

collected without a permit from the department concerned. An Italian law of 1931 stipulates that permits for the commercial collection of species that are listed to be of medicinal value will only be issued to people who have degrees in herbalism from any recognized school of pharmacy. Bulgaria has established a quota system for the gathering of certain MAPs that is reviewed annually; they also ban export, as did the Government of India in 1994 for 50 species believed to be endangered in the wild. Nepal's Forest Act of 1993 provides power to ban collections of forest products. Enactment of such laws and their enforcement may go a long way in conservation of medicinal plants.

Botanical gardens and seed banks offer a more attractive way of storing *ex situ* the genetic diversity of the MAPs. However, medicinal plants are poorly represented in seed banks. A major task for conservationists is to create opportunities for the sharing of knowledge to encourage learning, or else there is a risk that much of folk medicine knowledge will be lost. Efforts should be made to document and integrate indigenous knowledge on MAPs, vegetation and forest management, NWFPs, agroforestry, homegardens, and biodiversity. Huge quantities of MAPs collected from the wild are lost during harvest, storage, and processing. The involvement of all stakeholders, i.e., collectors, traders, manufacturers, and consumers, through sharing of benefits can help a great deal in conservation of this resource so vital for human health and survival. Appropriate management and harvesting methods need to be developed to allow regeneration and maintenance of viable population of medicinal plants in natural habitats including forests. Full participation of local communities in conservation and management of MAPs is desirable. Multinational pharmaceutical industries and drug manufacturers need to invest part of their income in conservation and management of MAPs. There is a need for more work to ensure that the benefits from new drugs or botanicals developed and manufactured using indigenous knowledge are fairly and equitably distributed, as required by the Convention on Biological Diversity. (Table 4)

See also: Medicinal, Food and Aromatic Plants: Edible Products from the Forest; Forest Biodiversity Prospecting; Medicinal and Aromatic Plants: Ethnobotany and Conservation Status; Tribal Medicine and Medicinal Plants. **Non-wood Products:** Resins, Latex and Palm Oil; Rubber Trees; Seasonal Greenery. **Silviculture:** Bamboos and their Role in Ecosystem Rehabilitation; Managing for Tropical Non-timber Forest Products. **Sustainable Forest Management:** Definitions, Good Practices and Certification.

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Medicinal and Aromatic Plants: Ethnobotany and Conservation Status

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Introduction

Ethnobotany is a multidisciplinary science involving the traditional use of plants by human beings. Billions of people in the world rely chiefly on herbal medicines. The great majority of medicinal and aromatic plants (MAPs) used locally or entering into trade and herbal industries comes from wild sources and constitutes the source of livelihoods of millions of people.

Ethnobotanical information and knowledge are believed to have contributed to the development of close to 30% of modern medicines. In recent years, the increasing demand for herbal medicines in industrialized countries is being fueled by a growing consumer interest in natural products. As international trade in medicinal and aromatic plants has grown to a multibillion dollar industry, local

harvesting patterns have shifted from subsistence local collection to commercial ‘mining.’ The continued growth in the global raw-material market of MAPs has largely contributed to this trend.

Assessment of the conservation status of MAPs involves consideration of different threat factors including biological and socioeconomic issues such as destructive harvesting, habitat change, species extinction and loss of livelihoods of locals that have contributed towards disturbing trends in species loss. The conservation and management measures adopted so far have proved to be grossly inadequate. Tangible improvements in the livelihoods of local communities and inculcation of conservation values in the minds of people may be more sustainable measures for long-term conservation of MAP diversity and associated ethnobotanical knowledge systems.

Ethnobotany

Plants have been the basis of life on earth. The identification of plants useful to human beings from natural stands commenced in prehistoric times. Experiments and trials were the two main ways through which humans have learnt the various uses of plants. Only a few of the useful plants have so far been domesticated, while a majority of them are still used from the wild. With the advancement of civilization, the plants found in nature have been put more to use in various ways. The importance of plants as a means to fulfill the basic requirements of human beings can be keenly observed in the rural and remote areas of the world.

Harshberger in 1896 coined the word ‘ethnobotany’ to denote the study of plants used by people living in traditional societies. Later various workers defined ethnobotany variously. Despite considerable variations in definition, almost every worker has accepted the subject of ethnobotany as dealing with the relationship between human societies and plants. Ethnobotany, therefore, has a broad coverage including any traditional use of plants and plant products. The subject is multidisciplinary, involving many interrelated subjects such as history, anthropology, culture, literature, etc.

Ethnobotany being a use-group of plants by human beings, any traditional use belongs to the ethnobotanical discipline. On the basis of variety of uses, ethnobotanical studies may belong to various use-categories (Table 1).

