



BIODIVERSITY, CONSERVATION AND CULTIVATION OF MEDICINAL PLANTS

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Abstract- Rapidly increasing world population (7 billion! and growing fast) coupled with widening economic divide between the poor and the rich is a serious global problem associated with the affordability of expensive quality healthcare by the economically weaker sections. World Health Organization's (WHO) recognition of traditional (TM) and complementary and alternate (CAM) systems of medicine to provide health security to the poor in developing nations is a welcome step. These systems widely use medicinal plants (MPs) for preparing drugs. Globally 77000 (18% of world flora) plants are presently used for healthcare. Global imports and exports (2005-2010) of medicinal plants and plant parts are to the tune of US\$ 2.09 and 2.08 billion/year, respectively. Out of the 3000 medicinal plants traded in global markets, only 900 are cultivated in different countries, mostly in developing economies. Unfortunately majority of the exported biomass is harvested from the wild often following non-scientific and unsustainable practices. Rapid loss of habitat, indiscriminate over harvesting, global warming and climate change are fast depleting MP populations, threatening the existence of about 15000 species and their future use. To conserve the natural biodiversity wealth of MPs to posterity, cultivation is an economically viable emerging option. Many exporting developing nations are favouring this option as cultivated MPs are accepted by user industries dealing with pharmaceutical botanicals. India with a wealth of 8000 MPs, availability of high yielding cultivars, cultivation and processing technologies, has excellent potential to harness the economic power of MPs.

Keywords- Medicinal Plants, TM, CAM, WHO.

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Introduction

Medicinal plants have been used in developing countries for thousands of years. World Health organization (WHO) estimated that 70-80% of the population living in Africa, India and other developing nations depend on traditional healthcare systems for primary healthcare. Medicinal plants (MPs) and herbal medicines form an important part of the treatment in the indigenous medicine systems such as Ayurveda, Unani, Siddha, Traditional Chinese Medicine, Tibetan Medicine, Julu etc. The ushering in of modern technologies catapulted MPs into patent war zone as highly valuable commodities. Many developed and developing countries are actively engaged in bio-mining MPs for therapeutically precious and biologically active phytochemicals. Many modern drugs for treating constipation to cancer are derived from plant kingdom. In

1980, 25% of the prescription drugs dispensed through community pharmacies in USA had one or more ingredients of plant origin. The value of these drugs was estimated at US\$ 8.1 billion. In 1981, 121 scheduled drugs obtained from 95 plant species were used globally. In 1995 it was presumed that tropical forests carry potential to produce 328 plant drugs worth US\$ 147 billion. Increasing pressure on forest lands due to uncontrolled population growth, changing weather patterns, biodiversity of plants in general and MP species in particular are facing threat of erosion and extinction in their natural habitats. This calls for immediate strategies for conserving MPs through policies that encourage sustainable supplies to meet the growing global demand (8-15% per annum)[4] for MP products.

Mega-biodiversity nations and biodiversity hotspots

World Conservation Monitoring Centre (WCMC) of United Nations Environment Program (UNEP) has identified 17 mega-biodiversity {biodiversity is the pool of terrestrial, marine, aquatic life forms on earth. Biodiversity refers to variety in living organisms such as plants, animals, insects, microorganisms, their habitats and genes (genetic diversity, species diversity and ecosystem diversity)} countries that house bulk of global floral and faunal species wealth including animal species (http://en.wikipedia.org/wiki/Megadiverse_countries). The mega-biodiversity countries are: Australia, Brazil, China, Colombia, Democratic Republic of the Congo, Ecuador, India, Indonesia, Madagascar, Malaysia, Mexico, Papua New Guinea, Peru, Philippines, South Africa, USA and Venezuela. Conservation International has identified 34 biodiversity hotspots (the term was coined by British biologist Norman Meyers in 1988) with high levels of species endemism (>1500 species) and biodiversity depletion (70% of original habitat destroyed), 2 of them (Eastern Himalayas and Western Ghats) which are rich repositories of MPs are in India (www.biodiversity.org). The species wealth in these two hotspots is fast depleting and unless urgent corrective measures are initiated many of the species will soon become extinct.

Number of MPs presently used worldwide

Globally 77000 plants (18.2% of total plant species) are currently put to use for medicinal purpose as shown in Table 1 [9]. A perusal of the table indicates that majority of the Indian plant species possess medicinal value. In some of the Indian states more than 50% of the plant species are regarded as medicinal plants. Currently 900-1100 species are used for medicinal purpose in different Indian systems of medicine. This does not include the number of species used by forest dwelling tribal communities.

