

Diversity and Concerns of Indian Medicinal Plants: A Scenario

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Keywords	Abstract
Medicinal plants Sustainable development Conservation	The paper highlights current status of knowledge on Indian medicinal plant species used in organized systems of medicine, ethnomedicine and modern medicine. It reviews all-pervasive concern of medicinal plants including role of institutions, organizations, government bodies, rules enforced by them, difficulties in field studies, etc. Current needs to reach sustainable development and their conservation are put together pertinently revealing the state of art of Indian medicinal plants. This review will help guide others interested in medicinal plant research, apart from ecologist, traders and industrialists.

1. Introduction

All human societies showed profound interest on utilization as well as conservation of biodiversity in sustainable manner to which India is no exception. India has two mega centers of biodiversity especially in plant species *viz.*, North eastern Himalayan region and Western Ghats. Indian forests are rich in medicinal plant species with a wide spectrum of healing properties. The Traditional Indian System of Medicine has been therefore well developed due to this richness of bio-resources. Interest on indigenous health traditions and demand for herbal remedies are undoubtedly discernible trends worldwide. These have culminated into over exploitation of our natural bio-resources leading some important medicinal plant species to rarity, extinction and endangered state. It, therefore, appears that current concern must to be addressed to the protection of species from over-exploitation and also enriching the biodiversity. It is therefore, desirable to strive towards these goals and lay emphasis on: i) Characterization of medicinal plants, ii) Assessing magnitude and distribution of medicinal plant diversity in different states, iii) Assessment of loss of medicinal plant diversity, iv) Monitoring and maintenance of inventory of medicinal plant diversity, v) Effective information management and communications, vi) Assessment of economic values of medicinal plant diversity, vii) Measures for conservation and sustainable use of its components. India's biodiversity is mainly distributed in Western Ghats, Andaman and Nicobar Islands, Northeastern India and the Himalayan region with about 80% of the global biodiversity. Indian sub-continent is enriched with about 45,000 plant species of which nearly 18,000 are flowering plants.

This vast degree of diversity is correlated to the greatly divergent ecosystems and altitudinal variations. The agro-biodiversity particularly in India is distributed in eight diverse phyto-geographical and 15 agro-ecological regions. The range of distribution of these plants differs from the wet evergreen forest in the Western Ghats to the Alpine scrubs of Himalayas, from the arid deserts of Rajasthan to the mangroves along the east coast, from the vast deciduous forests of Deccan to the Sholas of the high ranges, from the swamps of the Ganges to the moss laden tree trunks of the Silent valley. The indigenous diversity of the plant species of medicinal and aromatic value in the region is also unparallel. This is reflected from the Arogyapacha (*Trichopus zeylanicus*) of the Agastiar Hills to the Salaam panja of the Himalayas, from the tiny Drosera of the Sholas to the huge Dipterocarps of the Western Ghats, from the xerophytic Aloes to the marshy land Brahmis, from the wild turmeric to the cultivated peppers (Ved *et al.*)¹ There is 1500 species of codified knowledge. These are used in organized system of medicine like Ayurveda, Unani and Siddha. About 3000 species are available from the empirical knowledge. These are used as ethnomedicine. Their information is orally passed over generations. Nearly 700 species have been investigated pharmacologically and chemically. These are used in modern medicine. (Ved Prakash)². These figures have now obviously increased. Plants and plant-based products have been used traditionally by the inhabitants of India from the time immemorial. Several references of healing properties of plants are stated in Rigveda (400-1500 B.C.) Atharveda (1500 B.C.), Upnishada (1000 B.C.), Mahabharata and Puranas (700-400 B.C.). Charaka Samhita and Susruta

Samhita are other two monumental works (1000 B.C. to 600 B.C.). The invasions of Greeks and Muslims rulers influenced a lot in the use of plant based medicines. The rise of Buddhism also boosted to the study of herbal medicines in olden days. India has thus developed Ayurveda and Unani two important systems widely practiced in present Indian system of medicines. Many medicinal plants are advised in these systems, which are naturally distributed in India. This discloses the unique position of India in the utility of medicinal plants for long past. Utilization of our national heritage of medicinal plant resources should, therefore, be managed in such way that it must be aimed at conserving our bio-resources. It should divulge the maximum potential of the resources. This is dilated in the following.