Documentation of ethnobotanical information has mostly been based on archaeological sources, oral folklore, and other mythologies, literature sources, study of reference specimens in herbaria and

Table 1 Common ethnobotanical uses of plants and plant products

Agricultural implements
Beads and rosaries
Beverages
Ceremonial uses
Condiments
Containers
Cultural uses
Detergent
Dye
Edibles
Equipment
Essential oil
Fatty oil
Feed and fodder
Fiber
Fish-poison
Fragrances
Gum
Incense
Insecticide
Insect repellent
Intoxicant
Manure
Medicine
Musical instruments
Religious uses
Resin
Spices
Tan
Tools
Toxicant
Weapons

museums, etc. Field-based study is, however, the most popular.

Medicinal and Aromatic Plants (MAPs)

‘Medicinal plant’ is not a taxonomic but a use-group of plants. Any plant when used in medicine or for medicinal purposes, whether in modern or in organized systems of traditional medicines like Ayurveda, the Unani system, homeopathy, etc., or the widespread indigenous and folk systems, can be categorized as a medicinal plant. ‘Aromatic plants,’ on the other hand, are those plants containing essential oil, mostly having an aromatic flavor, which may be, but is also not only limited to, medicinal plants. Both the two groups are these days collectively termed as medicinal and aromatic plants (MAPs).

Traditional Medicine and Traditional Healers

In the beginning all drugs were natural, such as vegetable, animal, and mineral products in their crude forms. Until the beginning of the twentieth

century all medical practice was what we now call traditional. Traditional medicine is, therefore, used mainly to distinguish the ancient and culture-bound healthcare practices, which existed before the application of science to health matters in official modern scientific medicine or allopathy. Some frequently used synonyms are indigenous, unorthodox, alternative, folk, ethno, fringe, and unofficial medicine and healing.

A large number of individual therapies are currently in practice in different parts of the world, many of them increasingly employed for self-medication accompanied by faith and confidence with considerable extent of effectiveness, with or without the services of the traditional healers (Table 2).

The World Health Organization (WHO) has defined traditional medicine as:

the sum total of all the knowledge and practices, whether explicable or not, used in diagnosis, preven-

tion and elimination of physical, mental or social imbalance and relying exclusively on practical experience and observation handed down from generation to generation, whether verbally or in writing. Traditional medicine might also be considered as a solid amalgamation of dynamic medical know-how and ancestral experience.

In its *Traditional Medicine Strategy (2000–2005)*, WHO has defined traditional medicine as a comprehensive term used to refer both to traditional medical systems such as traditional Chinese medicine, the Indian subcontinent's Ayurveda and Siddha, and Arabic Unani medicine and also to various other forms of indigenous medicine.

Various traditional medical systems, with varying theories and formalities, are currently fulfilling the primary healthcare needs of more than three-quarters of the population of the developing world. Considering the coverage and effectiveness of these systems of traditional medicine throughout the world, the Alma-Ata Declaration of the WHO proposed the theme 'Health for all by the year 2000' in 1978. The commitment was reaffirmed by the International Consultation on Conservation of Medicinal Plants, organized by WHO/IUCN/WWF in Chiang Mai, Thailand, popularly known as the Chiang Mai Declaration (1988). It put emphasis on the primary healthcare approach and the principles of conservation and sustainable development, outlined in the World Conservation Strategy. In view of these facts, the World Health Assembly in May 1976 first discussed seriously the contribution that traditional healers make to the healthcare of communities worldwide.

The African Expert Group has defined traditional healer as:

a person who is recognized by the community in which he (or she) lives as competent to provide health care by using vegetable, animal and mineral substances and certain other methods based on the social, cultural and religious background as well as on knowledge, attitude and beliefs that are prevalent in the community regarding physical, mental and social well-being and the causation of disease and disability.

In almost every part of the world traditional healers are practicing means of healthcare coverage that is culturally acceptable to the local population, dealing more or less satisfactorily with many of their health problems. Conducting religious ceremonies, preaching of supernatural powers and evil spirits, psychotherapy, cauterization, prevention, surgery, use of animal and mineral products, etc., are the important basis of most folk therapies. Herbal medicine is, however, the most popular.

Table 2 Some of the well-known individual therapies

Acupressure
Acupuncture
Allopathy
Anthroposophical medicine
Apitherapy
Aroma therapy
Astrological diagnosis
Autogenic training
Ayurveda
Breathing
Clay and mud therapy
Color therapy
Dance therapy
Faith healing
Fasting
Flower remedies
Herbalism
High-fiber diet
High-protein diet
Homeopathy
Hot-spring bath
Hydrotherapy
Hypnosis
Magic
Medication
Monodiets
Moxibustion
Music therapy
Naturopathy
Osteopathy
Raw food therapy
Siddha system
Sun baths
Ultra-violet radiation
Unani system
Urine therapy
Vegetarianism
Witchcraft
Yoga