Table 1- Country-wise number of species used as MPs

Country	Plant species	MP species	%
Bulgaria	3567	750	21
China	32200	4941	15.3
France	4630	900	19.4
Hungary	2214	270	12.2
India	18664	8000	42.9
Jordan	2100	363	17.3
Korea Rep. of	2898	1000	34.5
Malaysia	15500	1200	7.7
Nepal	6973	900	12.9
Pakistan	4950	1500	30.3
Philippines	8931	850	9.5
Sri Lanka	3314	550	16.6
Thailand	11625	1800	15.5
USA	21641	2564	11.8
Vietnam	10500	1800	17.1
World	422000	77000	18.2

Number of MPs threatened and cultivated globally

IUCN (International Union for Conservation of Nature and Natural Resources) estimated that 70% of global plant species are threatened with extinction, of these 15000 species are MPs. Out of the 77000 MPs used worldwide 3000 MPs are internationally traded, only 900 species are cultivated and rest of the species are gathered from their natural homes (Table 2) [9].

Table 2- Number of MPs threatened and cultivated globally

Number of flowering plants worldwide	422000
Number of plants threatened (70%)	295400
Number of MPs (17.1%)	77000
Number of MPs threatened (20.8%) globally	15000
Number of MPs traded globally (4.2%)	3000
Number of MPs cultivated (1.3%) internationally	900

Conservation and protection strategies for MPs

Conservation is biodiversity management for human utilization to give sustainable benefit to the present generation while retaining its potential to meet the requirements and aspirations of future generations as well. In situ and ex situ conservation strategies as described in Table 3 need to be vigorously pursued by all the nations irrespective of their biodiversity status. Globally 115000 conservation and protection areas covering 12% of the land area have so far been created but need further strengthening. Similarly oceans, rivers, rivulets, tanks, springs and other water bodies and wetlands also need to be protected for preserving their biodiversity. According to Botanical Survey of India, the Government of India has created 16 biosphere reserves, 28 tiger reserves, 97 national parks (1.2% land area), 482 wildlife sanctuaries and several thousand Vana Rakshana Samithies (Forest Protection Councils) comprising communities dwelling in the forests and forest fringe areas to conserve and protect Indian biodiversity. A number of state governments have created MPs conservation areas each covering 200 hectares of forest cover.

Table 3- In situ and ex situ strategies to conserve and protect MPs

In situ conservation	Ex situ conservation
Medicinal plant conservation areas	Herbal gardens, theme parks
Biosphere reserves	Social/urban forestry, avenue plantations
National parks	Cultivation of specific species
Sacred groves	Gene banks: Seed, pollen, DNA
Cultivation in forests: Joint Forest Management	Tissue culture repositories
Legislation: Banning exports, converting forests for agricultural or commercial purposes such as mining	Cryopreservation

Global economic significance of MPs

The widespread use of MPs, their extracts, formulations and chemicals derived from them in different traditional and modern systems of medicine, nutraceuticals, cosmeceuticals, functional foods etc. is increasing the demand for herbal plants internationally. Table 4 provides an insight about the economic importance of MPs, their derivatives and products

Table 4- Economic power of MPs

International market for traditional therapies	US\$ 60 billion in 2002
World market for herbal medicines, herbal products and raw materials	US\$ 43 billion in 2000
Global market for herbal teas	US\$ 100 million
World market for nutraceuticals	US\$ 75 billion
International market for functional foods	US\$ 57 billion
Chinese trade in traditional medicines	US\$ 14 billion in 2005
Germany's herbal market	US\$ 12.7 billion in 1989
Brazil's market	US\$ 160 million in 2007
Western Europe's herbal market	US\$ 5 billion in 2003-04
Indian traditional medicine market	Rs. 88 billion in 2005-06

(WHO, FRLHT (Foundation for Revitalization of Local Health Traditions, Bangalore and several other sources).

Exports and imports of MPs

According to United Nations Comtrade database [10] world exports and imports (in million US\$) of perfumery and pharmaceutical plants and their parts grew by over 50% during the period 2005-2010 (Table 5). China, India, USA, Germany, Canada are the major exporting countries. USA, China/Hong Kong, Germany, Japan, France are the major importing nations. Indian exports and imports during this period are shown in Table 6. The value of Indian exports is steadily growing luring people for unsustainable, indiscriminate forest collections.

Table 5- World imports and exports of perfumery and pharmaceutical plants

Year	Imports (US \$ Millions)	Exports (US \$ Millions)
2005	1391.29	1252.09
2006	1524.71	1361.17
2007	1773.96	1613.47
2008	1964.81	1794.56
2009	1860.77	1774.68
2010	2094.02	2075.45
Growth rate	50.50%	65.80%

Table 6- Indian exports of perfumery and pharmaceutical plants

Year	Exports (Quantity in t)	Exports (US \$ Millions)
2005	50946.3	76.76
2006	46247.7	84.02
2007	50912.2	113.12
2008	50545.4	130.49
2009	48524.6	106.28
2010	NA	132.51
Growth rate	-	72.60%

Source of MPs

Majority of the MPs biomass is sourced from the forests (Table 7), through unsustainable and non-scientific, indiscriminate collections and harvest methodologies.

Table 7- Medicinal botanicals sources

World	India (FRLHT, Bangalore)
70-(90) % of the species are collected from their natural habitats.	77% of MPs are collected from natural habitats: Temperate forests: 12%; Tropical forests: 40%; Roadsides: 25%; Cultivated: 20%; Imported: 3%
50-(70) % of the MP biomass is from wild collections.	72% of MPs are collected in destructive manner seriously affecting natural propagation of MPs populations.

