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## MEDICINAL, FOOD AND AROMATIC PLANTS

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### Medicinal Plants and Human Health

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#### Introduction

Humanity's dependence on forests is probably as old as humanity itself. For most periods of 200 000 years of human existence on earth humans have been deriving all their material needs from the forest. During prehistoric days, virtually all human needs were met from non-wood forest products (NWFPs) except construction and energy. It was during industrial and postindustrial periods that we started looking at the forests as a source of timber, and NWFPs became minor and less important even though the variety and value of NWFPs have always been far greater than the woody forest products. Edible products and healing herbs have been the most important NWFPs since antiquity. Forests represent vast natural pharmacies by virtue of having an enormous stock of biological materials of which the indigenous populations had knowledge of the medical uses. Medicinal plants of forest origin constitute a vast undocumented and overexploited healthcare resource for a majority of the world's population. In the last few decades, due to the pressure of increasing population, the area under forests has been shrinking. Demand for medicinal and aromatic plants (MAPs) has been increasing due to the increased number of users and due also to a resurgence in interest in herbal medicines and cosmetics. The variety, tonnage, and

value of medicinal herbs extracted from forests are enormous. For example, more than 10 000 plants are used as medicines by the people of India, 70% of which come from the forests. Almost all medicinal plants collected, either legally or illegally all over Himalayas or even other parts of Asia for various purposes, are collected from the wild and only a very small number of species is cultivated. The medicinal plant resource in forests and in the wild are depleting rapidly so that a number of medicinal plants are threatened with extinction. The extinction of medicinal plants presents a hidden health risk to both developing countries and industrialized societies.

According to an estimate of the World Health Organization (WHO), medicinal plants form the basis of traditional or indigenous healthcare systems used by the majority of the population of most developing countries. The increasing demand for medicinal plants in healthcare is putting pressure on wild sources of plants. The herbalists have to walk increasingly greater distances for herbs that once grew almost outside their courtyards. Disappearance or drop in availability of herbs is forcing more and more rural populations to switch to modern medicines which have not yet reached many rural areas in developing countries. For example, only 3–30% of rural India is covered by modern medical facilities, which is also true for most developing countries. Thus there exists a strong positive relation between availability of medicinal plants and human health. There cannot be two opinions that any reduction in the supply of medicinal plants will adversely affect the health and well-being of people across the world. In recent years however, there has been a phenomenal growth of interest in the conservation of medicinal plants; this has occurred partly due to

the increasing demand for herbal medicines in North America and partly due to recognition of the value of biodiversity by governments, nongovernmental organizations (NGOs), and donor agencies particularly after the Rio Summit in 1992.

With tremendous advances in the area of modern synthetic drugs after World War II, the use of herbal medicines declined considerably and lost attention gradually. However, it is now realized that indiscriminate use of antibiotics and synthetic drugs may lead to health hazards owing to the toxicity associated with these drugs. Therefore, during recent times a new trend has emerged in the use of herbal preparations because it is believed that remedies of natural origin are relatively harmless to the systems of the body. Presently, a large number of herbal preparations are being produced in the pharmaceutical industries of developed countries. In America, Europe, and Japan the traditional herbal drugs of the Ayurveda, Unani, and Chinese systems are extensively used. More and more attention is being focused on the development of drugs from natural products, and many manufacturers of Western medicines are forging ties with traditional communities and herbalists for indigenous knowledge and exploring the world of biomedicines for development of new drugs particularly for emerging diseases like AIDS.

People have relied on plants for staying healthy and treating illness for millennia. In the New World tropics, for example, archaeological remains of plants used as medicine have been dated to 8000 BC. Extensive written lists of herbal medicines have survived since antiquity, including the *Pen Ts'ao*, written by herbalist Shen Nung in 2800 BC which lists 366 plant-derived drugs including the familiar *Ephedra*. The history of Western medicine begins with the Greek physician Dioscorides, who wrote *De Materia Medica* in AD 78, describing over 600 medicinal plants, including *Aloe* and *Opium*. The Swiss pharmacist-physician Theophrastus Bombastus von Hohenheim advocated the use of chemical remedies and originated the field of medicinal chemistry in the early sixteenth century; however, Dioscorides' writings remained the standard text until the early nineteenth century. In 1803 the German pharmacist Friedrich Wilhelm Adam Sertürner first isolated alkaloids from plants, a class of chemicals with many potent physiologically active compounds (including quinine, atropine, cocaine, and tubocurarine). In nations with rich botanically based medical traditions, such as India and China, plant medicines predominate. The earliest mention of the medicinal use of plants has been found in the *Rig Veda*, which were written between 4000 and

1600 BC. In the *Atharva Veda*, definite properties of plant-based drugs and their uses have been given in detail. *Charaka Samhita* is another earliest treatise on *Ayurveda* (600 BC) which lists a total of 341 plants and plant products for use in health management. *Susruta Samhita* also dealt with plants related to medicines. Subsequent authors of later treatises on ancient Indian systems of medicine have extended the list of plants to 600 species.

