**Ethnoforestry: The Future of Indian Forestry, pp. 139-160, 2009**
*Edited by S.C. Tiwari*
*Published by Bishen Singh Mahendra Pal Singh, Dehra Dun, India*

# Medicinal and aromatic plants and prospects of commercial cultivation in Meghalaya

**H. Kayang and B. Kharbuli**
*North Eastern Biodiversity Research Cell,*
*Laitumkhrah Bijni Complex, North Eastern Hill University,*
*Shillong - 793003, Meghalaya, India*
*(e-mail: hkayang@hotmail.com)*

## Introduction

Meghalaya comprises of South Garo Hills, West Garo Hills, East Garo Hills, West Khasi Hills, East Khasi Hills, Ribhoi and Jaintia Hills districts lying between 25°47" - 26°10" N latitude and 89°45" – 92°45" E longitude and covers an area of 22,549 km$^2$. The altitude ranges from 50 – 1960 m. It is bounded on the North, East and West by Assam and on the South by Bangladesh. The people in the state who belong to 3 major tribes like Khasis, Jaintias and Garos have their own healing practices and health care systems where many plant species are used. Major parts of the population are usually rural folk. The State possesses a great plant wealth that is yet to be fully tapped on commercial scale, which in turn could accrue abundant benefit to the farmers too. In fact, it has a great potential for the plantation of medicinal and aromatic plants because of ideal agro-climatic conditions and suitable soil.

Medicinal and aromatic plants in Meghalaya, are an essential part of traditional health care systems. Their gathering and cultivation provide a critical source of income for many rural communities, especially landless poor and marginalized farmers. Unfortunately, MAPs are increasingly threatened by various environmental, socio-economic and institutional problems. At the same time traditional and indigenous knowledge about these plants is weakening and, in some cases, vanishing altogether. The expansion of unregulated trade and commercial use of MAPs poses a major threat to biodiversity in the state. Local communities tend to collect the highest value or most popular plant species, leading to over-harvesting or species extinction (Kayang, 2005). Even when MAP species are safely

cultivated, if done with mono-cropping systems, local biodiversity can be weakened. Finally, as 95% of MAPs are harvested and collected in wild, the alarming levels of deforestation and ecosystem degradation in the state are also contributing to a decline in MAPs. Combined, all of these factors have severely reduced the availability of medicinal and aromatic plant ingredients and the overall environmental sustainability of the region (Kayang *et al.*, 2005).

**Prospects for cultivation and production of MAPs**

In a wider context there is a growing demand for plant based medicines, health products, pharmaceuticals, food supplements, cosmetics, etc., in the national and international markets. Conservation and sustainable use of medicinal plants are issues on which immediate focus is required in the context of conserving biodiversity and promoting and maintaining the health of local communities, besides generating productive employment for the poor with the objective of poverty alleviation in tribal and rural areas. It is evident that tribal in Meghalaya have a tremendous passion for MAPs. They use them for a very wide range of health related applications from common cold to memory improvement, treatment of poisonous snakebite to cure for muscular dystrophy and enhancement of body's general immunity (Samati, 2004). An analysis of published information on medicinal plant use indicates that around 8000 species are used by the different systems of medicines in our country. There are estimated to be around 25,000 effective plants based formulations used in folk medicine known to rural community all over country. Medicinal and Aromatic plants should therefore be given the status of a national resource as their sustained availability is essential to sustain these local health traditions and the increasing herbal and pharmaceutical industry. Table 1 gives the cross tabulation on the number of medicinal plants used in different systems of medicine. Around 10,000 brilliantly designed formulations are available in the indigenous medical texts many of which are yet to be sufficiently tapped.

The World Health Organisation (WHO) estimated that 80% of the population of developing countries relies on traditional medicines, mostly plant drugs, for their primary health care needs. Also, modern pharmacopoeias still contain at least 25% drugs derived from plants and many others which are synthetic analogues built on prototype compounds isolated from plants. Demand for medicinal plant is increasing in both developing and developed countries due to growing recognition of natural

**Table 1:** Cross tabulation on the count of medicinal plants usage across medical systems

| TYPES | AYURVEDA | FOLK | HOMEO | MODERN | SIDHA | TIBETAN | UNANI |
|---|---|---|---|---|---|---|---|
| **AYURVEDA** | **2351** | 900 | 189 | 80 | 1028 | 341 | 880 |
| **FOLK** | 900 | **5137** | 164 | 86 | 971 | 235 | 573 |
| **HOMEO** | 189 | 164 | **506** | 100 | 167 | 77 | 173 |
| **MODERN** | 80 | 86 | 100 | **204** | 65 | 25 | 75 |
| **SIDHA** | 1028 | 971 | 167 | 65 | **1785** | 277 | 641 |
| **TIBETAN** | 341 | 235 | 77 | 25 | 277 | **350** | 275 |
| **UNANI** | 880 | 573 | 173 | 75 | 641 | 275 | **979** |

Source: FRLHT Database

(The shaded figures give the count of plants used in each of the seven systems of medicine and the remaining ones represent the count of plants common across two of these)

products, being non-narcotic, having no side-effects, easily available at affordable prices and sometime the only source of health care available to the poor. Medicinal plant sector has traditionally occupied an important position in the socio cultural, spiritual and medicinal arena of rural and tribal lives of India. Table 2 shows India's pharmaceutical exports in World Trade from 1970 to 1998 and Table 3 lists the highly demanded top 20 medicinal plants traded in India. Table 4 lists the Medicinal plant species priotized and identified by the National Medicinal Plants Board of India and Table 5 shows the top 50 Medicinal Plants (Raw Drugs) from Eastern Region.

