

Collection and conservation of major medicinal plants of Darjeeling and Sikkim Himalayas

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The paper deals with use of certain indigenous medicinal plants among the local people of the Sikkim Himalaya (Eastern Himalaya), which includes the entire state of Sikkim and adjoining Darjeeling Hill district of West Bengal. The study highlighted the use of 28 plant species belonging to 26 genera and 19 families as herbal medicine in the treatment of various ailments. Considering the growing demand for raw materials of medicinal plants by the pharmaceutical companies and their depleting resource base, due to unscientific gathering from the wild, it is of utmost necessity to take up *ex-situ* cultivation and conservation of these medicinal plant species. Plant name, local name, family, along with their parts used, ethnobotanical application with active principles and conservation strategies are discussed.

Keywords: Conservation, Ethnomedicine, Medicinal plants, Darjeeling, Sikkim Himalayas, *Lepcha*, *Bhutia*, *Limbus*

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According to World Health Organization estimate, approximately 80% population in developing countries depend on traditional medicine for primary health care needs: a major portion of these involves the use of medicinal plants¹. In modern medicine too, nearly 25% are based on plants or plant-derived drugs². The world trade on herbal medicine is now estimated at US\$ 70 billion with an annual growth rate of 7%³. India has plans to increase the trade in medicinal plant extracts. New opportunities are thus being created that could lead to employment generation in medicinal plant sector⁴. India is one of the mega biodiversity centers of the world and the northeastern region of India belongs to the biodiversity hotspot. The floristic wealth of this region is nearly 43% of the country's total flora. A good number of known and unknown medicinal plants are found in the forests of Darjeeling Hill district of West Bengal and the state of Sikkim⁵⁻⁷. Local inhabitants use some of these plants as herbal medicine, which are highly effective against some diseases. Because of their availability and utility as herbal medicine, local people have been using these plants from time immemorial.

The major constraint in this sector is poor marketing facilities for raw materials as a result; the farmers are hesitant to take up large-scale cultivation of medicinal plants. Medicinal plants are generally marketed in private sector where intermediaries/middlemen keep a strong hold/ control on the market because they provide the collectors three essential services, *viz.*, quick credit, quick and non-bureaucratic payment and good organization⁸. Middlemen play an important role by centralizing supply among dispersed producers and help to absorb risk in markets that require product volumes too large to provide by individual producer. Middlemen, on the other hand, often exploit collector's ignorance of market factors and claim a disproportionate share of producer's value for themselves. With increased availability of market information, producers will have the potential to strengthen their position in markets and possibly get higher prices. Similarly, pharmaceutical industries should take initiative to purchase raw materials from both cultivators and legal contractors. The schedule of rates of every raw material of medicinal plants (non adulterate/ adulterate) should be fixed⁹. This would not only increase employment generation and income at local level but also encourage the local people to undertake commercial cultivation of medicinal plants.

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Methodology

Field trips were conducted in different areas of Darjeeling Hill district during January 2004 and in Sikkim during December 2004. Areas covered during these trips include Darjeeling, Sonada, Sukhiapokhri, Tonglu, Sukna, Bhuttabari etc. under Darjeeling district of West Bengal and Bitu, Thingum, Phodong, Singik, Tong, etc. under North district, Namli, Rumtek, 20th Mile, Kyongnslla, etc. under East district, Geyzing, Pelling etc. under West district and Jorethang, Gursay etc. areas under South district of Sikkim. Both the trips yielded 62 collections of different medicinal plants belonging to 28 species (Table 1). Collections were made from natural forest, roadsides, forests nurseries etc. Depending on population size, either random sampling from the population or selective sampling on individual plant basis was followed. Collected materials included live plants, rhizomes, cuttings, suckers, seeds etc. During the trips, tribal people including local healers, elderly persons, gardeners etc. were interviewed to get the ethnobotanical information like local names of the plants and their uses against different ailments following standard method¹⁰. The collected materials were taken to the NBPGR Regional Station, Barapani, Meghalaya and planted in the station farm for their multiplication and subsequent characterization. Later on, the plants were identified with the help of different floras¹¹⁻¹².