Traditional healers in India use more than 10 000 different plant species, out of which approximately 7500 are used in folk and tribal system, 1800 in Ayurveda, 500 in Siddha, 400 in Unani, and 300 in Amchi. In China where medicinal plant use goes back at least 4 millennia, over 5000 medicinal plants have been recorded, and about 1000 are used in current practice. In Western medicine, respect for the power of plants has largely been lost during the postindustrialization period but it is catching up very fast and today Europe and North America are emerging as the largest consumers of the medicinal herbs of South Asia.

In the remainder of this article, the use of medicinal plants in various health care systems will be described. Modern medicine, trade, threats, and conservation needs of medicinal plants are briefly discussed with the aim of elucidating the interactions among various factors affecting medicinal plants and human health.

## Traditional Systems of Medicine

Over 80% of the world's population relies on traditional plant-based medicines for their primary healthcare needs. According to WHO traditional system of medicine refers to:

the sum total of the knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable, or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness.

In many developing countries, traditional and herbal medicines are very much indispensable. Traditional systems of medicine (TSM) may be classified into three broad categories:

1. Traditional medicine, which has written traditions of documentation of knowledge, pharmacopoeias for doctors, often known as *Vaidyas*, *Hakeems*, and *Amchis*, and institutions for their training. This system of medicine is especially concentrated in Asia. Some of the more widely familiar traditional medicine systems are Ayurveda,

- Siddha, Unani, Chinese traditional medicine, Tibetan medicine, and Western herbal medicine.
2. Folk medicine. This is orally transmitted and associated with households, communities, or ethnic groups and is most prevalent among tribal and indigenous communities. The number of plants used in folk medicine is enormous, most of which still remains undocumented.
  3. Shamanistic medicine. This system has a strong spiritual element and can only be applied by specialist practitioners (shamans/doctor-priests).

### Ayurveda

The Ayurvedic system originated in India long back in pre-Vedic period which is believed to be 5000 years BC and is the earliest documented ancient Indian knowledge. Ayurveda recognized the medicinal value of plants and provided specific methods of treatments of several human ailments using plants. To cite one example, for at least 2500 years before the West recognized the medicinal properties of the *Rauwolfia* root, the Indian medicine men had been using it to calm violently disturbed patients. They called it snakeroot and used it to treat lunacy, and a whole range of afflictions, from snakebite to cholera. More than 1800 medicinal plants are used in Ayurveda. The important medicinal plants used in Ayurveda and their applications are given in Table 1.

### Siddha

The Siddha system is one of the oldest systems of medicine in India. The term 'Siddha' means achievement, and the Siddhars were saintly figures who achieved results in medicine through the practice of yoga. Eighteen Siddhars seem to have contributed towards the development of this medical system. The Siddha system is practiced in Tamil-speaking parts of India, and its literature is in Tamil. The system is also called Agasthyar system in the name of its famous exponent sage Agasthya. This system of medicine developed within the Dravidian culture, which is also of the pre-Vedic period. The Siddha system is largely therapeutic in nature. According to this system the human body is the replica of the universe and so are the food and drugs irrespective of their origin. The Siddhars investigated and studied the causes of many diseases and the effect of many locally available plants and minerals on these diseases. About 500 medicinal plants are used in Siddha.

### Unani

This is an age-old system that originated in Greece, from where it later spread to India through Arab and Persian traders. Hence it is also known as the

Greco-Arab system of medicine. Indian physicians enriched this system with their local knowledge of indigenous herbs, their own observations, and their experiments to make it one of the nationally accepted systems of treatment. The drugs used are mostly of plant origin. The history of herbalism in Unani medicine goes back to the history of pharmacology. About 400–700 medicinal plants are used in Unani.