**Table 2:** India's Pharmaceutical Exports in World Trade, 1970 to 1998 (Current Prices in Rs. crore)

| Year | Share of India in World Exports | |
|---|---|---|
| | All Merchandize | Pharmaceuticals |
| 1970 | 0.6 | 0.4 |
| 1975 | 0.5 | 0.4 |
| 1980 | 0.4 | 0.8 |
| 1985 | 0.5 | 0.8 |
| 1990 | 0.5 | 1.2 |
| 1995 | 0.6 | 1.0 |
| 1997 | 0.6 | 1.1 |
| 1998 | 0.6 | 1.0 |
| Source: www.techno-preneur.net | | |

The medicinal and aromatic plants sector at present is not well organized and needs special attention in Meghalaya. Cultivation is clearly a sustainable alternative to the present collection of MAPs from the wild. This can be a potential provider of returns to the farmers. There has not been any serious effort in the state to promote the cultivation of MAPs of importance. The only efforts are those of the Department of Environment and Forests and the Non-Governmental Organizations. Similarly, there is a serious lack of awareness among the people about the potential and scope of MAPs.

The history of exploration of MAPs in the state is rich and diverse. Some of the tribal medicines have been already incorporated in the organized systems of medicine and there is a great potential for their exploitation in industry and export. However, much larger number of folk medicines has remained endemic to certain tribal pockets in Meghalaya.

**Table 3:** Highly demanded top 20 medicinal plants traded in India

| Sl.No. | Trade name | Botanical name | Part used |
|---|---|---|---|
| 1 | Atis | **Aconitum heterophyllum* Wall. ex Royle | Tuberous roots |
| 2 | Meetha Telia/Bachnag | *Aconitum violaceum* (Jacq.) Stapf | Tuberous roots |
| 3 | Safed Musali | *Chlorophytum borivilianum* Sant. & Fernandez | Tubers |
| 4 | Guggul | *Commiphora wightii* (Arn.) Bhandari | Resin |
| 5 | Nanura/Mishmi-Bitter | *Coptis teeta* Wall. | Roots |
| 6 | Salam Panja/Salep | *Dactylorhiza hatagirea* (D.Don) Soo | Tubers |
| 7 | Vidanga/Baibaranga | *Embelia ribes* Burm. f. | Fruits |
| 8 | Nagkesar | *Mesua nagassarium* (Burm. f.) Kosterm. | Dry Stamens |
| 9 | Rampatri/Bombay Mace | *Myristica malabaric*a Lam. | Aril & Mace |
| 10 | Jatamansi | *Nardostachys grandiflora* DC. | Rhizomes & Roots |
| 11 | Gaozagan | *Onosma bracteatum* Wall. | Flowers |
| 12 | Kutki | **Picrorhiza kurrooa* Royle ex Benth. | Roots & Rhizomes |
| 13 | Kakra-Singi | *Pistacia integerrima* Stewart ex Brandis | Galls |
| 14 | Sarpagandha | **Rauvolfia serpentina* Benth. ex Kurz | Roots |
| 15 | Manjishta | **Rubia cordifolia* Linn. | Roots |
| 16 | Chandana/Sandalwood | *Santalum album* Linn. | Heartwood |
| 17 | Chọbchini Gulabi | **Smilax glabra* Roxb. | Roots |
| 18 | Chiraiyita | **Swertia chirayita* Karst. | Whole Plant |
| 19 | Taggar/Mushkbala | *Valeriana hardwickii* Wall. | Rhizomes & Roots |
| 20 | Banafsha | *Viola pilosa* Blume | Flowers |

Source: www.techno-preneur.net
* Species found in Meghalaya

**Table 4:** Medicinal Plant species prioritized and identified by the National Medicinal Plants Board of India

| Sl. No. | Local name | Scientific name |
|---|---|---|
| 1. | Amla | *Emblica officinalis* Gaertn.* |
| 2. | Ashok | *Saraca asoca* (Roxb) De. Wilde* |
| 3. | Ashwagandha | *Withania somnifera* (Linn.) Dunal* |
| 4. | Atees | *Aconitum heterophyllum* Wall.* |
| 5. | Bael | *Aegle marmelos* (L.) Corr.* |
| 6. | Bhumi Amlaki | *Phyllanthus amarus* Schum. & Thonn. (*P. niruri* Linn.) |
| 7. | Brahmi | *Bacopa monnieri* (L.) Pennell* |
| 8. | Chandan | *Santalum album* Linn. |
| 9 | Chirayita | *Swertia chirayita* Buch.-Ham.* |
| 10. | Giloe | *Tinospora cordifolia* Miers* |
| 11. | Gudmar | *Gymnema sylvestre* R. Br. |
| 12. | Guggal | *Commiphora wightii* (Arn). Bhandari |
| 13. | Indian Berberry (Daruhaldi) | *Berberis aristata* DC. |
| 14. | Isabgol | *Plantago ovata* Forsk. |
| 15. | Jatamansi | *Nardostachys jatamansi* DC. |
| 16. | Kalmegh | *Andrographis paniculata* Wall. ex Nees* |
| 17. | Kalihari | *Gloriosa superba* Linn.* |
| 18. | Keasr | *Crocus sativus* Linn. |
| 19. | Kokum | *Garcinia indica* Linn. |
| 20. | Kuth | *Saussurea costus* C. B. Clarke (*S. lappa*) |
| 21. | Kutki | *Picrorhiza kurrooa* Benth. ex Royle* |
| 22. | Liquorice (Mulethi) | *Glycyrrhiza glabra* Linn. |
| 23. | Long pepper (Pippali) | *Piper longum* Linn.* |
| 24. | Makoy | *Solanum nigrum* Linn.* |
| 25. | Musali | *Chlorophytum arundinaceum* Baker (*C. borivilianum*) |
| 26. | Pashan Bheda (Coleus) | *Coleus barbatus* Benth. |
| 27. | Sarpgandha | *Rauvolfia serpentina* Benth. ex Kurz* |
| 28. | Senna (Sanai) | *Cassia angustifolia* Vahl |
| 29. | Shatavari | *Asparagus racemosus* Wild.* |
| 30. | Tulsi | *Ocimum sanctum* Linn.* |
| 31 | Vai Vidang | *Embelia ribes* Burn. f. |
| 32. | Vatsnabh (Vish) | *Aconitum ferox* Wall.* |

