandal (2003) have described 91 species of common medicinal plants from Darjeeling Hills.

The table below shows a complete list of medicinal plants (Table 1.2) used in the traditional system of medicine in the Darjeeling Himalayan region and includes only the common species that have been verified through more than one source, i.e. traditional healers, medicine men, priests, village seniors, etc (Chettri *et al.,* 2005).

TABLE 1.2 DIVERSITY OF ETHNOMEDICINAL PLANTS IN DARJEELING HIMALAYA

Category	Dicots	Monocots	Gymno-sperms	Pterido-phytes	Total
Family	85	12	04	07	108
Genus	182	32	06	09	229
Species	225	41	06	09	281
Species showing new ethnomedicinal uses	132	24	04	04	164

The rural people rely heavily on plant resources for their primary healthcare and treatment of diseases. They have developed unique indigenous knowledge related to the uses of plant resources due to constant association with the forests. The traditional knowledge related to the therapeutic uses of plants may be utilized for the improvement of the economic status of the local communities. However, less priority has been given to document these valuable practices and plant resources. The importance of herbal medicines, which are not only used in the Indian system of medicine but also in modern system of medicines, are increasing day by day.

The population of medicinal plants is receding in their natural habitat because, even now, they are mostly collected from wild and sent to ready markets in the cities, although there is a ban on collection of material for fear of extinction. Conservation, cultivation and mass propagation of these plants is urgently needed to ensure their availability to the pharmaceutical industry as well as the traditional practitioners. Commercial cultivation will put a check on the continued exploitation from wild sources and serve as an effective means to conserve the rare floristic wealth, genetic diversity and protect endangered species. *In situ* conservation of these resources alone cannot meet the ever increasing demand of pharmaceutical industry. Appropriate cropping patterns should be suggested so that the plants can be incorporated into the conventional agricultural and forestry cropping systems.

Excessive collection of timber, fuel wood, food plants and commercial exploitation of medicinal plants has provided a great deal of vulnerability to individual species. Not to mention the influx of tourists who rampantly collect plants, monoculture and block cultivation methods of afforestation, cattle grazing, indiscriminate collection of the raw biomass of plants, use of herbicides and other chemicals on the 70-odd tea gardens in the region has led to substantial loss of medicinal plant biodiversity. Besides, natural calamities like landslides, earthquakes, etc. coupled with the demographic variation caused by increased birth rate and population migration lead to the loss of biodiversity (Given, 1996). The Sandakphu area in the Singalila range is a natural habitat of precious medicinal plants like *Aconitum*, *Picrorhiza*, *Nardostachys*, *Dactylorhiza*, etc., which are being destroyed by grazing. IUCN determines the criterion for categorization of threatened species. Out of a total of 281 odd ethnomedicinal plants (Table 1.2) reported from Darjeeling Hills, 40 species (14%) have been categorized as threatened (Table 1.3). Many of these plants are endemic to this region. Many of the local medicinal plants may some day disappear from the scene if timely intervention is not adopted for their protection and propagation (Chettri *et al.,* 2005).

TABLE 1.3 THREATENED MEDICINAL PLANTS OF THE DARJEELING HIMALAYA.