2. Discussion

The importance of medicinal plant is well known worldwide. Nevertheless, work on biodiversity on these received much less attention as compared to the food plant species. Commercial utilization including cultivation is a new phenomenon in medicinal plants. The recent trend of green chemistry of herbal remedies has caused a renaissance and rejuvenation in traditional systems of medicine. Demand for the herbal products is increasing worldwide. This trend has resulted into over-exploitation of the natural resources. It is now imperative to lay emphasis on the following activities:

Characterization of medicinal plants

In case of medicinal plant improvement, quality in terms of secondary metabolites is evaluated *viz.*, alkaloid, steroid or essential oil production etc., which is not apparently dependent on morphological characters. Mostly the function of these compounds and their benefit to the plants are unearthed. Secondary metabolites occur in specific plants or groups of plants and are an expression of the particular species they are not necessarily produced under all conditions (Dewick),³. Therapeutic value, therefore, is governed mostly by the secondary metabolites. It is an important factor in addition to yield in medicinal plants. Mode of inheritance of chemical constituents is hence very important in case of medicinal plants. Morphological characters are sometimes misleading and hence information on correlation between different morphological characters with yield and quality would be of great significance in medicinal species. Selection criteria and all the characterization objectives should therefore be directed so that these would enhance the total secondary metabolite content and

production in medicinal plants. Simple introduction of a species for successful cultivation in a new habitat and environmental conditions may be misleading sometimes and futile due to chemical changes and infra-specific chemical modifications. These changes or modifications take place due to changed ecological and geographical situations (Tetenyi)⁴.

Characterization of the germplasm at and below specific levels in medicinal plants would be hence significantly essential and unparallel for the selection of the right plant type having desired attributes or quality for cultivation. This would also enhance sustainable utilization of the medicinal plant diversity. Investigation on characterization in many medicinal plants carried out in India exhibited a wide spectrum of variability. In isabgol (*Plantago ovata*) a number of workers investigated plant variability within the germplasm, stability of the available lines, etc., (Bhagat),⁵, (Jindla *et al.*)⁶, (Sangan *et al.*)⁷, (Godawat)⁸, (Lal *et al.*)⁹, Germplasm studies conducted with 70 cultivars of isabgol revealed highest heritability in spike length, seed yield number of branches, spike number and length. These directly contributed to yield (Bhagat)¹⁰, In kalmegh, (*Andrographis paniculata*) cytotypes were reported from different collections of India and Bangladesh (Roy and Datta)¹¹ Genetic divergence study conducted by (Mishra *et al.*)¹² in Ashwagandha, (*Withania somnifera*), identified different parental lines within the available germplasm. In Safed musli (*Chlorophytum borivillianum*), work carried out at different, All India Coordinated Research Project on Ethnobiology (AICRPE)¹³, centres showed the variability in abundance in the available germplasm (Jat and Sharma)¹⁴; (Geetha and Maiti)¹⁵, (Bhagat and Jadeja)¹⁶. Use of different molecular marker tools such as isozyme, RAPD, AFLP analysis, etc., for evaluation of variability within the species or relatedness between the species were also used in medicinal plants e.g. *Plantago ovata*, (Pramanik *et al.*)¹⁷, *Andrographis paniculata* (Padmesh, *et al.*)¹⁸.

Assessment of magnitude and distribution of medicinal plant diversity in different states

Knowing of magnitude of diversity in medicinal species is crucial for fixation of its conservation, utilization and management strategies. This data bank will help safeguard sustainable utilization regulating the harvesting as per magnitude of species population in a given ecosystem. The magnitude of diversity in medicinal species can be observed by different scales, nevertheless the most important is the species diversity. About 141 endemic genera. 2532 endemic species are distributed in Himalayas, 1788 species in peninsular region and 185 species in the Andaman

and Nicobar islands. More than 7500 plant species are referred in Indian folklore. Only about 1700 plant species are mentioned in the documented form of ancient or past literature. A precise and accurate number of the total medicinally important species distributed in the area is difficult due to the difficulty in correlating the local names used in the traditional systems to the scientific names. Hence a national coordinated network programme is required to interlink all the traditional systems of medicines and document the species used in various systems and their scientific names with their distributional patterns to avoid synonyms, duplications and misnomer, etc., This is a common fact in case of Indian medicinal plant species because varied cultures, languages and dialects. Different vegetable sources provide the same mode of action against ailment and hence could be employed as per the availability of the species regionally. This will help to avoid over-exploitation of certain species from some regions. If concise information is made available in this respect we can avoid drug adulterations and check escalated demand and prices of certain raw drugs. Well known example in this case is the use of species of *Chlorophytum* and *Asparagus* as a source of raw drug Safed musali (Patil)¹⁹, Valerian (Ved Prakash)²⁰, Tukmaria (Shah)²¹ and Daruhridra where a number species like *Berberis*, *Coscinium*, etc. are used.