* Species found in Meghalaya

**Table 5:** Top 50 Medicinal Plants (Raw Drugs) from Eastern Region

| Sl.No. | Trade Name | Vernacular Name | Ayurvedic Name | Unani Name | English Name | Botanical Name |
|---|---|---|---|---|---|---|
| 1. | Agar | Agaru | Aguru | | Eagle wood | *Aquilaria agallocha* = *A. malaccensis* |
| 2. | Ajmod | Ajmuda Ajmod | Ajamoda | Ajmol | - | *Apium leptophyllum* |
| 3. | Amba Haldi | Amhaldi | Amba Haldi | | Mango Ginger | *Curcuma amada* |
| 4. | Arjun | Arjuna Arjun | Arjuna | | Arjun | *Terminalia arjuna* |
| 5. | Arnimool | Agnimantha | Agnimantha | | - | *Clerodendrum phlomides* |
| 6. | Ashok | Asoka | Asoka | | Ashoka | *Saraca asoca* |
| 7. | Ban Tulsi | Bana Tulasi | - | | - | *Majorana hortensis* |
| 8. | Bhringraj | Bhagara | Bhrngaraj | | - | *Eclipta alba* |
| 9. | Brahmi | Brahmi | Brahmi | | Thyme Leaves Gratiola | *Bacopa monnieri* |
| 10. | Chawal Mongra | - | - | | - | *Gynocardia odorata* |
| 11. | Chirayita | Chirayita | Kiratatikta | | Indian Gentian | *Swertia chirayita* |
| 12. | Chobcchini | Chobchini | - | | China Root | *Smilax china* |
| 13. | Daruhalsi | Daruhaldi | Daruharidra | | Indian Berberry | *Berberis aristata* |
| 14. | Gaj Pippali | Gajapeepal | Gajapippali | | - | *Scindapsus officinalis* |
| 15. | Gilo | Giloe | Guduci | | Moon Creeper | *Tinospora cordifolia* |
| 16. | Gudhal | Japa | Japa | | China Rose | *Hibiscus rosa-sinensis* |
| 17. | Inderjau | Indraju | Indrajava | | Shoe flower | *Holarrhena pubescens* |

*Contd. ...*

| Sl.No. | Trade Name | Vernacular Name | Ayurvedic Name | Unani Name | English Name | Botanical Name |
|---|---|---|---|---|---|---|
| 18. | Jivanti | Jivanti | Jivanti | | - | *Leptadenia reticulata* |
| 19. | Kachur | Kachur | Karcura | | Zedoary | *Curcuma zedoaria* |
| 20. | Kalonji | Kalonji | Upakuncika | | Small Fennel | *Nigella sativa* |
| 21. | Kapoor Kachri | Kapur-kachri | - | | - | *Kaempferia galanga* (ii) *Hedychium spicatum* |
| 22. | Kateli | Kantakari | Kantakari | | Febrifuge Plant | *Solanum* sp. |
| 23. | Kulanjan | Bara Kulanjan | - | | Siamese Ginger | *Alpinia galanga* |
| 24. | Kusum Phool | Kusum | Kasumsha | | Safflower | *Carthamus tinctorius* |
| 25. | Kutaj | Kutaj | Kutaja | | Ester Tree | *Holarrhena pubescens* |
| 26. | Lodh | Lodha | Lodhra | | Symplocos Bark | *Symplocos racemosa* |
| 27. | Majith | Majeeth | Manjistha | | Indian Madder | *Rubia cordifolia* |
| 28. | Meda | Meda | Meda | | - | *Polygonatum cirrhifolium* |
| 29. | Mushkdana | Mushkdana | - | | Musk Mellow | *Hibiscus abelmoschus* |
| 30. | Nagbeli | Nagbeli | - | | - | *Lycopodium clavatum* |
| 31. | Nageshwar Phool | Nagkesar | Nagkeshar | | Iron wood | *Mesua ferrea* |
| 32. | Nisoth | Nisoth | Trivrt | | Terpeth Root | *Operculina turpethum* |
| 33. | Palsh Papda | Palasa | Palasa | | Bengal Kino Tree | *Butea monosperma* |
| 34. | Parul | Paral | Patalai | | - | *Stereospermum suaveolens* |
| 35. | Pipal (Borki) | Pippali | Pippali | | Long pepper | *Piper longum* |

*Contd. ...*

| Sl.No. | Trade Name | Vernacular Name | Ayurvedic Name | Unani Name | English Name | Botanical Name |
|---|---|---|---|---|---|---|
| 36. | Pipal (Gol) | Pippali | Pipali | | - | *Piper mullesua* |
| 37. | Pipal (Savali) | Pippali | Pippali | | Long Pepper | *Piper longum* |
| 38. | Priyangu (Phool) | Priangu | Priangu | | - | *Callicarpa macrophylla* |
| 39. | Punarnava | Punarnawa | Rakta Punarnava | | - | *Boerhavia diffusa* |
| 40. | Ratti | Gunngchi | Gunja | | - | *Abrus precatorius* |
| 41. | Rohitak | Rohitak | Rohitaka | | Rohida Tree | *Tecomella undulata* |
| 42. | Rudraksh | Rodraki | Rudraksa | | - | *Elaeocarpus ganitrus* |
| 43. | Sarpagandha | Sarpagandha | - | | Serpent wood | *Rauvolfia serpentina* |
| 44. | Sona | Syonaka | Syonaka | | Indian Trumpet flower | *Oroxylum indicum* |
| 45. | Sonth | Sonth | Sunthi | | Dried Ginger | *Zingiber officinale* |
| 46. | Taj | - | - | | Cassia | *Cinnamomum cassia* |
| 47. | Tejpatra | Teipat | Tvakpatra | | Indian Cassia Lignea | *Cinnamomum tamala* |
| 48. | Ulatkambal | Ulatkambal | - | | - | *Abroma augusta* |
| 49. | Val-vidang | Vidanga | Vidanga | | Embelia | *Embelia ribes* |
| 50. | Vidraikand | - | - | | - | *Pueraria tuberosa* |