### Chinese Medicine

The medicinal and pharmaceutical traditions of China have evolved over the centuries as essential parts of its civilization and are widely recognized today as representing its rich cultural and scientific heritage. As this medical knowledge and expertise were built on a land endowed with an abundance of varied flora, it is not surprising that medicinal plants play a central role in Chinese medicine and the country's achievement in the utilization of its native plants in healthcare delivery has been admired and acknowledged throughout the world. The total number of species of medicinal plants used in different parts of China adds up to over 10 000. The official Pharmacopeia of the People's Republic of China lists 709 different drugs. Among these only 40 items are animal and mineral products, the others all being derived from plant material. Plant material accounts for more than 80% of the drugs sold in the Chinese market. About 1000 species of plants are now commonly used in Chinese medicine and about half of these are considered as the main medicinal plants that are in particularly common use. Most plant materials used in Chinese medicines originate from wild sources.

Recent researches in this system of medicine have proved that a synergy between Chinese and western system of medicine can help in formulation of drugs for treatment of some presently almost incurable diseases like AIDS, cancer, and hepatitis.

### Western Herbal Medicine

Western herbal medicine has traditionally been used mainly for treating specific conditions, such as headache, cough, arthritis, menstrual problems, skin sores, insect bites, colds, sore throat, etc. It is a curious fact that herbal medicine, as it seems to be most widely known in Canada and the USA, has been so little influenced by the great systems of herbal thought that once flourished in Asia. The use of herbs in the western hemisphere stretches back into antiquity well into the Paleolithic or Old Stone Age. The beginnings of organized study of herbal therapeutics in the West are in the ancient Mesopotamian, Egyptian, and later Greek civilizations. By