Ethnobotany of Medicinal and Aromatic Plants

Health issues have always been of prime importance for humankind since the very beginning of civilization. The use of plant resources for medicinal purposes is one of a number of practices developed by ancient people. The early use of plants as medicine must have been learnt and developed by humans through constant trial and error, probably at the cost of many lives and sufferings. People adopted various herbs that exhibited curative properties. Due to lack of communication, and varying ways of life, many of these earlier remedies survived only by word of mouth from generation to generation. These remedies not only exist but also are being largely practiced in most parts of the world, particularly in rural and tribal societies. The absence of acculturation has, in many instances, helped in the preservation of this knowledge in almost original form. In most developing countries, the indigenous modes of herbal treatment are a part of the culture and the dominant method of therapy. These remedies, with a considerable measure of effectiveness, are socially accepted and economically viable, and are often the only available source to the rural poor.

Ethnobotanical studies have mostly been employed to study the medicinal uses of plants in general, involving a range of disease and ailments. Medicinal plants used to treat a particular category of health problem have become increasingly popular, e.g., to treat skin diseases, to heal wounds, to kill intestinal worms, to treat digestive and other abdominal complaints including diarrhea and dysentery, to treat amoebic and respiratory diseases, to treat malaria and other types of fever, to treat venereal diseases, to induce antifertility effects, to terminate pregnancy, to regulate fertility, to treat reproductive disorders, to treat cancer, etc. Consequently, ethnomedicobotanical studies have recently been focused on some more specialized health disciplines, e.g., papers have been published under the discipline of ethnonarcotics, ethnopediatrics, ethno-obstetrics, ethnogynecology, ethno-veterinary medicine, etc.

Conservation Status of Medicinal and Aromatic Plants

Estimation and monitoring of the conservation status of medicinal and aromatic plants, in general, is an important but challenging issue that can be realized only after identifying the various threat factors and their extents including use and trade as well as by evaluating the conservation measures and management practices adopted so far.

Medicinal and Aromatic Plants in Folk Medicine

The great majority of species of medicinal plants which are the dominant mode of therapy in almost all developing countries and that are used in folk or ethnomedicine, are collected from the wild. The WHO has listed 20 000 medicinal plants used in different parts of the globe. Other estimates indicate the number to range between 35 000 and 70 000 worldwide.

An estimated 70–80% of people worldwide rely chiefly on herbal medicine to meet their primary healthcare needs. In south Asia only, over 800 million people rely on herbal medicine. In China, 40% of urban patients and more than 90% of rural patients depend on plant-based medicine. Some 10 000–11 250 species are used in ethnomedicine in China, 6000–7500 in India, 2237 in Mexico, 2572 traditionally by North American Indians, and 1600 species in Nepal. Considering the extent of fieldwork ongoing in different parts of the developing countries among various tribes, ethnic groups, and other indigenous communities generating additional information on indigenous medicinal plants, the number of plants known to be used in human medicine is likely to increase considerably in the future.

Medicinal and Aromatic Plants in Organized Systems of Traditional Medicine

Many countries, especially in Asia and Africa, have officially recognized the use of plant-based traditional medicine in their healthcare delivery systems. These organized traditional medical systems employ relatively few species, viz. 500–600 in traditional Chinese medicine, 1106 in Tibetan medicine, 1250–1400 in the Ayurveda, 342 in the Unani, and 328 in the Siddha systems.

The value of traditional medicines in China is estimated at US\$571 million per year. In 1995, according to the State Administration of Traditional Chinese Medicine, the countrywide sale of crude plant drugs was at US\$2.3 billion. China's demand for medicinal plant material has grown at an annual rate of 9% over the last two decades. In India, there are 7843 registered pharmacies of ISM and 851 of homeopathy and a large number of non-registered small-scale production units. About 240 000 tonnes of crude herbs, representing about 10% of the quantity collected from the wild, are processed per annum by the Indian herbal pharmacies. The herbal product market in Germany in 1989 was estimated at US\$1.7 billion. In the urban

areas of contemporary Africa, there is a burgeoning demand for herbal-based traditional medicines. The same tradition is active in many South and South-east Asian countries such as Bhutan, India, Myanmar, Nepal, Thailand, and Vietnam.

Herbal medicine is becoming even more popular in richer countries, a market sector that has grown at 10–20% annually in Europe and North America over recent years. In industrialized countries, the demand is being fueled by an outburst of consumer interest in natural products. The extent of interest on the part of the general public is demonstrated by the fact that in 1990 the trade in herbal remedies in the European Union has been valued at over US\$1000 million and rising at 13% year⁻¹. Similar growth rates have been recorded and are expected to continue in rich countries like Canada, the United States, Germany, Japan, and others. In Japan, pharmaceutical expenditures for Kampo medicines (adopted from Chinese traditional medicine) in 1983 was US\$150 million.