Source: Medherb green pages, India 2003

Much of this knowledge is acquired through experiences and usually passed on through oral traditions. Thus, the potentialities of ethno-medicinal studies in the state should be given due importance as it can provide a very effective strategy for the discovery of more and potential useful chemical compounds. Their identification and conservation also deserves careful attention. While attempts have been made both at local and national levels to address these issues, they have suffered from inadequate funding, a lack of government prioritization, and insufficient information sharing and coordination among stakeholders. Thus, the aim is to improve resource conservation and livelihood security in rural and marginalized communities.

Cultivation of medicinal and aromatic plants is important not only from the commercial point of view but also from the conservation perspective. It can make a substantial contribution to the state economy and employment generation as well. More than 95% (from an estimated 800 species) of the medicinal plants used in industry are, till now, collected from the wild and therefore face threat of extinction. Destructive harvesting from the wild is another factor augmenting this threat. It is estimated that about 1000 medicinal plant species are facing threat of extinction while some of them have already become extinct in the wild even though they are under cultivation. It is essential to take immediate steps to conserve our medicinal plants wealth. Conservation of the medicinal wealth of the state will not only serve national interest but also serve global needs, since there is growing world-wide demand for natural medicines. Table 6 lists some of the species selected and areas proposed for Cultivation & Conservation of Medicinal and Aromatic Plants in Meghalaya.

**Conservation and management strategies**

According to the World Health Organisation (WHO) more than 1 billion people rely on herbal medicines to some extent. The WHO has listed 21,000 plants that have reported medicinal uses around the world. India has a rich medicinal plant flora of some 2500 species. Of these, 2000 to 2300 species are used in traditional medicines while at least 150 species are used commercially on a fairly large scale. India and Brazil are the largest exporters of medicinal plants (Hanfee, 1998). Medicinal plants in India are estimated to be worth Rs. 550 crore per year. India's total turnover of the counter products contribute around Rs.1,200 crore, ayurvedic ethical formulations contribute the remaining sum-cosmetic industry as well as aroma therapy are two important areas where Indian medicinal plants and their extracts, essential oil can contribute globally.

**Table 6:** List of MAPs selected and areas proposed for Cultivation and Conservation of Medicinal and Aromatic Plants in Meghalaya

| State | Areas proposed for cultivation | Species for cultivation |
|---|---|---|
| Meghalaya | Umsohlait (Ri Bhoi)<br>Byrnihat (Ri Bhoi)<br>Mawkyrwat (West Khasi Hills)<br>Nongstoin (West Khasi Hills)<br>Nartiang (Jaintia Hills)<br>Kyndong Tuber (Jaintia Hills)<br>Nangbah (Jaintia Hills)<br>Sohryngkham (East Khasi Hills)<br>Mawphlang (East Khasi Hills)<br>Jongksha (East Khasi Hills)<br>Tura (West Garo Hills)<br>Pedaldoba (West Khasi Hills)<br>Baghmara (South Garo Hills)<br>Chokpot (South Garo Hills)<br>William Nagar (East Garo Hills) | *Aloe vera* (LA & HA)<br>*Aristolochia cathcarthii* (LA & HA)<br>*Aristolochia tagala* (LA & HA)<br>*Artemisia nilagirica* (HA)<br>*Catharanthus roseus* (LA & HA)<br>*Cymbopogon flexuosus* (LA)<br>*Cymbopogon winterianus* (LA)<br>*Emblica officinalis* (LA)<br>*Flemingia vestita* (HA)<br>*Gaultheria fragrantissima* (HA)<br>*Litsea cubeba* (LA & HA)<br>*Nepenthes khasiana* (LA)<br>*Paederia foetida* (LA)<br>*Panax pseudoginseng* (HA)<br>*Smilax glabra* (LA)<br>*Solanum myriacanthum* (LA & HA)<br>*Solanum nigrum* (LA & HA)<br>*Solanum torvum* (LA & HA)<br>*Taxus baccata* (HA)<br>*Tinospora cordifolia* (LA) |
| **LA** – Low Altitudes; **HA** – High Altitudes | | |

Medicinal and aromatic plants have a high market potential with the world demand of herbal products growing of the rate of 7 percent per annum (Anon., 1998).

We have short listed few valuable MAPs all of which are found in the Meghalaya, which are proposed to be developed for income generation that can be adopted in villages as well as for community based conservation. The intention is to investigate the economics of cultivating the most popular and most highly valued species, as these would probably be the most commercially feasible options. If commercial cultivation is not feasible with these species, then it will probably not be feasible for the lower valued species. Since medicinal and aromatic plant sector has tremendous potential to generate revenue and employment for the tribal communities, therefore concerted efforts will definitely contribute to the state's economy in a sustainable manner. The following MAPs have been selected and focused for propagation and trade in Meghalaya.