Assessment of loss of medicinal plant diversity

Investigations on assessment loss of medicinal plant diversity will help the understanding of forces of interference, needs for its re-instatement, management and execution of different creative measures for its sustainable utilization and conservation. Biodiversity loss is a common phenomenon throughout the world. But the pace at which the species experience the problem of extinction is alarming. The biodiversity loss because of urbanization, industrialization, etc., has become common phenomenon in developing countries. This has bearing on medicinal plant diversity also. In addition, the medicinal plants as such are facing another dimension of loss because of indiscriminate harvesting to meet the increased demand of the herbal drugs. This has culminated in unsustainable harvesting in view of quantity as well as time and method of harvesting leading to overexploitation. It is possible to categorise the medicinal plant diversity loss into: (i) The global phenomenon of habitat loss. (ii) The overexploitation of medicinal plants. Population explosion, expansion of agricultural land, industrialization, etc. caused a vast destruction in the forest area. This automatically threatened the survival of many of the plant species that they shelter. Globally about 10% of world flora

may be threatened (Cody)²² According to the 1997 IUCN Red list; about 12.5 % of World's flora is facing the threat of extinction. The same or probably more serious threat is there for the medicinal plants. Using the current global rate of species extinction, about 10-12 % of the medicinal plants of India (i.e. about 800-1000 species) are likely to be threatened. About 95% of medicinal plants in trade in India are obtained from the wild. The rising demands for natural products such as herbal medicines, cosmetics, food supplements and health products, etc. in the national and international markets caused mining of medicinal plant species from the wild. High consumption of wild flora and their destructive collection methods caused some of the species vulnerable to the survival of this invaluable wealth in nature. It is estimated that over 70% of the plant collection involve destructive methods. The quantity of the collected material from the wild often becomes the focus of criticism at the cost of the time and method of harvesting. The methods, time and quantity of collections from a particular area are also critical for depleting biodiversity or its total loss. On account ruthless collections of raw material of a species from its natural habitat, population size will decline and small population attracts less pollinators and have low reproductive success (Jennersten)²³. Unbalanced male female ratios of a dioecious species also have bearing on the population growth. Life spans of species matter since short-lived species need lesser time for extinction if it is overexploited.

Monitoring, maintenance and inventory of medicinal plant diversity

Convention on Biological Diversity (CBD)²⁴, raised the need for monitoring and maintenance of diversity inventory. The CBD is a landmark in protecting environment and its development field, since it takes, for the first time, a comprehensive rather than a sectorial approach to the conservation of the Earth's biodiversity and sustainable use of bioresources with benefit sharing. India is signatory of the (CBD)²⁴ and therefore, responsible to promote the cause of protecting biodiversity for the posterity of the human race. One of the major recommendations of the CBD is maintenance of biodiversity inventory. Maintenance of medicinal plants inventory and its monitoring on a regular basis would need serious attention for taking appropriate steps in maintenance and conservation of depleting populations of species or species groups with high demand. Occurrence and diversity of medicinal species is considerably diverse and unparallel in India. Biodiversity inventorying includes data on surveying, sorting, cataloging,

quantifying and mapping of individuals, species, populations, habitat, biotypes, ecosystem, etc. Repetitive inventorying over time will help monitor the biodiversity at a particular locality it provides information on changes occurring in biodiversity over time. Data from these activities will aid in providing information for policy and management goals for land used, trade, environmental impact assessment and conservation. Inventories of species and its population of medicinal species could be employed efficiently and prioritize research objectives in these group of species. Inventorying biodiversity includes physical census and remote sensing coupled with ground truth data.

Enumeration and documentation of the species diversity within the geographic area of the country would be very important considering the new developments in the sovereignty of the country on its germ-plasm resources. This is so because biological entities are not restricted by political boundaries National and international agreements are required where there is sharing of expertise, facilities and information for a full-proof data base under these circumstances. Developing a Traditional Knowledge Digital Library (TDKL) to save India's ancient knowledge is one attempt of documentation of usages of medicinal plant diversity. This is because of patent claims which may develop worldwide for non- original inventions based on different Indian medicinal species.