**Table 1** Some medicinal plants commonly extracted from Indian forests for Ayurvedic medicines

<i>Species</i>	<i>Medical application</i>
<i>Acorus calamus</i>	Nervine, antispasmodic, sedative, stomachic, expectorant, emetic, laxative, diuretic
<i>Artemesia absinthium</i>	Anthelmintic
<i>Artemisia vulgaris</i>	Anthelmintic, expectorant
<i>Asparagus racemosus</i>	Galactogogic, antispasmodic, antidiarrhetic, demulcent
<i>Azadirachta indica</i>	Skin disease, blood disease, antibacterial
<i>Bacopa monnieri</i>	Nervine, tonic, diuretic, sedative
<i>Boerhavia diffusa</i>	Diuretic, expectorant, laxative
<i>Boswellia serrata</i>	Antiarthritic, analgesic, anti-inflammatory
<i>Buchanania lazan</i>	Skin disease, laxative
<i>Butea monosperma</i>	Diarrhea, flatulence, anthelmintic
<i>Callicarpa macrophylla</i>	Joint pain, skin disease, blood disease
<i>Calotropis gigantea</i>	Bronchitis, diarrhea, tonic, cancer (?)
<i>Cannabis indica</i>	Insomnia, cachexia, dysmenorrhea
<i>Capsicum annum</i>	Rubefacient, stimulant, tonic
<i>Carum carvi</i>	Flatulence, stomachic
<i>Carum copticum</i>	Spastic bowel, flatulence, dyspepsia
<i>Cassia angustifolia</i>	Constipation, liver disease, joint pain
<i>Cassia fistula</i>	Ringworm, constipation, fever, antibacterial
<i>Cedrus deodara</i>	Fever, diarrhea, urinary disorders
<i>Centella asiatica</i>	Tonic, sedative, alterative, anxiolytic
<i>Cichorium intybus</i>	Emmenagogue, digestive
<i>Cinnamomum camphora</i>	Diarrhea, nervousness, muscular pain, fever
<i>Cinnamomum zeylanicum</i>	Dyspepsia, flatulence, diarrhea, menorrhagia
<i>Cissampelos pareira</i>	Bowel disease, uterine prolapse, alterative
<i>Clitoria ternatea</i>	Constipation, edema, anthelmintic, demulcent
<i>Cocos nucifera</i>	Fever, pharyngitis, skin disorders, alterative
<i>Coleus aromaticus</i>	Kidney stones, conjunctivitis, spastic colon
<i>Cordia myxa (obliqua)</i>	Expectorant, colic, dyspepsia, ulcers, cough
<i>Coriandrum sativum</i>	Flatulence, colic, joint pain, antiseptic
<i>Crinum deflexum (asiaticum)</i>	Emetic, inflammatory conditions
<i>Crocus sativus</i>	Nervine, sedative, emmenagogue, aphrodisiac
<i>Cuminum cyminum</i>	Diarrhea, dyspepsia, antiseptic, hookworm
<i>Curculigo orchoides</i>	Hemorrhoids, asthma, kidney stones, skin disease
<i>Curcuma longa</i>	Arthritic pain, anti-inflammatory, skin disease
<i>Curcuma zedoaria</i>	Cough, asthma, leukorrhea, tonsillitis
<i>Cynodon dactylon</i>	Diuretic, styptic, hematuria, hemorrhoids
<i>Cyperus rotundus</i>	Antiinflammatory, flatulence, fever, estrogenic
<i>Datura metel</i>	Antispasmodic, jointpain, asthma, dysmenorrhea
<i>Dolichos biflorus</i>	Edema, kidney stone, asthma, dysmenorrhea, tumors
<i>Eclipta alba</i>	Hepatic deobstruent and tonic, alterative, emetic, purgative, antiseptic, antiviral
<i>Elettaria cardamomum</i>	Bronchitis, flatulence, dyspepsia, hemorrhoids
<i>Emblica officinalis</i>	Fruit: cooling, laxative, stomachic, tonic, diuretic
<i>Evolvulus alsinoides</i>	Anxiety, diarrhea, bronchitis, memory loss, fever
<i>Ferula foetida</i>	Flatulence, cough, constipation, palpitations, aphrodisia
<i>Ficus religiosa</i>	Ulcers, skin disease, diabetes, constipation
<i>Ficus racemosa</i>	Diarrhea, hemorrhoids, bleeding disorders, antiseptic
<i>Foeniculum vulgare</i>	Cough, flatulence, dysmenorrhea, hookworm, edema
<i>Gmelina arborea</i>	General tonic, to increase strength, antiviral, indigestion
<i>Grewia hirsuta</i>	Diarrhea, wounds, heart disease, fever
<i>Gymnema sylvestre</i>	Diuretic, astringent, hypoglycemic, refrigerant, stomachic
<i>Hemidesmus indicus</i>	Excellent alterative, to increase appetite, cough, skin
<i>Holarrhena antidysenterica</i>	Diarrhea, dysentery, amebiasis, anthelmintic
<i>Hyoscyamus niger</i>	Chronic dementia, hysteria, palpitations, asthma, sedative
<i>Hyssopus officinalis</i>	Cough, asthma, bronchitis, amenorrhea
<i>Ipomoea digitata</i>	Cough, hoarseness, respiratory stimulant, tonic
<i>Justicia adhatoda</i>	Bronchitis, asthma, jaundice, antispasmodic
<i>Linum usitatissimum</i>	Cystitis, bronchitis, boils, expectorant, demulcent
<i>Luffa acutangula</i>	Splenomegaly, emetic, excellent for skin disease, expectorant
<i>Madhuca longifolia</i>	Tonsillitis, cough, rheumatic joints, diabetes, appetizer
<i>Michelia champaca</i>	Gastritis, chronic arthritis (?), emmenagogue, diuretic, colic
<i>Mimosa pudica</i>	Menorrhagia, hemorrhoids, skin wounds, diarrhea
<i>Mimosa elengi</i>	Tonic, cardiogenic, urogenital disease, snakebite, skin sores

Table 1 Continued

Species	Medical application
<i>Morinda citrifolia</i>	Acne, eczema, hyperlipidemia, bronchitis, diarrhea
<i>Moringa oleifera</i>	Source of vitamin C, colds, boils, fever, joint pain, gout
<i>Mucuna pruriens</i>	Nervine tonic, aphrodisiac, parkinsonism, hypercholesterolemia
<i>Nardostachys jatamansi</i>	Nervousness, anxiety, dysmenorrhea, insomnia, hair tonic
<i>Nelumbo nucifera</i>	Refrigerant, sedative, demulcent
<i>Nyctanthes arborescens</i>	Liver diseases, constipation, anthelmintic, antihistaminic
<i>Ocimum sanctum</i>	Demulcent, expectorant, antecatharral, antispasmodic, anthelmintic
<i>Paederia foetida</i>	Rheumatic joint pain, edema, bladderstones(?), inflammation
<i>Papaver somniferum</i>	Anxiety, diarrhea, aphrodisiac, sedative
<i>Peucedanum graveolens</i>	Flatulence, colic, abscesses, digestive
<i>Phyllanthus fraternus</i>	Jaundice, liver disease, fever, genitourinary disease, edema
<i>Picrorhiza kurroa</i>	Hepatitis, asthma, anorexia
<i>Piper nigrum</i>	Dyspepsia, cough, pharyngitis, headache, diarrhea
<i>Plantago ovata</i>	Constipation, colitis, irritable bowel, cystitis
<i>Premna integrifolia</i>	Flatulence, fever, arthritis, liver deobstruent
<i>Pterocarpus santalinus</i>	Skin tonic, liver disorders, fever
<i>Punica granatum</i>	Anthelmintic (esp. tapeworm), diarrhea, dyspepsia
<i>Randia dumetorum</i>	Fruit and rind are emetic, diaphoretic, and antispasmodic; bark is sedative and nervine calmate
<i>Rauwolfia serpentina</i>	Hypertension, anxiety, insomnia, colic