Darjeeling Hill district of West Bengal is situated between 27°13' - 28°31' N latitude and 87°59' - 88°53' E longitude in the Eastern Himalayan region of India. It occupies an area of 3264 sq km with an elevation range of 92-2659 m. Depending on elevation, the climate of the district varies from tropical in the lower hills to sub-alpine in the high hills. The district comprises of 2417 sq km of hilly areas with above one million populations, of which 78.42% live in rural areas. This part of the Himalayas is the cornucopia of ethnicity. The major ethnic groups of the region are *Lepcha*, *Bhutia* and the Nepalese. Nepalese is a conglomerate of Mongoloid tribal like *Sherpa*, *Limbu*, *Tamang*, *Yolmo*, *Kagatay*, etc. and the Aryan non-tribal like *Chhetri*, *Bahun*, *Sanyasi*, *Kami*, *Damai*, etc. Intermediates between these two groups are the *Newas*, showing partial characteristics of both the groups. Each of these tribal groups has its own distinct culture, language and traditions. However, Nepali language is the medium of communication between the tribes. These tribes also have rich

ethnomedicinal traditions. The tough terrain and vast natural barriers force the people of this region to depend on herbal medicine. However, the use of traditional medicine is prevalent even among the urban people of this region.

The Himalayan state of Sikkim lies between 27°46'-28°7'48" N latitude and 88°0'5"-88°55'25" E longitude in the lap of Eastern Himalayas below Khangchendzonga with an area of 7299 sq km and a population of 496, 457, 88% of which live in villages¹³. Administratively, Sikkim is divided into four districts, North, East, West and South. The main ethnic groups of the state are *Lepchas*, *Bhutias*, *Limbus* and the Nepalese. 36% of the total geographical area of the state is under forest, 15% is under agriculture, 10% is pasture and 25% is barren land¹⁴. The state contains over 4000 species of flowering plants, which includes over 600 species of orchids and more than 100 species of medicinal plants¹⁵. The elevation ranges from 300 m in the south to more than 6,000 m in the north with perpetual snowy mountain ranges. Depending on elevation, the climate of the state may be divided into tropical in lower hills (300 – 900 m), sub-tropical in mid-hills (900–1,800 m), temperate (1,800–2,700 m) and sub-alpine (2,700–4,000 m) in hills and alpine (4,000–>5,000 m) climate in very high hills. The average rainfall of the state varies from 1,200 mm (at 300 m elevation) to 4,500 mm (at 2,000 m elevation), and over 80% of the rain comes during the monsoon season (June to September). Depending upon season and elevation, the average maximum temperature varies from 13°C to 35°C while the minimum temperature ranges from 0°C to 23°C¹⁴.

Results and discussion

Medicinal plants have curative properties due to the presence of various complex chemical substances of different composition, which are found as secondary plant metabolites in one or more parts of these plants¹⁶. The ethnobotanical information serves as a base for new compounds with active principles for phytochemical, pharmacognostical, pharmacological and clinical research. Indigenous people use many of the medicinal plants traditionally for treating their ailments. In each village and community, there are experts who practice such treatments and thus an effective local health tradition exists. There is a large market potential for such drug yielding plants. About 90% of the raw materials required come from wild

Table 1—Details of collection of medicinal and aromatic plant germplasm undertaken in Sikkim Himalayan region

Area explored	Period of survey	Diversities collected
Sonada, Tonglu, Sukna, Darjeeling, Bhuttabari, and Sukhiapokhri under Darjeeling Hill District of West Bengal	19-01-2004 to 28-01-2004	<i>Aconitum ferox</i> (1)*, <i>Adhatoda vasica</i> (2)*, <i>Artemisia vulgaris</i> (4), <i>Berginia ciliata</i> (2), <i>Hedychium spicatum</i> (1)*, <i>Kalanchoe pinnata</i> (1), <i>Sapindus mukorossi</i> (1), <i>Taxus baccata</i> (2)**, <i>Zingiber cassumunar</i> (1)
Kyongngslla, Namli, Rumtek and 20 th Mile under East District; Tong, Singik, Phodong, Thingum and Beetu, under North District; Geyzing and Pelling under West District; Jorethang and Gursay under South District of Sikkim	11-12-2004 to 23-12-2004	<i>Aconitum ferox</i> (1), <i>Acorus calamus</i> (3), <i>Aloe barbadensis</i> (1), <i>Astilbe rivularis</i> (1), <i>Centella asiatica</i> (1), <i>Curcuma aromatica</i> (1), <i>Kaempferia rotunda</i> (2), <i>Ocimum basilicum</i> (2), <i>Picrorrhiza kurroa</i> (1), <i>Sapindus mukorossi</i> (1), <i>Swertia chirata</i> (2), <i>Tupistra nutans</i> (1)
		<i>Acorus calamus</i> (4), <i>Aloe barbadensis</i> (2), <i>Astilbe rivularis</i> (1)*, <i>Curcuma aromatica</i> (2), <i>Kaempferia rotunda</i> (2)*, <i>Panax pseudoginseng</i> (1)*, <i>Swertia chirata</i> (3)***, <i>Tupistra nutans</i> (1), = 31
		<i>A. heterophyllum</i> (1), <i>Allium wallichii</i> (1), <i>Artemisia vulgaris</i> (1), <i>Berginia ciliata</i> (3), <i>Costus speciosus</i> (1), <i>Curcuma caesia</i> (1), <i>Nardostachys jatamansi</i> (1), <i>Orchis latifolia</i> (1), <i>Panax pseudoginseng</i> (1), <i>Podophyllum hexandrum</i> (2), <i>Tinospora cordifolia</i> (1), = 31
1)	Number within parentheses indicates the number of accessions collected.	
2)	Number of * indicates the number of accessions could not acclimatize and died.	