Effective information management and communications

The biological and genetic resources are now conceived as natural resources with potential economic value after CBD establishment. Other such international agreements. viz., the Convention on International Trade in Endangered Species (CITES), Chapter 15 Of Agenda 21, the World heritage Convention and the Global Biodiversity Strategy, etc., also suggested the effective management, organization and use of biodiversity information. Information Management and communication makes a strong footing while taking any decisions for protections of various concerns about biodiversity conservation and its utilization. In India, though information management and its dissemination through effective communication system is recognized as an essential government activity, development and use of medicinal plants biodiversity information has not received sufficient importance. The efforts in this area have been undertaken by scientific government bodies e.g. Botanical Survey of India. AICRPE (1992-1998) reported 8000 wild plant species useful by tribal for their healthcare, of which 2000 are with new claims and worthy of scientific scrutiny, the indigenous

knowledge thus provides fuel for biologically active molecules. Creation and broadening of the authentic medicinal plant biodiversity information data base and its use by the various stakeholders are real challenge and needs attention of all stakeholders. While striving towards this goal, it is necessary to network the information data base of the stakeholders of medicinal plants users and producers. However, before switching over to this task, herculean task should be taken for the formulation of methodologies and data organizations.

Assessment of economic values of medicinal plant diversity

The turn over of Indian herbal industry is estimated to be around 4000 crore per annum. The current use of medicinal plant resources on the basis of market signals is, however, inefficient and inadequate. Nearly 500 plant species are used by the pharmaceutical industry in India. Majority of the medicinal plants, especially medicinal tree species, are presently collected from the wild. Recently, utilization of medicinal plants has increased multifold due to ever increasing market of herbal industry. Medicinal plant cultivation is comparatively new phenomenon. Introduction of a new species may be in high demand; however, profitability of the species may be very low. Only a few medicinal species are under cultivation.

Measures for conservation and sustainable use of its components

Some conservation strategies have been adopted by the government and non-governmental organizations. Government of India has published a list of plants that are prohibited from trade by collection from nature considering the vulnerability of some medicinal plant species in nature. (Table-I) Still we are not convinced about their correct status of danger. It is worth to note that while developing curricula for tertiary education, due attention is sought for avoiding rare threatened plant species from wild. This is so since the maximum number of medicinal plants species used in trade is hailed from wild it is, therefore, necessary to have preference to examine commercialization of such taxa.

List-I: Prohibited Medicinal Taxa: *Aconitum* sp., *Aquilaria malacensis*, *Coptis teeta*, *Coscinium jenastratum*, *Cycas beddomei*, *Dactylorhiza hatagirea*, *Dioscorea deltoidea*, *Euphorbia* sp., *Frerea indica*, *Gnetum* sp., *Gentiana kurroo*, *Kaempferia galanga*, *Nepenthes khasiana*, *Orchidaceae* sp., *Panax paendogsenseng*, *Paphiopedilum* sp., *Picrorhiza kurroo*, *Pterocarpus marsupium*, *Rauwolfia serpentina*, *Renanthera imschootiana*, *Swertia chirata*, *Taxus wallichiana*, *Vanda coerulea*, etc.

List-II: Medicinal Species Commercially Unexploited: *Abrus precatorius*, *Argeria nervosa*, *Bacopa monnieri*, *Boerhavia diffusa*, *Cassia sophora*, *Centella asiatica*, *Chlorophytum arundinaceum*, *Cissampelos pariera*, *Cissus quadrangularis*, *Clitoria ternatea*, *Convolvulus microphyllus*, *Costus speciosus*, *Curculigo orchioides*, *Curcuma zedoaria*, *Cynodon dactylon*, *Cyperus rotundus*, *Datura sp.*, *Desmodium gangeticum*, *Eclipta alba*, *Evolvulus alisnoides*, *Gymnema sylvestris*, *Hemidesmus indicus*, *Hygrophila auriculata*, *Indigofera tinctoria*, *Leucas aspera*, *Leptadaenia reticulata*, *Mimosa pudica*, *Paedaria foetida*, *Pedalium murex*, *Plumbago zeylanica*, *Rata graveolens*, *Sida sp.*, *Smilax zeylanica*, *Solanum nigrum*, *Solanum surretense*, *Solanum viarum*, *Spilanthes acmella*, *Tylophora indica*, *Urginia indica*, *Vernonia anthelmintica*, *Vitex negundo*.