3000 BC the Egyptians and Sumerians had written traditions of systematic herbal use, and by 400 BC there were numerous medical schools in Greece practicing various forms of natural medicine, including herbology, cupping, and progressive open-air sanatoriums for the mentally ill. In modern times, since the scientific revolution of the nineteenth and twentieth centuries, Britain and Germany have rich traditions of herbal medicine use.

### Tibetan Medicine

Tibetan medicine (Amchi) originated with the local folk tradition (known as Bon) that dates back to about 300 BC and was formally recorded by Xiepu Chixi, the physician to the Tibetan King Niechi Zangpo, in 126 BC. Aspects of both the traditional Chinese and Indian (Ayurvedic) medical systems were added later. Ayurveda has had the most profound influence on Tibetan medicine. The medicine of India was introduced to Tibet as early as AD 254, with the visit of some Indian physicians.

Tibetan medicine has been practiced also throughout Central Asia since at least the eighteenth century. The concepts are deeply grounded in the concept of universal compassion associated with the local religions of Buddhism and Bönpo; the latter is the ancient religion of Tibet. Historically, most Amchis (Tibetan medicine men) belonged to a lineage of healers and were taught medicine by their fathers or other elder male relatives. For them the healing value of plants and their precise identification is crucial. Tibetan herbal formulas they brought with them have been available as pharmaceutical products in Europe since 1980.

The modern Materia Medica of Tibet is derived from the book *Jingzhu Bencao* (The Pearl Herbs), published in 1835 by Dumar Danzhenpengcuo. This text has been compared to the famous Chinese herbal *Bencao Gangmu*. Its format includes two sections, one being in the style of the Buddhist sutra with praise of the medicines, and the other being a detailed classification of each substance, giving the material's origin, environmental conditions where it is found, quality, parts used, and properties. The text included 2294 materials, of which 1006 are of plant origin, 448 of animal origin, and 840 minerals. About one-third of the medicinal materials used in Tibetan formulas are unique to the Tibetan region (including the Himalayan area in bordering countries), while the other two-thirds of the materials are obtained from India and China. Although Tibetan herbal medicine includes the use of decoctions and powders, for the most part, Tibetan doctors utilize pills that are usually made from a large number of herbs (typically 8–25 ingredients). In general, Tibetan remedies emphasize the use of spicy (acrid), aromatic, and warming herbs. About 300 medicinal plants are used in Tibetan traditional system of medicine.

### Folk Medicine

This system of medicine is very diverse and each type is specific to its own ecosystem and ethnic community. It is an oral tradition purely empirical in nature that exists in all rural, indigenous, and tribal communities of the world. Folk medicine knowledge is considered to be the most valuable asset of human

civilization. Some folk medicine practices are described below.

### **Folk Medicine in India**

This is widely practiced throughout the length and breadth of India. Its practitioners include housewives and village elders, herbal healers, bone setters, and 'Visha vaidyas' (poison healers). Almost every hamlet in rural India has a medicine man. An estimate suggests that more than 7500 plant species are used by folk medicine practitioners of India. Several Indian folk medicine plants or their extracts have already been adopted by Western modern medicine, e.g., *Psyllium husk* for bowel problems and *Cassia fistula* for antibiotic activity.

Northeastern India has rich knowledge of folk medicines. Meghalaya, a small state with 2 million population has thousands of traditional herbal practitioners.

### **Folk Medicine in Africa**

People in rural Africa depend almost entirely on folk medicine. Traditionally, rural African communities have relied upon the spiritual and practical skill of traditional medical practitioners, whose botanical knowledge of plant species and their ecology and availability are invaluable. This dependence has led many medical scholars to believe that Africa, the cradle of humanity, is the birthplace of traditional methods of treatment. Folk medicines, as well as traditional practitioners, enjoy a special status in African societies.