Table 2—Ethnobotanical information of the collected medicinal plant germplasm species

Plant name (Family)	Habitat	Local name	Parts used	Uses with active principles
<i>Aconitum ferox</i> Wall. Ex Ser. (Ranunculaceae)	Wild in hilly areas	<i>Bikhumma</i>	Rhizome	Plant is considered bitter tonic and febrifuge, antidiabetic. It is used in malaria and other fevers, abdominal pains, diarrhoea and indigestion particularly for children. Roots contain pseudoaconitine, bikhaconine, indaconitine, bikhaconitine, chasmaconitine, acetyl bikhaconine.
<i>Aconitum heterophyllum</i> Wall. Ex Royle (Ranunculaceae)	Wild in hilly areas	<i>Aatish</i>	Rhizome	Used as bitter tonic and antidote for snakebite. Roots contain alkaloids atidine, hetisine, heterophyllisine, heterophylline, atisine, heterophyllidine and benzoylheteratisine.
<i>Acorus calamus</i> L. (Araceae)	Grows in marshy land	<i>Bojo</i>	Rhizome	Used for the treatment of epilepsy and other mental ailments, intermittent fever, chronic diarrhoea, asthma, cough, sore throat, colic pains and as a brain tonic. Essential oil contains two isomeric substances- α and β asarone. Roots yield acoric acid and coline.
<i>Adhatoda vasica</i> L. (Acanthaceae)	Common in wasteland and forests	<i>Basak</i>	Leaves and roots	Fresh leaf paste is given in dysentery, cough, fever, bronchial congestions, gout and muscular sprains. Fresh root paste is applied on abdomen and vagina just minutes before childbirth for easy delivery. Leaves contain very small quantity of an essential oil, a crystalline acid and an alkaloid, vasicine.
<i>Allium wallichii</i> Kunth. (Liliaceae)	Grows wild in high altitude hilly regions	<i>Dung-dunge</i>	Whole plant	It is used for the preparation of scented food items, also helps in digestion.
<i>Aloe barbadensis</i> Mill. (Liliaceae)	Grows wild as well as cultivated	<i>Gheukumari</i>	Whole plant	It used as stomachic, tonic, purgative, and anthelmintic. Leaf-juice is put on head in high fever to reduce body temperature. Leaves contain barbaloin, aloe-emodin. Other constituents of plant are aloesin and aloesone.

Contd.

Table 2—Ethnobotanical information of the collected medicinal plant germplasm species—*Contd.*