Medicinal and Aromatic Plants in Modern Medicine

A large number of drugs of the modern system or allopathy were discovered from plants based on their ethnobotanical uses (Table 3). Further, many other pure constituents obtained from plant sources are used as drugs in modern medicine (Table 4). Today, there are approximately 119 pure chemical substances extracted from higher plants and in use in modern medicine throughout the world. Out of these, more than 90 chemicals have been isolated from plants having ethnic uses; others are either from random screening or screening certain plant families that are known to be rich sources of biologically active compounds.

Approximately 25% of all prescriptions dispensed from community pharmacies in the USA between 1959 and 1973 contained one or more ingredients derived from higher plants. It has been estimated that the total economic value to the USA from plant-derived pharmaceuticals is the total sale of US\$12 400 million year⁻¹. Financially, the retail sale of plant-based pharmaceutical products was estimated at US\$80–90 billion globally in 1997, with medicinal plants contributing very significantly.

Medicinal and Aromatic Plants in Trade

In many parts of the world there is virtually no cultivation on any significant scale, including for example in Albania and Turkey in Europe, Pakistan, Bhutan, and Nepal in Asia, and most countries in Africa. Large quantities of MAPs are traded into

urban centers from rural areas in developing countries, and also regionally and internationally. The global demand for medicinal plants and herbal medicine is very large, estimated at US\$40–60 billion year⁻¹, and still growing.

China's output of medicinal plants from cultivated and wild harvested sources, considered together, was 1.6 million tonnes in 1996, with a total value (excluding exports) in terms of finished products of US\$3.7 billion. The reported annual global imports of MAP material during the 1990s amounted to an average of 400 000 tonnes, valued at US\$1.2 billion, showing a 100% rise from 1991 to 1997. The three leading exporting countries are China (140 000 tonnes year⁻¹ over 1991–1997), India (50 000 tonnes year⁻¹), and Germany. Hong Kong is considered the largest herbal market in the world, importing in excess of US\$190 million per year. Europe, especially Germany, is the major trading center for MAPs globally, with imports into one European country or another amounting to 440 000 tonnes in 1996. The WHO had estimated the world trade of medicinal plants at US\$500 million in 1980.

India exports large quantities of Ayurvedic and Unani herbs and preparations over a very wide geographical area including Bangladesh, Japan, Nepal, Pakistan, Saudi Arabia, the UAE, Russia, and USA, and accounts for 12% of global herbal pharmaceutical trade. The annual herbal medicine sales in Eastern Europe, Asia, Japan, and North America are US\$6000, US\$2300, US\$2100, and US\$1500 millions respectively with a total derived from higher plants amounting to US\$11 billion. In 1999, the world market for herbal remedies was calculated to be worth US\$19.4 billion, with Europe in the lead (US\$6.7 billion), followed by Asia (US\$5.1 billion), North America (US\$4.0 billion), Japan (US\$2.2 billion), and finally the rest of the world (US\$1.4 billion).

Habitat Degradation and Loss due to Commercialization

The great majority of the medicinal and aromatic plants used locally or entering into trade and used in herbal industries comes from wild harvesting. In China, the annual demand of plant materials for traditional as well as officially decreed medicines has been reported to exceed 1.6 million tonnes, more than 80% of which come from wild sources. More than 95% of the medicinal and aromatic plants of Nepal out of 10 000–15 000 tonnes that enter into trade annually are harvested from wild sources. In India, 90% of the medicinal and aromatic plants that enter into trade and industry are harvested from wild