1. ***Flemingia vestita*** (Family: Fabaceae): A much-branched trailing herb with tuberous roots, found practically throughout the Himalayas and Khasi Hills up to an elevation of 8,000 ft. Stems 1-3 ft. long, hirsute, wiry; leaves trifoliolate with obovate-cuneate leaflets; flowers bright red; pods sub-cylindrical, hairly, 1-seeded. The plant is cultivated in Khasi hills, often following a potato crop, for its tuberous roots. It is sown in February-May and harvested in August-November. About 4 maunds of 'seed' in the form of tubers are sown per acre and a yield of 30-40 maunds per acre obtained. The tubers are nearly elliptical, 1.5-2 in. long and possess an agreeable nutty flavour. The skin which is somewhat pungent is removed by rubbing under water or by peeling and the tubers eaten raw. Peel of tubers is used as an anthelminthic agent. The local price of the fresh tubers with peel is Rs. 200-250/ kg. After processing and peeling the rate is Rs. 500-550/kg.

2. ***Gaultheria fragrantissima*** (Family: Ericaceae) or the Indian Wintergreen is a much-branched, evergreen, aromatic shrub, 1-3 m height, with orange-brown bark, commonly found in the Central and Eastern Himalayas, Khasi Hills and the hills of Western Ghats at altitudes of 1500-2500msl. It is also grown as an ornamental plant in the hill areas. The leaves contain oil, called as oil of wintergreen; the main use is as an anti-rheumatic, anti-sciatica, painkiller, stimulant, carminative, antiseptic, vermicide and as ingredient in perfumery, insecticidal repellents, soft drinks and dentifrices. The species is still abundant but the large-scale *jhumming* and the slash and burn method of cultivation practiced in the hills has posed a threat to the species, especially its regeneration by natural means. The species acts as a soil binder in the hilly slopes. Since the species is a well known medicinal and aromatic plant it is exploited by herbalists to a large extent even at present. Indian wintergreen oil is distilled in small scale in Assam. The principal constituent of the oil is methyl salicylate. Methyl salicylate obtained from natural sources is in very high demand in the market as starting material for aspirin and other medicinal compounds. A 100g of leaves yield approximately 0.6% oil of wintergreen. A fully grown *Gaultheria fragrantissima* shrub, if the leaves are harvested at the right season, about 10 kgs of leaves can be obtained. The oil yield is approximated at 6 gms/kg, therefore, the expected oil yield will be 60 gms per shrub. The current market rate of pure methyl salicylate is Rs. 800 per 100 gms. Considering the abundance of this plant, which at some areas is considered a weed, the income generated from this source can be quite substantial.

3. ***Litsea citrata*** syn. *L. cubeba* Blume (Family Lauraceae) is a common deciduous shrub or a small tree found in the Eastern Himalayas, up to an altitude of 850-1000msl. Flowers and fruits are aromatic and yield on distillation volatile oils. The oil is also used as insect repellent, in perfumery industries and as a basic ingredient in toiletries.

The matured fruits on distillation yield about 95% citral, the flowers about 37% citral and the seeds about 20% of pale yellow fat. The leaves and bark of the tree also yields volatile oils and two alkaloids namely laurotetanine and methyl laurotetanine. If the extraction of *Litsea citrata* is over in the summer of a given year, the economy of the users will be replaced by *Gaultheria fragrantissima* the oil yield of which is better if extracted during the winter season. Hence, there is continuity in the income generating activities in the participating villages and for the users as well. Plantations can easily be raised for both species as an alternative to combat *jhumming* in the hills and to control rampant exploitation of other valuable forest resources. Both species are good coppicers and soil binders hence they are also prescribed for watershed areas. Citral obtained from natural sources still commands a better market than the one obtained synthetically. The current market price of 95% citral is approximately Rs. 6000/- per litre. In a good fruiting season, a matured tree can yield up to 30 kg of fruits. This will work out to approximately 500 gms of 95% citral yield per tree. The oil obtained with such a high percentage of citral will easily find a good market in most pharmaceutical and phytochemical industries besides perfumery and other related industries within the country as well as outside.

4. ***Nepenthes khasiana*** (Family: Nepenthaceae): The plant deserve a special mention which immediately needs conservation and trade restrictions. It is an insectivorous plant which is endemic to Meghalaya, listed in the Cites Index and IUCN as the most endangered species and globally knows the presence of this species only in Meghalaya (Khliehriat area and War Jaintia of Jaintia Hill, Mawsynram of West Khasi Hill and Garo Hills Districts) at an altitude of 1200m. The pitcher water is used as medicine by the villages and trade in this species is also unregulated and rampant in the West Khasi hills. Trade restrictions or ban is needed at present to save this species from extinction. The species of *Nepenthes* are characterized by the peculiar pitcher-like appendages terminating the leaves used by the plants for catching insects. The pitchers vary greatly in shape and size, and often brightly coloured, being red, green, purple, yellow or various combination of

these colours. Numerous nectar glands are studded on the inner lid surface and at the entrance to the pitcher (rim); the interior of the lower part of the pitcher also bears numerous glands, which secrete digestive enzymes. Insects which are attracted by their colour and nectar glands slip down into the liquid at the bottom of pitchers, where their bodies are digested and the products of digestion absorbed by the plant.

Pitchers plants thrive best in moist atmosphere, where temperature ranges from 21°-30°C or a few degrees less in winter. They make excellent baskets plants when planted in a compost of equal parts of peat, left mould and sphagnum. They are propagated by cuttings, layers and seeds. The pitchers of the plant, containing insects, is made into a paste, mixed with water, and given to cholera patients. The liquid formed in the pitchers is used by the Khasi and Jaintia traditional practitioners as a remedy for diabetes and urinary troubles when administered orally, and for redness and itching of the eye if used as eye drops. The Garo local herbal practitioners use the powder of the pitcher for affected parts of leprosy patients. The stems and old tendrils of pitchers plants are very tough and are used for rough cordage. It has been conserved by the forest department of Meghalaya in Baghmara Pitcher Plant Wildlife Sanctuary (WLS) of Garo Hills district and in Jarain of Jaintia hills districts by Jaintia autonomous district council.