Plant name (Family)	Habitat	Local name	Parts used	Uses with active principles
<i>Artemisia vulgaris</i> L. (Asteraceae)	Grows wild in forests, hills, roadsides etc.	<i>Titepati</i>	Leaves	It is used to treat nose bleeding, nervous and spasmodic affections, asthma and diseases of the brain. Chief constituents of its essential oil are camphor, 1:8-cineole and borneol along with a little quantity of β -tujone, β -pinene.
<i>Astilbe rivularis</i> Ham. (Saxifragaceae)	Grows wild in medium to high hill conditions	<i>Buro Okhote</i>	Root	Used against stomach ailments. Powdered root is taken with curd to cure jaundice. It is also taken with honey to control excessive bleeding in ladies.
<i>Berginia ciliata</i> (How.) Sternb. (Saxifragaceae)	Grows wild on rocky surfaces in forests and hills	Pakhanbed	Rhizome and root	Dried rhizome is astringent, given in ulcers, tuberculosis, cough and spleen enlargement. Root paste is applied on burns and cuts. Roots contain (+)Afzelachin, Bergein and β -sitosterol.
<i>Centella asiatica</i> (L.) Urban (Apiaceae)	Common in marshy places	<i>Brahmi</i>	Whole plant	Used to treat leprosy, fever, asthma, bronchitis, and in the preparation of brain tonic. Plant contains brahmoside, brahminoside, brahmie acid, iso-brahmie acid, betulic and various amino acids.
<i>Costus speciosus</i> Smith (Zingiberaceae)	Common in moist, shady places in the forests	<i>Betlauree</i>	Rhizome and root	Used in gout, jaundice, anaemia, bronchitis, fever, rheumatism; as stimulant, anthelmintic, anti-inflammatory.; Rhizome decoction is given in urinary stones. Tubers contain diosgenin, sitosterol, β -sitosterol- β -D-glucoside, dioscin, gracillin and quinones.
<i>Curcuma aromatica</i> Salisb. (Zingiberaceae)	Grows wild as well as cultivated	<i>Fatcheng</i>	Rhizome	It is used as an appetizer, tonic, carminative and applied to bruises and sprains. Rhizome-powder is anthelmintic. Rhizome-oil is useful in the treatment of early stages of cervix cancer. Rhizome essential oil contains <i>l</i> - β -curcumenes, <i>d</i> -camphor, <i>d</i> -camphene, <i>p</i> -methoxycinnamic acid.
<i>Curcuma caesia</i> Roxb. (Zingiberaceae)	Grows wild as well as cultivated	<i>Kalohaldi</i>	Rhizome	It is stomachic, diuretic, aromatic, stimulant, carminative and used to cure sprain & bruises, cough, asthma, and allergic eruption. Dry rhizomes yield 1.6% essential oil containing 76.6% <i>d</i> -camphor, camphene and bornylene.
<i>Hedychium spicatum</i> Sm. (Zingiberaceae)	Grows wild in hilly areas	<i>Sara</i>	Rhizome	It is used to treat liver disorders, vomiting, and stomach ailments. Rhizomes contain sitosterol and its glucoside. Essential oil contains cineole, γ -terpinene, limonene, β -phellanderene and β -terpineol.
<i>Kaempferia rotunda</i> L. (Zingiberaceae)	Cultivated in the gardens	<i>Bhuichampa</i>	Tuber	It is used to cure swellings, fracture, mumps and wounds. Tubers contain crotopoxide and β -sitosterol.
<i>Kalanchoe pinnata</i> (Lam) Pers. (Crassulaceae)	Grows wild as well as cultivated	<i>Patharkuchi</i>	Leaves	Leaves are applied on wounds, bruises, swellings, and insect bites. Leaves contain P-coumeric, ferulic, syringic, caffeic and p-hydrobenzoic acids, β -amyrin and sitosterol.
<i>Nardostachys jatamansi</i> DC. (Valerianaceae)	Found in high altitude hilly regions	<i>Jatamansi</i>	Rhizome	It is used as a substitute for valerian. It is used as a tonic, stimulant, antispasmodic, diuretic, and antifatulent. Oil is good for hair growth. Plant essential oil contains an alcohol, a sesquiterpene ketone (jatamansone), jatamansic acid, etc.
<i>Ocimum basilicum</i> L. (Lamiaceae)	Grows wild in fields or forests and cultivated	<i>Tulsi</i>	Leaves and seeds	Leaf juice is used against cold & cough. Seeds are used in dysentery, gonorrhoea. Essential oil contains cineole, eugenol, limonene, ocimene, geranial, citronellol, α -terpineol, estragole.
<i>Orchis latifolia</i> L. (Orchidaceae)	Grows wild in forests	<i>Panch-aunlay</i>	Tuber and root	Plant is used as nervine tonic and aphrodisiac. Plants contain volatile oil and leaves contain loroglossin.

Contd.

Table 2—Ethnobotanical information of the collected medicinal plant germplasm species—Contd.