Table 3 Important drugs discovered from ethnobotanical leads

<i>Drug</i>	<i>Medicinal use</i>	<i>Plant species</i>	<i>Family</i>
Ajmalin	Heart arrhythmia	<i>Rauwolfia canescens</i>	Apocynaceae
		<i>Rauwolfia serpentina</i>	Apocynaceae
Aspirin	Analgesic, anti-inflammation	<i>Filipendula ulmaria</i>	Rosaceae
Atropin	Ophthalmology	<i>Atropa belladonna</i>	Solanaceae
Benzoine	Oral disinfectant	<i>Styrax tonkinensis</i>	Styracaceae
Caffeine	Stimulant	<i>Camellia sinensis</i>	Theaceae
Camphor	Rheumatic pain	<i>Cinnamomum camphora</i>	Lauraceae
Cascara	Purgative	<i>Rhamnus purshiana</i>	Rhamnaceae
Cocaine	Ophthalmologic anaesthetic	<i>Erythroxylum coca</i>	Erythroxylaceae
Codeine	Analgesic, antitussive	<i>Papaver somniferum</i>	Papaveraceae
Colchicine	Gout	<i>Colchicum autumnale</i>	Liliaceae
Demecolcine	Leukemia, lymphomata	<i>Colchicum autumnale</i>	Liliaceae
Deserpidine	Hypertension	<i>Rauwolfia canescens</i>	Apocynaceae
		<i>Rauwolfia serpentina</i>	Apocynaceae
Dicoumarol	Thrombosis	<i>Melilotus officinale</i>	Fabaceae
Digitoxin	Atrial fibrillation	<i>Digitalis purpurea</i>	Scrophulariaceae
Digoxin	Atrial fibrillation	<i>Digitalis purpurea</i>	Scrophulariaceae
Emetine	Amoebic dysentery	<i>Cephaelis ipecachuanha</i>	Rubiaceae
Ephedrine	Bronchodilator	<i>Ephedra sinica</i>	Ephedraceae
Eugenol	Toothache	<i>Syzygium aromaticum</i>	Myrtaceae
Gallotanins	Hemorrhoid suppository	<i>Hamamelis virginiana</i>	Hamamelidaceae
Hyoscyamine	Anticholinergic	<i>Hyoscyamus niger</i>	Solanaceae
Ipecac	Emetic	<i>Cephaelis ipecacuanha</i>	Rubiaceae
Ipratropium	Bronchodilator	<i>Hyoscyamus niger</i>	Solanaceae
Morphine	Analgesic	<i>Papaver somniferum</i>	Papaveraceae
Noscapine	Antitussive	<i>Papaver somniferum</i>	Papaveraceae
Papain	Attenuates mucus	<i>Carica papaya</i>	Caricaceae
Papaverine	Antispasmodic	<i>Papaver somniferum</i>	Papaveraceae
Phyostigmine	Glaucoma	<i>Physostigma venenosum</i>	Fabaceae
Picrotoxin	Barbiturate antidote	<i>Anamirta cocculus</i>	Menispermaceae
Pilocarpine	Glaucoma	<i>Pilocarpus jaborandi</i>	Rutaceae
Podophyllotoxin	Vermifuge, Cancer	<i>Podophyllum hexandrum</i>	Berberidaceae
		<i>Podophyllum peltatum</i>	Berberidaceae
Proscillaridin	Cardiac malfunction	<i>Drimys maritima</i>	Liliaceae
Protoveratrine	Hypertension	<i>Veratrum album</i>	Liliaceae
Pseudoephedrine	Rhinitis	<i>Ephedra sinica</i>	Ephedraceae
Psoralen	Vitiligo	<i>Psoralea corylifolia</i>	Fabaceae
Quinidine	Cardiac arrhythmia	<i>Cinchona pubescens</i>	Rubiaceae
Quinine	Malaria prophylaxis	<i>Cinchona pubescens</i>	Rubiaceae
Rescinnamine	Hypertension	<i>Rauwolfia canescens</i>	Apocynaceae
		<i>Rauwolfia serpentina</i>	Apocynaceae
Reserpine	Hypertension	<i>Rauwolfia canescens</i>	Apocynaceae
		<i>Rauwolfia serpentina</i>	Apocynaceae
Sennoside-A	Laxative	<i>Cassia angustifolia</i>	Caesalpiniaceae
Sennoside-B	Laxative	<i>Cassia angustifolia</i>	Caesalpiniaceae
Scopolamine	Motion sickness	<i>Datura stramonium</i>	Solanaceae
Stigmasterol	Steroidal precursor	<i>Physostigma venenosum</i>	Fabaceae
Strophanthin	Congestive heart failure	<i>Strophanthus gratus</i>	Apocynaceae
Teniposide	Bladder neoplasms	<i>Podophyllum hexandrum</i>	Berberidaceae
		<i>Podophyllum peltatum</i>	Berberidaceae
THC	Antiemetic	<i>Cannabis sativa</i>	Cannabinaceae
Theophylline	Diuretic, asthma	<i>Camellia sinensis</i>	Theaceae
Toxiferine	Surgery, relaxant	<i>Strychnos guianensis</i>	Loganiaceae
Tubocurarine	Muscle relaxant	<i>Chondrodendron tomentosum</i>	Menispermaceae
Vinblastine	Hodgkin's disease	<i>Catharanthus roseus</i>	Apocynaceae
Vincristine	Pediatric leukemia	<i>Catharanthus roseus</i>	Apocynaceae
Xanthotoxin	Vitiligo	<i>Ammi majus</i>	Apiaceae

sources. An estimated 99% of the 400–550 species currently sold for use in traditional medicine in South Africa originate from wild sources. Only 130–140 of

the 1200–1300 species that are both traded in, and native to, Europe are derived predominantly from cultivation. An estimated 70–90% of the medicinal