There are hundreds of thousands of traditional healers in Africa, e.g., 900 000 in Nigeria, 700 000 in South Africa, 50 000 in Zimbabwe, and 450 000 in Senegal. Traditional healers use powders and other forms of medicines mainly extracted from plants, as well as superstitious practices, such as necromancy.

### **Folk Medicine in Other Parts of the World**

As stated earlier folk medicines are known to almost every community of the world. The traditions of folk medicine are strong in Russia, Central Asia, Iran, Afghanistan, Mongolia and Manchuria. Equally, herbal medicines are an integral part of Brazilian folk medicine. Folk medicines are also popular in primary healthcare in several developed countries like Belgium, France, Germany, and the Netherlands.

## **Modern Medicine**

### **Homeopathy**

Homeopathy is based on the principle that substances that are poisonous in large doses can be very

beneficial in small doses. Homeopathy is a form of medicine that treats the body as a whole and helps it to heal itself. Most homeopathic medicine preparations are partly or fully plant based. According to a recent estimate 482 medicinal plants are used in homeopathy. The applications of the drugs used in homeopathy are given in Table 2.

### **Allopathy**

Allopathic system of medicine is also known as 'modern,' 'western,' or 'scientific' medicine. It is firmly rooted in the products of synthetic chemistry, as its drug arsenal. Nevertheless, in the developed world, 25% of all medical drugs are still plant-based and in the developing world this is closer to 75%. Allopathy will continue to depend on plants for its drugs and this dependence is more likely to increase rather than decrease. A large number of modern drugs have been derived from plant products, e.g., morphine, steroids, quinine, artemisinin, etoposide, taxol, etc.

## **Medicinal Plants in Modern Medicine**

Modern pharmacology recognizes the therapeutic effects of plants: over 25% of all prescriptions in Western Europe and North America and up to 60% of those in Eastern Europe consist of unmodified or slightly altered higher-plant products. More than 40% of the industries producing modern medicines use plants as their active ingredient, although generally in a synthesized and more concentrated formula. The active ingredient in aspirin, for example, was originally found in the bark of willow trees (*Salix* spp.).

Western medicines produced from medicinal plants include contraceptives, steroids (e.g., prednisone), and muscle relaxants for anesthesia and abdominal surgery; quinine and artemisinin against malaria; digitalis derivatives for heart failure; and the anticancer drugs vinblastine and vincristine, etoposide and taxol. These cannot be fully synthesized in a cost-effective manner. Therefore their production requires reliable supplies of plant materials, either from cultivated plants or from the wild. These few examples suggest how modern drug delivery depends on continuing availability of raw materials and how vulnerable it is to the exhaustion of natural resources.

Pharmaceutical industries look at biodiverse forests of tropics as an unmatched source of chemicals with potential for new drug development. Several national laboratories in North America, Europe, and Asia and drug industries are actively engaged in screening of plants for medicines. Quite a few

**Table 2** Some medicinal plants collected from Indian forests for use in homeopathy

Species	Application
<i>Abroma augusta</i>	Diabetes mellitus, dysmenorrhea
<i>Aconite</i> sp.	Pain of abdomen, retention of urine, coldness, respiration, etc.
<i>Azadirachta indica</i>	Malarial fever, liver and spleen enlarged, skin diseases, leprosy
<i>Berberis vulgaris</i>	Peptic and renal disorders with pain in liver and abdomen with gravel in the kidney
<i>Cannabis sativa</i>	Gonorrhea, inflammation of the bladder, thin scanty pus, intense burning and pain, asthma
<i>Desmodium gangeticum</i>	Fever, burning in palms, soles, eyes, and face
<i>Dioscorea</i>	Biliary colic, flatulent colic, flatulent dyspepsia, gastralgia
<i>Drosera</i> sp.	Whooping cough
<i>Eupatorium</i> sp.	Snake bites, bleeding from lungs with cough, dysentery, etc.
<i>Equisetum</i> sp.	Enuresis
<i>Ficus indica</i>	Profuse mucus and blood in acute dysentery stools, emission of blood followed by evacuation of faeces with colic and tenosmus
<i>Geranium maculatum</i>	Hemorrhage from lungs and stomach
<i>Gynocardia odorata</i>	Leprosy, secondary syphilis, rheumatism, scabies, eczema, cutaneous eruptions
<i>Hypericum perforatum</i>	Injury of nervous tissue, spinal injury, shocks, gunshot wounds, etc.
<i>Jacaranda caroba</i>	Warts, redness after the syphilitic ulcer is cured
<i>Lobelia inflata</i>	Headache, nausea, vomiting
<i>Momordica charantia</i>	High temperature developed due to smallpox, measles
<i>Nyctanthus</i> sp.	Fever with vomiting, constipation, diarrhea, etc.
<i>Passiflora incarta</i>	Tetanus, dysmenorrhea, asthma
<i>Ricinus communis</i>	Stimulates the secretion of the mammary glands
<i>Rauwolfia serpentina</i>	High blood pressure, insanity
<i>Tinospora cordifolia</i>	Chronic malaria, especially after abuse of quinine with enlarged spleen and liver, yellowness of conjunctiva, diarrhea, vomiting
<i>Tribulus terrestris</i>	Impotence, gonorrhea, mental, nervous and physical weakness
<i>Viscum album</i>	Gonogorrrheal rheumatism of joints and glands, especially in women