Botanical name	Family	Local Name (Nepali)	Life form	Altitudinal range (masl)	Threat Status
***Abutilon indicum* (Linn.) Sw.**	Malvaceae	Ghanti phool	Shrub	100–2200	EX
***Aconitum heterophyllum* Wall.**	Ranunculaceae	Bikhumma	Herb	3000-3500	CR
***Aconitum palmatum* D. Don**	Ranunculaceae	Bikhumma	Herb	2800-3600	CR
***Aconitum spicatum* Stapf**	Ranunculaceae	Bikh Herb	Herb	2800-3600	VL
***Aeschynanthus sikkimensis* (Cl.) Stapf**	Gesneriaceae	Sinduray	Herb	1500-2400	CR
***Cissampelos pareira* Linn.**	Menispermaceae	Batulay	Climber	100-300	VL
***Cinnamomum tamala* Nees & Eberm.**	Lauraceae	Sinkauli	Tree	1200-2100	LR
***Clematis buchaniana* DC.**	Ranunculaceae	Pinasay lahara	Climber	1200-2700	VL
***Curcuma zeodaria* Rosc.**	Zingiberaceae	Kalo hardi	Herb	1000-1500	CR
***Dactylorhiza hatagirea* (Don) Soo**	Orchidaceae	Panch aunlay	Herb	3000–3660	CR
***Elaeocarpos granitus* Roxb.**	Elaeocarpaceae	Rudraksha	Tree	100–500	EN
***Gloriosa superba* Linn.**	Liliaceae	Bikhphool	Herb	300-2000	EX
***Gynocardia odorata* R. Br.**	Flacourteaceae	Gantay	Tree	1400-2100	EN
***Hedychium spicatum* Ham. ex Sm.**	Zingiberaceae	Dudh kewnra	Herb	1500-2200	VL
***Juglans regia* Linn.**	Juglandaceae	Okkhar	Tree	900-2500	VL
***Mahonia acanthifolia* G. Don**	Berberidaceae	Chutro	Tree	1600-2400	LR
***Mesua ferrea* Linn.**	Clusiaceae	Negeswor	Tree	900-1500	EN
***Nardostachys jatamansi* DC.**	Valerianaceae	Jatamaasi	Herb	3300-3600	CR
***Ophioglossum vulgatum* Linn.**	Ophioglossaceae	Jibray saag	Herb	1500-2700	EN
***Piper longum* Linn.**	Piperaceae	Pipla	Climber	200-1400	VL
***Panax pseudoginseng* Wall.**	Araliaceae	Salanay	Herb	1900-2800	EN
***Picrorhiza kurroa* Royle ex Benth.**	Scrophulariaceae	Kutki	Herb	2700-3660	CR
***Podophyllum hexandrum* Royle**	Podophyllaceae	Papari	Herb	2800-3660	CR
***Rheum acuminatum* Hook f. & Th.**	Polygonaceae	Padamchal	Herb	3000-3600	EN
***Rhododendron anthopogon* D. Don**	Ericaceae	Sunpatay	Shrub	300–3600	VL
***Rhododendron arboreum* Sm.**	Ericaceae	Lali Gurans	Tree	1700-3000	VL
***Rhododendron campanulatum* D. Don**	Ericaceae	Nilo Chimal	Shrub	2500-3600	LR

***Rhus semialata* Murr.**	Anacardiaceae	Bhakimlo	Tree	1000-2000	VL
***Saussurea costus* (Falc.) Lipsch.**	Asteraceae	Kuth	Herb	2500-3300	EN
***Stephania glabra* (Roxb.) Miers**	Menispermaceae	Nimilahara	Climber	1500-2000	EN
***Stephania hernandifolia* (Willd.) Walp.**	Menispermaceae	Tamarkay	Climber	100–1500	CR
***Swertia chirata* Buch.-Ham.**	Gentianaceae	Chireto	Herb	1500–2500	VL
***Swertia pedicillata* Ban.**	Gentianaceae	Chireto	Herb	2200-3000	EN
***Taxus baccata* Linn.**	Taxaceae	Dhyangre salla	Tree	1500-2700	CR
***Thalictrum foliolosum* DC.**	Ranunculaceae	Chitray	Herb	1500-2500	VL
***Tinospora cordifolia* (Willd.) Miers.**	Menispermaceae	Gurjo	Climber	200-1000	EN
***Valeriana herdwickii* Wall.**	Valerianaceae	Nakli jatamaasi	Herb	1500-3400	EN
***Viscum articulatum* Burm.**	Loranthaceae	Harchur	Herb	1000-2200	VL
***Woodfordia fruiticosa* Kurz**	Lythraceae	Dhangera	Shrub	100-1200	LR
***Zanthoxylum oxyphyllum* Edgew.**	Rutaceae	Timmur	Shrub	188-2800	EN

CR: Critically rare; EN: Endangered; VL: Vulnerable; LR: Low risk-near threatened; Ex: Extinct in the wild.

The agro-climatic conditions and the soil of Darjeeling and Sikkim are very conducive for medicinal plants cultivation. This can be exploited for the economic development of this region. Besides, these conditions help in introduction and cultivation of a number of income generating plants with minimum effort. People living in villages and far-flung areas depend completely on forest resources for maintaining their day-to-day needs like medicine, food, fuel and household articles. Darjeeling Himalaya also has rich ethnomedicinal traditions. People are largely dependent on herbal medicine for their healthcare. This part of the Himalayas is the cornucopia of ethnicity. The major ethnic groups of this region are Lepcha, Bhutia and the Nepalese which have their own distinct culture, language and traditions, including ethnomedicinal practices and excellent knowledge of the plant wealth in their surroundings. The medicinal plants of the Himalayas used in different medicine systems are the centre of interest of the world today.

The economy of this Himalayan region has always been dependent on traditional agriculture, horticulture, and tourism and to some extent floriculture. In the rural areas the majority of the population lives below the poverty line. Since most of the people are engaged in agriculture related activities, the alternatives should also be farm-based .Of the

farm-based alternatives mention may be made of floriculture, horticulture and the cultivation of medicinal plants. In this context the most suitable section open to mountain farmers is the cultivation of medicinal plants that promises a high economic return, could be produced in small land holding, posses no problem in preservation, packaging and transportation. Moreover it presents little global competition and is based on the local resources.