5. ***Swertia chirayita*** (Chiretta) (Family: Gentianaceae): Also known as Chirata in trade. An erect annual, 60-125 cm, tall, found in the temperate Himalayas at altitudes of 1,200-3,000m from Kashmir to Bhutan, and in the Khasi hills in Meghalaya at 1,200-1,500m. The plant spreads quickly from seeds which are shed during October-November. The herb can also be cultivated in suitable localities in the temperate Himalayas. The seeds, which are very small, should be shown in a nursery and the seedling transplanted later in the field. The drug (Chiretta), obtained from the dried plant, is held in high esteem in India. The whole plant is medicinal, but the root is said to be the most powerful part. The Chiretta is much prized in India as a tonic and bitter without aroma or astringency. It enjoys a special reputation in western India as a remedy for bronchial asthma and liver disorders. If taken with sandal wood paste, it is said to stop internal haemorrhage of the stomach. It is anthelmintic, and anti-diarrhoel properties in Indian medicinal system. As the species is commonly found in all the districts of Meghalaya, there is ample scope for production in cultivated form

as well as to process them in the states of northeast itself by setting up small scale/cottage units. Current market price of the crude drug in northeast India is Rs. 150/kg.

6. ***Solanum khasianum*** (Family: Solanaceae): A stout, much-branched undershrub up to 1.5 m tall with almost straight prickles, found in Meghalaya, Nagaland, Manipur and Arunachal Pradesh up to an altitude of 1850m. *S. khasianum* has recently come into prominence as a rich source of solasodine. Fruit of the plant is reported to be a richer source of the steroidal alkaloid than leaves of S. aviculare, used in some countries for the production of solasodine. A survey carried out by the Botanical Survey of India has shown that the mature fruits of *S. khasianum* var. chatterjeeanum, collected from different areas varies; thus, fruits collected from Cherrapunji, Meghalaya contain 3.2 per cent solasonic and those from Khasi and Jaintia hills, 2.1 and 2.02 per cent respectively. The concentration of solasonic is maximum in mature fruits when the colour changes from green to yellow (50-60 days after fruit set). Immature fruits and over-ripe fruits contain very small quantities of alkaloid. The fleshly cover and washed seeds, which form about 60 per cent of the whole fruit, do not contain any alkaloid. The alkaloid is concentrated in the mucilage surrounding the seeds. Leaves contain 0.69 per cent total alkaloids. A new glycoalkaloid, solakhasianin, containing glactose and rhamnose as sugar components has been reported. Fruits contain diosgenin. Fruits are sold as crude drug at the rate of Rs. 100/kg.

7. ***Potentilla fulgens*** (Rosaceae) Silverweed: A large genus of herbs or rarely shrubs distributed chiefly in the North Temperate Zone. Nearly 50 species occur wild in India, and some exotics have been introduced into the gardens. Potentillas, commonly known as Clinquefoils, are suitable for borders and rock gardens. They thrive in heavy soils. Propagation is done through seed, cuttings, or division of rootstocks. *Potentilla fulgens* is an erect, perennial herb, 15-75 cm high, with a thick rootstock, pinnate leaves and yellow flowers, distributed in the temperate Himalayas from Himachal Pradesh to Sikkim and in the hills of Assam and Meghalaya at altitudes of 1,200-4,350 m. The rootstocks are believed to strengthen the gums and teeth and also reported to be used in diarrhoea.

*Potentilla* rootstock is dug out from the soil and washed in water. The root bark is peeled off and only the fleshy part is used. Traditional

betel chewers used the cut pieces of the fleshy rootstock and chew them fresh with betel nut, betel leaf and lime. The rootstock is bitter (astringent) to taste but when mixed with traditional Khasi betel quid its taste changes favourably. For general health, the peeled rootstocks are boiled in water and taken as such. It is observed that habitual chewers rarely suffer from gum problems and stomach ailments. The watery extract is used as a mouthwash and gargling for treatment of throat infections and infected gums. The rootstocks may be taken for conditions leading to diarrhea, colitis, ulcerative colitis and dysentery and also for piles. The dark brown crystalised mass obtained from methanolic extracts is found to be effective for Dalton's Lymphoma (a type of cancer in mice), antidiabetic, antigastritis, etc (Syiem *et al.*, 2002). The rootstocks are tied in bundles and sold. In local market of Meghalaya, one bundle (approximately 100 grams) cost about Rs. 5-10 only.

8. ***Piper longum*** (Piperaceae): A slender aromatic climber with perennial woody roots occurring in the hotter parts of India, from Central Himalayas to Assam, Khasi and Mikir hills, lower hills of Bengal and evergreen forests of western ghats from Konkan to Travancrore. The fruits are used as spice and also in pickles and preserves. They have a pungent pepper-like taste and produce salivation and numbness of the mouth. Recent work on the fruit of *P. longum* has shown the presence of the alkaloids piperine (4-5%) and piplartine (m. p. 124-250), and two new liquid alkaloids, one of which is designated as alkaloid A. This is closely related to pellitorine producing marked salivation, numbness and tingling sensation of mucous membranes of the mouth. Sesamin (C20H18O6, m. p. 1220), dihydrostigmasterol and a new sterol, piplasterol are also present. A sample of dried fruit of *P. longum* on steam distillation gave 0.7 per cent of an essential oil with spicy odour resembling that of pepper and ginger oils. Besides fruits, the roots and thicker parts of stem are cut and dried and used as an important drug (*Piplamul*) in the Ayurvedic and Unani systems.