Table 4 Some pure constituents from plant sources as useful drugs

<i>Drug</i>	<i>Medicinal use</i>	<i>Plant species</i>	<i>Family</i>
Ajmalicin	Antihypertensive, tranquilizer	<i>Rauwolfia canescens</i>	Apocynaceae
		<i>Catharanthus roseus</i>	Apocynaceae
Ajmaline	Antihypertensive, tranquilizer	<i>Rauwolfia serpentina</i>	Apocynaceae
Artemisinine	Antimalarial	<i>Artemisia annua</i>	Asteraceae
Digoxin	Cardiotonic	<i>Digitalis lanata</i>	Scrophulariaceae
Diosgenin	Induces sterilization	<i>Dioscorea deltoidea</i>	Dioscoreaceae
Emetine	Antiamoebic	<i>Psychotria ipecacuanha</i>	Rubiaceae
Gossypol	Male contraceptive	<i>Gossypium herbaceum</i>	Malvaceae
Hyoscyamine	Anticholinergic	<i>Atropa belladonna</i>	Solanaceae
		<i>Datura stramonium</i>	Solanaceae
		<i>Hyoscyamus muticus</i>	Solanaceae
Ipecac	Induces vomiting	<i>Cephaelis ipecacuanha</i>	Rubiaceae
Khellin	Vasodilator	<i>Ammi visnaga</i>	Apiaceae
L-DOPA	Antiparkinsonian	<i>Mucuna pruriens</i>	Papilionaceae
Marsilin	Sedative, anticonvulsant	<i>Marsilea minuta</i>	Marsileaceae
Pseudo-ephedrine	Central nervous system stimulant	<i>Ephedra sinica</i>	Ephedraceae
Rutine	Decreases capillary fragility	<i>Ruta graveolens</i>	Rutaceae
Taxol	Overian cancer, breast cancer	<i>Taxus brevifolia</i>	Taxaceae
		<i>Taxus wallichiana</i>	Taxaceae
Theobromine	Diuretic, myocardial stimulant, vasodilator	<i>Camellia sinensis</i>	Theaceae
Theophylline	Cardiac stimulant, vasodilator, smooth muscle relaxant	<i>Camellia sinensis</i>	Theaceae

plant material imported into Germany, the third largest importer, is wild-harvested and only 50–100 species among these are currently propagated on a large scale. The commercial sector of medicinal and aromatic plant is, therefore, facing serious problems due to the excessive dependency of users on resources sourced from the wild.

In addition to factors lying beyond human control, viz. landslides, flood, fire, etc., the most serious proximate threats to plant resources in general and medicinal and aromatic plants in particular are habitat loss, habitat degradation, and overharvesting. Forests are home to more than half the world's terrestrial species, but population pressure and the proportionately increasing demand for forest products are causing a rapid depletion of habitats in almost every part of the world. As the result, more than 50% of the world's original forest cover has already been wiped out and each year alarmingly big areas are cut, bulldozed, or burned. Poor people in the developing countries such as Bangladesh, Bhutan, India, Laos, Mexico, Myanmar, Nepal, the Philippines, and Vietnam, among many others, are pushed to destroy forests in desperate efforts to raise living standards. As a result, countless plant species including medicinal plants are facing considerable danger of extinction due to loss of habitat or its degradation.

Extensive destruction of medicinal plant-rich habitats such as tropical forests, wetlands, Mediterranean ecosystems, parts of the arid zone, etc., are enhancing the rate of extinction of biodiversity including medicinal and aromatic plants. Ninety-

three percent of the original primary forest in Madagascar has been eliminated. It has been estimated that 12 000 plant species and probably around 190 000 animal species have been lost in Madagascar. All the forests of Western Ecuador have been destroyed to make way for banana plantations, oil wells, and human settlements, destroying almost 200 000 species of plants and animals.

Worldwide, the verdant tropical forests that existed in 1985 covered only 900 million ha out of 1.5–1.6 billion ha that once existed. Between 7.6 million and 10 million ha are eliminated each year and at least a further 10 million ha are grossly disrupted annually. Like other natural resources the forests of the world are being sacrificed on the altar of development. By giving the definition that affluence is development, the rich countries have set an unsustainable path to achieve human prosperity. Human activities, under the so-called development initiatives, have posed considerable threats to habitats and ecosystems, thus threatening biological diversity, in general. Major human impacts includes a significant lowering of the upper timberline, conversion of forest to arable land, commercial timber cutting, excessive use of timber for domestic purposes, construction of roads, dams, and canals, high-tension electricity cables, etc. One glaring example is the Amazon forests, when Brazil decided to construct a highway in 1970, and deforested an area almost equal to that of India.

It has been estimated that the average background rate of extinction has been roughly 2–3% year⁻¹.

Current species extinction rates are estimated at approximately 10 000–20 000 year⁻¹ or between 1000 and 10 000 times faster than the natural rate or maybe 1 million times faster than the rates of speciation. This increased rate of plant extinction means loss of immense biodiversity much before these species are properly understood.