Plant name (Family)	Habitat	Local name	Parts used	Uses with active principles
<i>Panax pseudoginseng</i> Wall. (Araliaceae)	Grows wild in high altitude forests	<i>Panchapatte y</i>	Rhizome	Roots are used as stimulant; combating general debility, weakness, headache, vomiting, blood pressure, etc. It Used as a carminative tonic and expectorant.
<i>Picrorrhiza kurroa</i> Royle ex Benth. (Scrophularaceae)	Grows wild in upper hilly tracts	<i>Kutki</i>	Root	It is used as bitter tonic, laxative, stomachic, effective in dropsy, etc. Also used in fever, diseases of liver and spleen including jaundice, anaemia, scorpion stings, etc. Roots contain kutkin, picroside, kutkoside, kutkiol and kutkisterol.
<i>Podophyllum hexandrum</i> Royle (Podophyllaceae)	Grows wild in upper hills or forests		Rhizome and root	Rhizome and roots are used as purgative, hepatic stimulant, bile expellant, bitter tonic, antidiarrhoeal and in skin diseases. Roots contain podophyllotoxin, demethylpodophyllotoxin, α β -peltatin, podophyllotoxone.
<i>Sapindus mukorossi</i> Gaertn. (Sapindaceae)	Found in forests as well as cultivated	<i>Ritha</i>	Fruits and root bark	Used as tonic, anthelmintic, purgative, in asthma, hysteria, dandruff, piles, etc. Fruit pericarp contains a crystalline saponin, mukorosside.
<i>Swertia chirata</i> Ham. (Gentianaceae)	Grows wild in hilly regions	<i>Chireto</i>	Whole plant	Used as bitter tonic and febrifuge; used in liver disorder, cough, constipation, fever, skin diseases and worms. Plants contain alkaloids- gentianine, gentiocrucine, enicoflavine, severchirin.
<i>Taxus baccata</i> L. (Taxaceae)	Grows wild in hilly areas	<i>Dhegreshalla</i>	Leaves and bark	It is the source of anticancer drug- taxol. Leaves are antispasmodic; used in nervousness, hysteria and epilepsy. A tincture of young shoots is used in headache, giddiness, diarrhoea, liver disorder, etc. Bark contains taxol, ecdysterone, β -sitosterol, campesterol; leaves contain ephedrine, millosine, taxine A and B.
<i>Tinospora cordifolia</i> (Willd.) Miers (Menispermaceae)	Grows wild in forests, fields, along roadsides	<i>Gurjo</i>	Stem	It is used in gonorrhoea, skin diseases, dyspepsia, urinary diseases, fever, etc. Stem juice is considered aphrodisiac and applied against swollen muscles. Stems yield diterpenoid- tinosporide and perberilin, cordifol, tinosporidine, heptacosanol and β -sitosterol.
<i>Tupistra nutans</i> Wall. (Liliaceae)	Grows wild in mid hills	<i>Teeta Nakemo</i>	Whole plant	Powdered roots, and flower decoction are taken to control diabetes.
<i>Zingiber cassumunar</i> Roxb. (Zingiberaceae)	Grows wild as well as cultivated	<i>Banada</i>	Rhizome/ inflorescence	It is used against cough & fever; inflorescence cooked-eaten in dyspepsia; inflorescence heated in fire and sniff against sinusitis. The essential oil from the rhizome contains terpinen-4-ol, α - and β -pinenes, sabinene, myrcene, terpinene, limonene, <i>p</i> -cymene and terpinolene.

sources¹⁷. Exploitation from wild results in depletion of resource bases endangering the species. Realizing the importance, it has been felt necessary to undertake both *in-situ*, as well as *ex-situ* conservation. *Ex-situ* conservation may be done in the form of depositing the live materials in the gene bank, establishing field gene bank and also promoting cultivation of medicinal plants. Ethnomedicinal aspects of 28 plant species belonging to 26 genera distributed over 19 families, collecting from the Sikkim Himalayan region has been enumerated (Table 2). The collected materials have been introduced in the field gene bank of the Regional Station located at mid-hills of

Meghalaya. Some of the high altitude plant species viz. *Podophyllum hexandrum*, *Picrorrhiza kurroa*, *Aconitum ferox*, *A. heterophyllum*, *Nardostachys jatamansi*, etc. collected during the exploration trips are getting it difficult to acclimatize in this mid-altitude situation. Therefore, utmost care is being taken for their maintenance and subsequent multiplication. Vegetative propagation by cuttings, some specialized structures like suckers, rhizomes, tubers etc. and sexual propagation through seeds are being followed for the multiplication of the collected materials. All the plants were found to be used by the tribal people of the area for the treatment of various

ailments. People use these plants in different forms such as juice, extract, decoction, paste, infusion, powder, etc. All the collected plant species have been arranged alphabetically along with their plant names, family, local names and uses.

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