The fruits as well as the roots are attributed with numerous medicinal uses, and may be used for diseases of respiratory tract, viz. cough, bronchitis, asthma etc. as counter-irritant and analgesic when applied locally for muscular pains and inflammation; as snuff in coma and drowsiness and internally as carminative; as sedative in insomnia and epilepsy; as general tonic and haematinic; as cholagogue in obstruction of bile duct and gall bladder; as anemmenagogue and abortifacient; and for miscellaneous purposes as anthelmintic, and in dysentery and leprosy. Sun dried black pepper is sold at Rs. 85/kg in local markets.

9. ***Taxus baccata*** (Family: Taxaceae) found in the high altitudes of Sub Himalayan forest, particularly Arunachal Pradesh and Meghalaya of Northeast India. It has a restricted distribution in Himalayas occurring sporadically under mixed coniferous forests at altitude 2,500-2,700 msl. The plant is in great demand nationally and internationally for its leaf and barks as pharmaceutical raw material and has gained importance recently. Local herbal practitioners in West Kameng, Arunachal Pradesh, observed that the price eventually paid to the villager is around Rs. 4/kg of *Taxus* leaves, whereas in Tezpur it is priced at Rs. 35/kg. The illegal collection of *Taxus* ranges from 5 to 6 trucks per trader. *Taxus* yield the drug taxol from its leaves and barks. Taxol is used for the treatment of ovarian and breast cancer. The market price of taxol is far more fantastic, because of its rareness and effectiveness. As per the market price of 1994, one kilogram of taxol costs Rs. 180 crores. However, to produce one kilogram of taxol about 2000-3000 fully grown *Taxus* trees will be necessary. Therefore it is apparent that the value of about 25,000 trees will far exceed the value of entire forest wealth of a state like Arunachal Pradesh or Meghalaya. Area which were abundant in its population, are now devoid of it's and the natural stands can be found only on the Northern ridges of Himalaya. In Meghalaya this species was abundant only in the "Law Lyngdoh" sacred grove of Mawphlang and West Khasi hills. Destruction of its natural location and illegal trade to be checked to conserved it *in situ* as far as possible or grown *ex situ* in protected areas under similar conditions of habitat and climate. Conservation in Botanical and Experimental Gardens should be considered, propagation through seed and other technique be attempted. As per the market price of 1994, one kilogram of taxol costs Rs. 180 crores.

10. ***Smilax glabra*** (Family: Smilacaceae): The rhizomes of several species of this genus furnish the drug Sarsaparilla. Since botanical description of the various species generally deal with the aerial parts of the plants, details regarding the rhizomes are lacking for most species. *Smilax glabra*, *Smilax lanceolata, Smilax perfoliata* are some of the Indian species having tuberous rhizomes. *Smilax china* Linn., a native of China, has such tuberous roots which are well known as China Root and are employed medicinally in India under the name *Chob-chini*. The rhizomes of many other tuberous species of *Smilax* found in India are used as medicine for the same purposes. The tubers are fleshy when immature but become woody later on; the tubers and young

asparagus-like shoots of a number of species are eaten raw or cooked as vegetable. Alcoholic extract of the plant is reported to contain a glucoside and a colouring matter. Decoction of the fresh root is used for the treatment of sores and venereal complaints. The plant is collected from Moreh and other parts of Manipur and Ri Bhoi district of Meghalaya. This is then dried (root parts) and the peel is taken out and then sent to Ayurvedic drug manufacturing companies and other parts of India for its medicinal values. The cost of dried roots is about Rs. 200/kg.

11. ***Curcuma longa*** syn. *Curcuma domestica* (Zingiberaceae): Turmeric's bright yellow colour and spicy taste are familiar to lovers of Indian food, its medicinal value is not so well known. During the last two decades, turmeric's ancient use as a treatment for digestive and liver problems has been largely confirmed by scientific research. The herb has also been shown to inhibit blood-clotting, relieve inflammatory conditions and help lower cholesterol levels. Turmeric is cultivated throughout Jaintia Hill district of Meghalaya. It is propagated by cuttings from the root, and needs well-drained soil and a humid climate. The rhizome is unearthed in winter.

Despite its longstanding use in India and China, the therapeutic action of turmeric were not researched until recent decades when there was an upsurge of interest in food and medicines that lower cholesterol levels or have antioxidant properties (neutralize harmful free radicals). Research since the early 1970s, mainly in India, has confirmed turmeric's traditional actions and revealed potential new uses for it. When applied to the skin and exposed to sunlight, turmeric is stronger antibacterial. Curcumin is the constituent responsible for this action. Curcumin is also more strongly antioxidant than Vitamin E. Turmeric may be a valuable preventive remedy for those at risk of developing cancer, but more research is needed. Research has shown that turmeric has an anticoagulant action, keeping the blood thin. It also increases bile production and flow, and has a protective action on the stomach and liver.

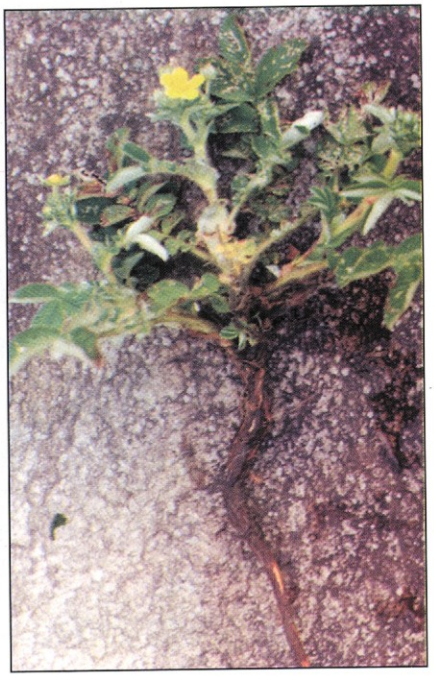
Turmeric improves the action of the liver and is traditional remedy for jaundice in both Ayurvedic and Chinese herbal medicine. It is also an ancient herb for digestive problems such gastritis and acidity, helping to increase mucus production and protection and protects the stomach. The herb also alleviates nausea. Even though turmeric does not relieve pain, its anti-inflammatory action makes it useful for arthritis and other inflammatory conditions such as asthma and eczema. Due to its anti-