Besides high economic returns, the cultivation of medicinal plants helps to maintain ecological conditions. This practice also helps in replenishing the already dwindling stock of wild plants and in the conservation of species. In the mountain villages the farmers face quite a problem from wild animals. It has always been a great problem to save the traditional crops like potato, maize, cabbage etc, from wild animals such as wild boar, bear, monkey etc. Medicinal plants have the advantage of being a non-edible item to these animals.

The fragile ecosystem of the Himalayan regions with unstable nature of the soil makes it prone to landslide if it is disturbed too much for cultivation processes. Medicinal plant cultivation could be done with minimum disturbance to the soil strata and thereby minimizing the chances of landslides. The conservation and multiplication of medicinal plants should go hand in hand and people concerned should get the economic incentives. These ways the plants will be conserved and all the mountain villages will become economically viable in days to come.

IMPORTANCE OF *SWERTIA CHIRAYITA*

Among the different species of *Swertia* reported in India, *Swertia chirayita* Roxb. ex Fleming (Karsten) of Family Gentianaceae, commonly known as 'East Indian Balmony', is considered the most important for its medicinal properties. The plant is a native of temperate Himalayas and occurs from 1200 to 3000 meters. However, existing population of *S. chirayita* is diminishing due to rapid increase of human interference, stress on natural habitat in the forests, collection at immature stage, lack of scientific understanding of the plant and awareness among the local people. Out of all the varieties, *S. chirayita*, the one which is commercially more important, is in the danger of getting lost. Hence according to the new International Union for Conservation of Nature and Natural Resources (IUCN) criteria, *S. chirayita* has been categorized as critically

endangered (Joshi and Dhawan, 2005). Under Foreign Trade Development and Regulation Act-1992, Government of India, law prohibited 29, along with *S. chirayita,* highly endangered medicinal plants for export. However, these plants can be exported by cultivating and then producing a certificate of the source of cultivation by the competent authority. Furthermore, National Medicinal Plants Board, Ministry of Health & Family Welfare, Government of India (2000) has listed 32 commercially important plants for conservation and cultivation; *S. chirayita* is one among them.

Although this plant is profitable for cultivation but due to lack of suitable agro-technique of cultivation and substandard viability and longevity factors in seeds, erratic behaviour of seed germination, it is not being popularized among the Himalayan cultivators. Considering in mind such vital problems of this promising plant, an attempt was made in this investigation to invigourate the seeds by chemical manipulations. Further, potential performance of the plants were analyzed by a number of physiological and biochemical tests. A regular monitoring was done for the principle active compound constituents at different stages.

Only the preliminary studies have been recorded about the seed germination and viability of *S. chirayita*. There is no established agro-technique for promoting its cultivation (Joshi and Dhawan, 2005; Pant, 2007). The massive use of this plant in different traditional as well as in the modern medicines generated a great domestic and international market (M.Karan *et al.,* 1996).

The plus points for cultivation of *Swertia chirayita* are:

1. Less requirement of maintenance in the field for it has zero management crop features.
2. Considerably higher productivity even in the fallow land and rocky areas.
3. Less damage by the wild animals.
4. All plant parts are used for medicine.
5. Low volume-high return plant.

However, this plant has some negative features for which it is not widely accepted by the Himalayan cultivators. These are:

1. Seed germination behaviour is very erratic and the plant habit has no consistency.

2. Rapid depletion of this plant from the natural habitat has different factors, out of which the monocarpic character accelerates its depletion.
3. The seedling and sapling stages of the plant cover more than 60 % of the total period of the life cycle.
4. Plant is erect with less number of branches.

In the back drop of the problems and prospects mentioned above in the plant, attempts were made in the present investigation to obviate or to reduce the deleterious features impairing productivity of plant by chemical manipulative methods which included using some plant growth regulators of the promoter class like Gibberellins (GA_3), Indole Acetic Acid (IAA) and Kinetin (KIN) and of the retardant class like Maleic Hydrazide (MH), Succinic Acid Dimethyl Hydrazide (SADH) and Abscisic Acid (ABA). Strategies to obviate the deleterious features also include selection of the optimum concentrations of the chemicals as well as selection of the ideal stage of the plant development for application of the chemicals for obtaining the most coveted response.

Objectives of the study:

In view of the problems of the plant cultivation there is enough scope for undertaking a comprehensive work on crop improvement. Keeping in mind the specific problems of the germination and the prolong life cycle of the chirata plant, the objectives are pinpointed in the following lines:

1. To analyze the phenology of the plant to get an insight into the important events in the life cycle as well as productivity.
2. To identify the best mode of exploitation of the chemicals considering their concentrations and appropriate time of treatment during storage or during growth phase of plants.
3. To analyze the efficacy of the plant growth substances for shorting of the seedling or sapling stages by promoting the rapid initiation to maturing stage.