companies have made formal agreements with local indigenous communities and medicine men for the collection of medicinal plants on the basis of sharing of profits.

## Trade

The world market for medicinal plant based products is estimated to be US\$60 billion year<sup>-1</sup> with a growth rate of 7% per annum. In Germany and France many herbs and herbal extracts are used as prescription drugs, while in USA herbal drugs are sold in food stores with turnover of US\$4 billion in 1996, which was expected to double by the year 2000. The herbal medicine trade is booming business worldwide. In India, for example, there are 46 000 licensed pharmacies manufacturing traditional remedies, 80% of which come from plants. It is estimated that India expected to export crude drugs worth US\$600 million in the year 2003 which may grow to US\$2000 million by 2010. China exports crude drugs worth US\$4400 million and Thailand worth US\$2000 million. Europe is the major trading center for medicinal and aromatic plants globally, with imports into one European country or another amounting to 440 000 tonnes in 1996. There are at least 2000 MAPs marketed in Europe, which originate from over 120 countries. In 1999, the world market for herbal remedies was calculated to

**Table 3** Twelve leading exporting countries of medicinal plants, according to export volumes (1992–95)

Country	Export volume (tonnes)
China	121 900
India	32 600
Germany	14 000
Singapore	13 200
Egypt	11 250
Chile	11 200
USA	10 150
Bulgaria	7 800
Morocco	6 850
Mexico	6 300
Pakistan	4 800
France	4 700

be worth US\$19.4 billion, with Europe in the lead (US\$6.7 billion), followed by Asia (US\$2.2 billion), North America (US\$4.0 billion), Japan (US\$2.2 billion) and the rest of the world (US\$1.4 billion). Hong Kong is claimed to be the largest market in the world, importing MAPs worth over US\$190 million annually. A list of the leading countries exporting MAPs are given in Table 3.

## Threats to Medicinal Plants

The increasing population, desire to earn more money, and increasing acceptability of herbs as medicine are among some of the factors responsible

for rising trade and increasing threats to the medicinal plants in the wild. Earlier, the harvesting of medicinal plants was the domain of specialist herbal healers but now harvesting has become the domain of uncertain and often indifferent commercial gatherers leading to a decline in wild stock.

The international herb trade, which has grown into a multi-billion dollar business, is depleting the local stock of the medicinal plants. International and national demands have changed a local harvesting pattern to commercial gathering without any regard to the regeneration of species for future yields. Most of Europe and North America's herbal medicine needs are fed from unsustainable wild collections in South Asia. There is a vast, secretive and largely unregulated market of medicinal plants sourced mainly from forests and the wild. The size of the market is growing dramatically, leading to depletion of resource base and making the species vulnerable to extinction.

The total number of plant species estimated to be threatened by IUCN is about 36 000, of which about 10 000 are medicinal plants (Table 3). The most serious threats to medicinal plants generally are habitat loss, habitat degradation, and overharvesting. The threats from overharvesting are also due to collection for purposes other than medicinal; for example, the African trees *Acacia sebgal*, *Boswellia*

*papyrifera*, and *Pterocarpus angolensis* are often harvested for timber. Another reason why medicinal plants have become increasingly threatened has been the weakening of customary laws traditionally regulating the management and use of natural resources. The collapse of customary institutions has been connected directly to changes in the ways that medicinal plants were exploited and this has become a widespread phenomenon. Different countries may have different factors which result in the loss of medicinal plants; for example, in Pakistan a majority of medicinal plant species is facing severe threats from extraction, grazing, cutting, deforestation, unawareness, and misuse by the local vendors who are making key traded species vulnerable. In northeastern India and Nepal, deforestation, forest fires, shifting cultivation, overgrazing, and overharvesting have significantly eroded the medicinal plants resources.