*Flemingia vestita*

*Gaultheria fragrantissima*

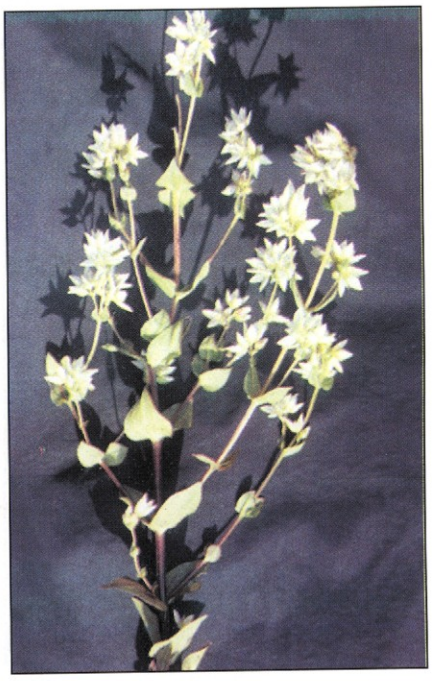
*Litsea citrata*

*Nepenthes khasiana*



*Potentilla fulgens*

*Smilax glabra* (rhizome)



*Swertia chirayita*

inflammatory, blood-thinning and cholesterol lowering properties, turmeric is now used to reduce the risk of strokes and heart attack. Applied to the skin, turmeric is useful in treating a number of conditions, including psoriasis, and fungal infections such as athlete's foot. In the International market the price of pure curcumin is Rs. 5000/gm. In the local market the crude powder is sold at the rate of Rs. 500/kg and the fresh rhizomes at the rate of Rs. 200/kg.

## Conclusion

Although presently not much land is under cultivation of medicinal and aromatic plants, but increasing interest of farmers shows that in future the area will definitely increase. Cultivation of MAPs has to be encouraged for meeting the future needs. The MAPs described above is specially to target unmanaged jhum fallow lands and/or degraded forest lands by making them more productive and effective, thereby facilitating and increasing the economic earnings of the *jhumias* and the rural communities.

The cultivation of these plants could provide farmers with an attractive opportunity to increase their income. The additional supply of MAPs through cultivation can also reduce pressure on wild resources, thus contributing to conservation of biodiversity. Nevertheless, attempts in Meghalaya are now under way to cultivate some species and protect important natural habitats in order to reduce the pressure on these vital resources. Indeed, cultivation offers the best hope for conserving many medicinal and aromatic plants found in the wild while maintaining demand at today's levels. Cultivation also permits better species identification, improved quality control, and increased prospects for genetic improvements. The immediate need is to plan some conservation and management strategies and implement them without any delay to develop these valuable resources.

An analysis of the situation in Meghalaya indicates that the trade in indigenous plants plays an important role in society's welfare and that this role is being threatened by unsustainable harvesting. The potential welfare losses have been recognized in the past, and cultivation is suggested as a solution. However, little or no commercial cultivation has taken place, mainly because of the lack of understanding with respect to marketing and cultivation economics. Farmers and other potential growers have not considered the cultivation of indigenous plants for traditional markets because of their limited understanding of the market and of the production of indigenous plants.

A synthesis of botanical, social and economic information, like that now in progress, will provide opportunities to identify the most economically efficient cultivation strategies. Such strategies could then be assessed by various producers in terms of their own limitations and opportunities. This is why a main focus has been on the conservation of endangered and economically useful medicinal and aromatic plants. This approach provided strong basis for biodiversity conservation in general, and for the improvement of livelihoods of people living in and around areas where these plants are present. The North Eastern Biodiversity Research Cell was seeking to identify and conserve this important resource, safeguard the traditional knowledge related to its benefits and promote its sustainable use through community involvement.

**Acknowledgement**

The authors are grateful to the North Eastern Council (NEC), Shillong for providing financial assistance to the North Eastern Biodiversity Research Cell (NEBRC), North Eastern Hill University, Shillong.

**References**

Anon. 1998. Current trends in International market. *Journal of Medicinal and Aromatic Plant Sciences* 20: 113.

Hanfee, F. 1998. *Wildlife Trade: A Hand-book for Enforcement Staff.* Traffic DIA p.30.

Kayang, H. 2005. Biological Diversity in Northeast India: Conservation Strategies. *Hills and Mountain Today*, 1(1): 30 -37.

Kayang, H., Kharbuli, B., Syiem, D. and Myrboh, H. 2005. Medicinal Plants of Khasi Hills of Meghalaya, India. *Proc. Third World Congress on Medicinal and Aromatic Plants* (WOCMAP.III) Vol I. Bioprospecting and Ethnopharmacology. Eds. J. Bernath., E. Nemeth, L.E. Craker and Z.E. Gardner. Acta Horticulturae 675, ISHS, pp. 75-80.

Samati, H. 2004. Kitchen garden plants of pnar tribe in Jaintia Hills district, Meghalaya. *Ethnobotany*, 16: 125-130.

Syiem, D., Syngai, G., Khup, P.Z., Khongwir, B.S., Kharbuli, B. and Kayang, H. 2002. Hypoglycemic effects of *Potentilla fulgens* L. in normal and alloxan – induced diabetics mice. *Journal of Ethnopharmacology* (Elsevier, UK), 83: 55-61.