Traders and exporters exploit local communities for collecting MPs from forests ignoring CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna) guidelines leading to fast biodiversity degradation, revenue loss to governments, seriously eroding livelihood options of forest dwelling tribal communities and is against the spirit of Convention on Biological Diversity (CBD) objectives (conservation of biological diversity, sustainable use of biological resources and fair and equitable utilization of genetic resources). Governments of exporting nations should initiate practicable methodologies to protect the interests of these communities and MPs from overexploitation. The urgent need is to educate and train the local communities to regulate collections following the guidelines provided by:

- International Standard for Sustainable Wild Collection of Medicinal Plants (ISSC-MAP).
- WHO Guidelines for Good Agricultural and Collection Practices for Medicinal Plants.
- WHO/IUCN/WWF (World Wide Fund for Nature) Guidelines on the Conservation of Medicinal Plants.

Collection vs. Cultivation

The debate on the preference of wild or cultivated plants as sources of drugs is long standing. Researchers feel that the preference for wild plants is often determined by local perceptions rather than scientific proof of better performance of wild plants to cultivated plants [8]. It is argued that the concentrations of pharmaceutically important secondary metabolites are higher in the wild plants than in the cultivated species. Scientific studies conclusively proved that it is possible to regulate the concentrations of these secondary plant metabolites in cultivated species [7]. Majority of the transnational firms that deal with botanicals readily accept cultivated plant material [6]. Certification for wild collections is being insisted for international trade. Table 8 lists the advantages and disadvantages of collection versus cultivation of MPs.

Table 8- Advantages and disadvantages of collection versus cultivation of MPs

Collection	Cultivation
Extinction of species, biodiversity depletion, genetic erosion, exploitation of local communities	Conservation of species, crop improvement and organic certification possible
Irregular/diminishing availability and supplies	Sustainable availability, high yields through scientific cultivation methods
Admixture of related species, sometimes with poisonous species	Purity of species guaranteed
Variable quality	Uniform quality
Difficulties in harvesting, handling, storage, transportation	Harvesting, handling, storage, transportation regulated
Pest control difficult	Pest management possible
Seasonal employment for collectors	Year round employment possible
Sometimes hazardous to collectors	Protection to workers
Product cheaper	Product relatively expensive

Cultivation of MPs

Species that are currently available in abundant quantities in forests and that can easily be propagated in their native habitats need not be brought under cultivation immediately, but their collections need to be regulated to guarantee sustainable supplies. Limited cultivation in forests by trained tribal communities is a strategy pursued by some developing countries that is paying rich dividends. Ex situ cultivation through herbal gardens/parks and home herbal gardens in villages, towns and cities is gaining popularity for plants used in home herbal remedies. China has several gardens planted with 700-1300 MP species and 33000 hectares under MPs cultivation [1]. Botanical Survey of India, CSIR-CIMAP, Tropical Botanical Garden and Research Institute, Trivandrum and many other Indian institutions are maintaining herbal gardens and conservatories. In India, MPs are cultivated in more than 95000 hectares [2] and the area is steadily increasing as the demand for these plants is escalating. In addition to India and China cultivation of MPs is practiced in many developing countries namely, Brazil, Korea, Nepal, Pakistan, Philippines, Thailand, Sri Lanka, Vietnam etc. and developed nations such as Germany, Japan,

Russia, UK, USA etc.

Threats and Opportunities

With the signing of GATT (general agreement on trade and tariffs) by more than 100 countries markets have opened up for international companies and intellectual property protection (IPR) issues have become a serious problem to protect indigenous knowledge on MPs and their traditional use from biopiracy. India has successfully digitized 220268 medicinal formulations employed in different systems of medicine (Table 9) through TKDL (Traditional Knowledge Digital Library) project (<http://www.csir.res.in>). The project is continuing to include many more formulations of local communities. India is also helping other countries in inventorising their traditional knowledge. Globalization on the other hand opened plethora of opportunities to innovatively market MP products.

Table 9- Number of formulations of Indian medicinal systems digitized by CSIR (Council of Scientific and Industrial Research) under TKDL project

Traditional Indian medicine system	Number of formulations
Ayurveda	85500 formulations
Unani	120200 formulations
Siddha	13470 formulations
Yoga	1098 postures
Total	220268 medicinal formulations

Conclusions

The demand for wild as well as cultivated MPs and their products is increasing globally providing opportunities for biodiversity rich developing nations to utilize their natural resource prudently and innovatively to earn foreign exchange through exports of crude drugs and value added products and to create jobs for both unskilled and skilled youth. However, to regulate over harvesting of natural populations and exploitation of local communities by traders and exporters these communities need to be trained in scientific methods of collection and marketing. Conservation of biodiversity and protection of indigenous knowledge is an important aspect that needs to be addressed to prevent biopiracy. Cultivation of MPs is emerging as an economic opportunity which needs to be utilized judiciously. Governments need to devise practically viable policies for protection and sustainable utilization of biodiversity and wealth creation through this bio-resource.

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