The CBD also decided to implement provision for the conservation and sustainable utilization on biodiversity. Realizing sovereign right of the States to use their own biological resources, The CBD desires the parties to facilitate access to genetic resources by other parties for environmentally sound purposes subject to national legislation and on mutually agreed upon terms (cf. Articles 3 & 15 of CBD). Article 8 (i) of Convention of Biological Diversity (2001) recognizes contributions of local and indigenous communities to the conservation and sustainable utilization of biological diversity through traditional practices, knowledge and innovations. It provides for equitable sharing of benefits with such people arising from the utilization of their knowledge, practices and innovations. It is through Intellectual Property Rights (IPR) and particularly patents that control an ownership over traditional knowledge are being usurped by commercial interest (Pushpangandan and Kumar)²⁵. Benefit sharing with Kani tribe on 1:1 ratio is a model given by TBGRI and widely accepted (Puhpangandan and Kumar)²⁵. Earlier to these agreements, there was no separate policy or regulation to facilitate conservation of medicinal species in India. Their conservation was chiefly covered under the forest Act and Wild Life Protection Act (1972). It was implemented by the State Forest Department and Indian Government's Directorate of Wild Life Preservation. The central Government has brought Biological Diversity Act, 2002 after CBD agreement. It has following functions: (i) to regulate access to biological resources of the country with the purpose of securing equitable share in benefits arising out of the use of biological resources and associated knowledge relating to biological resources, (ii) to conserve an sustainable use of biological diversity, (iii) to respect and protect knowledge of local communities related to biodiversity, (iv) to secure sharing of benefits with local people as conservers of biological resources and holders of knowledge and information relating to the use of biological resources. (v) conservation and development of

areas of important from the standpoint of biological diversity heritage sites, (vi) protection and rehabilitation for threatened species, (vii) involvement of institutions of State government in the broad scheme for the implementation of the Biological Diversity Act through constitution of committees. But the idea of sustainable harvesting is greatly challenged by the lack of information of the life cycle, regeneration habit, reproductive biology, etc., of many of these plants. So serious efforts are required in this direction especially by the floral biologist also and the information collected thus should be shared with the collectors for the development of a sustainable collection parameters.

In situ conservation project for the conservation of medicinal species was started in the States of Karnataka, Kerala and Tamil Nadu involving the State Forest Departments, research institutes in collaboration with FRLHT (Foundation for Revitalization of Local Health Traditions-A Bangalore based NGO group) in 1993. It was sponsored by Government of India. This developed a network of Medicinal plant Conservation Sites (MPCA), Medicinal Plant Conservation Parks (MPCP) and Medicinal Plant Development Sites (MPDA). Indigenous societies have their own ways and means for the conservation of bio-resources. One of such conservation practices is the 'Sacred groves'. These are areas which are devoted to Gods and are strictly protected from human interference (cf. Vartak and Gadgil; Gadgil and Vartak),²⁷ It can be considered as the first human effort for the *in situ*, conservation of biodiversity. But in present era, these great traditions are also facing a lot of threats because of the change in values, living styles and acculturation etc., and numbers of such *in situ* conservation sites are declining. This type of our cultural trends must be recognized and should pay attention towards hardness for the continuation of preservation of varied cultures and ecosystems. Seed gene banks, field gene banks, *in vitro* gene banks, herbal and botanical gardens, etc., are working for *ex situ* conservation. National Medicinal Plant Board (NMPB) through State Medicinal Plant Board (SMPB) promotes medicinal plant cultivation of selected species by providing monetary supports and marketing facilities. The major disadvantage of the *ex situ* conservation is the lack of natural evolution within the conserved materials. This problem can be partially resolved by linking *ex situ* intervention to *in situ* program wherever, feasible.

3. Concluding Remarks

The strategies for sustainable utilization of our medicinal species may be summarize in a nutshell:

a) Collection of critically endangered species and sustainable harvesting from the wild should be strictly banned from the trade for the certain period. It requires a full-hearted co-operation of the Forest Departments and the local human societies. Benefits accrued from such attempts should be shared with the local societies as well.

b) Endeavors to evaluate the threat status of different enlisted medicinal plants should be appreciated in order to prioritize the plants to be selected for immediate care. People's participatory program can be included for this study as the local people are the factual information source for obtaining the clear idea of the present and past distribution of a particular species at a particular locality. This information should be complemented with the information gained through from remote sensing.

c) Species with medicinal significance under high demand and whose demand is ascertained stable and also under the threat category has to be given prime importance for future investigations.

d) Integration should be practiced between food crops and medicinal plant cultivation, wherever possible.

e) Net working system involving public and private institutions should be adopted so that there is complete linkage. Mass cultivation projects funded by industries on marginal lands with the available agro-techniques so as to stabilize the supply regularize trade and quality material.

f) Research program should be started from for those species whose regenerative capacity with the available material is very poor and are little known for their biology.

g) Strict observation of laws should be made by the conventions, acts, etc. from time to time.

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