### Conservation Needs

Considering the importance of medicinal plants for human health and well-being, there is an urgent need for their conservation. Some countries have laws that regulate the commercial collection or trade of medicinal plants. For example, Poland lists species of medicinal and aromatic plants that cannot be

**Table 4** Some endangered plants of actual or potential use in traditional medicine

Species	Family	Threatened range	Use
<i>Acorus calamus</i>	Araceae	India	Sedative
<i>Alpina galanga</i>	Zingiberaceae	India	Drug
<i>Arbutus canariensis</i>	Ericaceae	Canary Islands	Vitamin C
<i>Artemisia granatensis</i>	Asteraceae	Spain	Infusion
<i>Catharathus coriaceus</i>	Apocynaceae	Madagascar	Alkaloids
<i>Commiphora wightii</i>	Burseraceae	India	Drug
<i>Dendrobium nobile</i>	Orchidaceae	India	Dendrobine
<i>Dendrobium pauciflorum</i>	Orchidaceae	India	Alkaloids
<i>Dioscorea deltoidea</i>	Dioscoreaceae	Afghanistan to Vietnam	Cortisone
<i>Diplomeris hirsuta</i>	Orchidaceae	India	Alkaloids
<i>Dracaena draco</i>	Liliaceae	Canary Islands, Cape Verde Islands, Madeira	Gum resin
<i>Gentiana kurroo</i>	Gentianaceae	India	Drug
<i>Lodoicea maldivica</i>	Arecaceae	Seychelles Islands	Drug
<i>Nelumbo nucifera</i>	Numphaecaceae	India	Drug
<i>Paeonia cambessedesii</i>	Paeoniaceae	Balearic Islands	Epilepsy
<i>Panax quinquefolius</i>	Araliaceae	US	Tonic tea
<i>Paphiopedilum druryi</i>	Orchidaceae	India	Alkaloids
<i>Pelagodoza henryana</i>	Arecaceae	Marquesas Islands	Endosperm
<i>Podophyllum hexandrum</i>	Berberidaceae	India	Drug
<i>Rauwolfia serpentina</i>	Apocynaceae	India	Drug
<i>Rheum rhaponticum</i>	Polygonaceae	Bulgaria, Norway	Medicine
<i>Rumex rothschildianus</i>	Polygonaceae	Israel	Medicine
<i>Ruta pinnata</i>	Rutaceae	Canary Islands	Balsma-like properties
<i>Santalum album</i>	Santalaceae	India	Drug
<i>Saussurea lappa</i>	Asteraceae	India	Various
<i>Sisymbrium cavanillesianum</i>	Brassicaceae	Spain	Mustard-like properties
<i>Toxocarpus schimperianus</i>	Adelepiadaceae	Seychelles Islands	Pharmacology



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.

## Further Reading

- Bhatt KKS (2003) Medicinal plant information databases. In: *Non-Wood Forest Products for Rural Income and Sustainable Forestry*. pp. 1–18. Rome: Food and Agriculture Organization.
- FAO (2003) *Non-Wood Forest Products for Rural Income and Sustainable Forestry*. Rome: Food and Agriculture Organization.
- Organization (2002) *Regional Workshop on Wise Practices and Experiential Learning in the Conservation and Management of Himalayan Medicinal Plants*, 15–20 December 2002, Kathmandu.
- Rana AK (2003) Indian medicinal and aromatic plants special – I and II. *The Indian Forester* 129: 1–297.
- Sharma R (2003) *Medicinal Plants of India – An Encyclopedia*. Delhi, India: Daya Publishing House.
- Shankar D and Majumdar B (2003) Beyond the Biodiversity Convention: the challenges facing the biocultural heritage of India's medicinal plants. In: *Non-Wood Forest Products for Rural Income and Sustainable Forestry*. Rome, Italy: FAO.
- Tiwari BK and Tynsong H (2003) *Medicinal Plants of Meghalaya, India*. Unpublished Technical Report. Shillong, India: Centre for Environmental Studies, North-Eastern Hill University.

## 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