Conservation and Management of Ethnobotanical Resources

In some communities, women play a significant role in medicinal plant conservation and cultivation, e.g., the women herbalist in Kabale, Uganda grows most of her herbs in her home compound. The same trends have recently evolved in certain localities of Bangladesh and India. Valuing the forest as a source of medicine, in Manongarivo, a tropical rainforest area in northern Madagascar, the local community has preserved an area of forest as a 'green pharmacy' that, otherwise, would have been slashed and burned for subsistence agriculture. In the same line, sacred groves, which are patches or pockets of climax vegetation preserved on religious grounds by the local communities, are still found scattered in different parts of India, Nepal, and Sri Lanka.

Many countries have little or no regulations controlling the collection of plant material from the wild. In India, however, 29 species of medicinal plants, thought to be threatened in the wild, have been restricted from collection. Nepal has, likewise, imposed different levels of restriction on the harvesting and trade of 16 medicinal and aromatic plant species including 10 species of trees. These restrictions are mainly aimed at protecting the wild flora and encouraging their cultivation practices.

Medicinal and aromatic plants are important components of the local flora, and valuable parts of the ecosystem. However, these ecosystems and communities are being degraded and destroyed and species are being driven to extinction, thus threatening the resource base of MAPs as well. Due to various human activities loss of biodiversity is occurring at all levels. Considering the importance of biological diversity, of which medicinal and aromatic plant resources are an important component, conservationists lay emphasis on the conservation of the entire habitat and the ecosystem to safeguard the biological resources and their inevitable interactions. With the aim of protecting representative samples of natural ecosystems, a number of protected areas of different status have been established in almost every country that cover a significant proportion of the earth's surface.

In India, 87 National Parks and 441 Wildlife Sanctuaries, respectively, cover 34 819 km² and 115 903 km² of the forestland. This accounts for 4.5% of the land of the country and 14% of the land under forest. In Nepal, 16.71% of the country's land has been brought under different levels of conservation and protection. In Bangladesh, 0.8% of the land of the country has been declared protected area. Bhutan has set aside 10 513 km² of its forestland under different types of protected/conservation areas including 535 km² as the 'buffer zone.'

The establishment of extractive reserves in Brazil is an important first step in resolving some of the problems like the development of viable extractive economies that is being hindered by destructive harvesting. In South India, a number of Medicinal Plant Conservation Areas (MPCAs) have been established that included the historically/traditionally known areas for rich medicinal plant diversity.

In Nepal, the management of the national forest is being systematically handed over to identified communities of users characterized by a comparatively high level of participation by women. As a group, they share the rights and responsibilities of using and managing the forest. So far, about 20% of the national forest including about 12 000 patches of forests have been handed over to the communities to manage. In most cases the communities have shown their efficiencies in terms of conservation, management, and development of the forest and the program in Nepal has so far been very successful. Many of them have started the commercial harvesting of MAP resources in a sustainable manner although in many cases they had to deal with severely degraded forest patches.

Discussion

Billions of people on earth depend chiefly on herbal medicines that have been significantly contributing to their primary healthcare needs. The curative properties of folk herbal medicines have always been a miracle and almost every folk remedy poses more questions than it answers. However, many of these questions are better answered today than in the past. Because so many people use medicinal plants, or plants as medicine, mostly collected from the wild, in the folk healing systems, it may be considered a serious threat to their conservation. But the problem, as usually repeated, is not always so severe, although it is critical indeed. So far as collection for medicinal purposes is concerned, there is general agreement that collection for household use is not overwhelmingly the problem. So many thousands of species are used in folk medicines, and just because a species

has been used somewhere medicinally, it does not follow that it is so used everywhere and at all times. Its designation as a medicinal plant may carry little or no meaning to people living in the neighborhood. In several African, Asian, and some other countries wild harvesting for local requirements has not been experienced as detrimental to plant survival as the quantity collected tended to be small and also most of the material collected came from rather weedy species and common varieties. Ethnic medicinal plants can have other uses than as sources of medicines, and the threats from overharvesting may be due, or partly due, to collection purposes other than medicinal. There may be good reasons, for the purpose of genetic conservation, to conserve particular populations of medicinal plants, as many times a locally endemic or highly fragmented population of plants may have local uses.

The number of species used in herbal trade and industries is relatively small but this group of plants is most threatened in the wild. Despite efforts now under way, there remain many challenges in the conservation and sustainable management of wild medicinal plant resources, and it has now become inevitable to evaluate the threat status and conservation needs of the local and regional floras, more particularly the medicinal and aromatic plant resources. As it is unfair to tar every taxon with the same brush, the first and possibly the most desired step is to identify the potentially threatened species, assess them in terms of threat factors and conservation status, and carry out the recommended measures.

The IUCN-Species Survival Commission's Conservation Assessment and Management Planning (CAMP) exercise has recently been recognized as a suitable mechanism for using available information to assess possibly threatened taxa and to initiate adequate conservation and management planning. The five threat categories, involving evaluation of threat factors and conservation status are Critically Endangered (CE), Endangered (EN), Vulnerable (VU), Near Threatened (NT), and Least Concern (LC), based mainly on information on their distribution, regeneration potentials, productivity, use, interacting threats, etc. CAMP exercises have been successfully used to identify threat factors and to assess conservation status of some species of MAPs in different regions.

The collection of medicinal plants from wild habitats has long been a mode of self-employment for most rural people. Although the wild resource-based herbal trade and industries have remained functional for a long period of time, it cannot always serve as a model for the future. As international trade

in medicinal and aromatic plants has grown to a multi-billion dollar industry, local harvesting patterns have shifted from subsistence local collection to commercial 'mining' without regard to the generation of species for future yields, in most cases. The growth in the alternative medicine market in industrialized nations is a significant contributor to this trend.

Because processing and marketing are mostly exogenous to the supply area, control of the system of gathering and trade also tends to be found mostly in the hands of people external to the region. When an outside interest dictates the volume and price of a resource, local biodiversity suffers irreversible harm. The marginalized and poor people generally take the view that 'If I don't pick what I can today, someone else will get it tomorrow.' Consequently, the local people are generally losing control over the conservation and management of their resources.

The threats caused due to overharvesting usually recover with time but the damage due to loss of habitat is irreversible. The loss or degradation of forests and grasslands worldwide has led to the habitats of medicinal plants shrinking in almost every country. This has affected not only the few hundred commercial medicinal plants but also many thousands having no commercial uses but still serving the medicinal purposes of billions of rural people who mostly have no other alternative facilities.

The conservation and management initiatives focused on medicinal and aromatic plants in various countries and among various communities, although laudable, appear highly inadequate to cope with the negative efforts in practice so far. The protected areas network worldwide represents various physiographic and climatic zones, admirably contributing to the conservation of biological diversity, and it is wise to continue to stress the future significance of these efforts. While the protected areas have assured protection of certain species, such protected areas, however, are usually surrounded by damaged habitats, making them habitat islands. Habitats outside protected areas are under continuous pressure from human activities which, mostly, have increased beyond the carrying capacities of the ecosystems. Many of them are degraded and converted into agricultural lands.

In most of the supplier countries, although there is considerable evidence of overharvesting of medicinal plants, quantitative analyses of the effect of extraction on natural populations are lacking. Without these analyses, it is not possible to assess the effect of harvesting on depletion of resources, nor is it possible to formulate appropriate conservation and management strategies.

Conservation of natural resources are necessary for future generations, and this need has been so often repeated that the phrase has almost lost its importance. There is no comfort in thinking that species extinction is a natural process and therefore inevitable for the organisms that are extinct or on the way to extinction. While natural processes are involved, the activity of human beings accelerates and multiplies the means by which extinction can occur. Once a particular species is extinct, literally millions of years of evolution become undone and nothing can retrieve the situation. In the plant kingdom, the time for warning has matured. The destruction of many wild habitats and their inhabitants has already taken place and continues.

In the developing countries that are the major suppliers of wild medicinal plant materials, the overwhelming concern of the majority of the population is meeting their immediate needs. It is, therefore, difficult to conserve and direct resources for the benefit of future generations. The over-exploitation of wild medicinal plant resources by rural people is therefore not just a case of preference but also of a situation where there is no other option.

At the community level, local people are the true resource managers, with a vested interest in maintaining the natural resources on which they heavily depend. But poverty, and to some extent ignorance, has forced rural people to continue activities that help them survive in the present but which will cause more severe problems in the future. The conclusion is, therefore, a challenge. Our approach to conserving wild medicinal plants for sustainable exploitation should be targeted at different levels, from improving living standards to changing the attitude of the people.

See also: Medicinal, Food and Aromatic Plants: Edible Products from the Forest; Forest Biodiversity Prospecting; Medicinal Plants and Human Health; Tribal Medicine and Medicinal Plants. **Non-wood Products:** Resins, Latex and Palm Oil; Rubber Trees; Seasonal Greenery; Seasonal Greenery. **Silviculture:** Bamboos and their Role in Ecosystem Rehabilitation; Managing for Tropical Non-timber Forest Products. **Sustainable Forest Management:** Definitions, Good Practices and Certification.

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Tribal Medicine and Medicinal Plants

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Introduction

Nearly 80% of the world population is dependent on indigenous medicines for primary healthcare. Tribal medicine is an age-old system of health care practiced by aboriginals in remote villages and forests. Tribal remedies consisting of simple methods of treatment developed by trial and error hold an