

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

important place in almost all societies. The study of nature by forest-dwellers started out of necessity. Thus the first study of plants by ethnic communities was undoubtedly a practical study centered on the importance of plants as a source of food for human nourishment, of fiber for clothing the human body, of drugs for the treatment of human diseases, etc. As civilization advanced over centuries rational human beings with their probing intellect and reasoning faculties enquired, investigated, and discovered various biological processes and began to unfold nature's magnificent creations. Even after advancement people remained in remote forests and hilly tracks, far away from the so-called urban civilization, carrying out their existence meeting all their requirements from the environs of forests. As they live in small ethnic groups or tribes, they are nowadays called tribal people or aboriginals.

Religion, magic, and medicine were integral parts of life of prehistoric peoples. Any person in the community with religious bent and knowledge of diseases and spirits assumed the headship of the community or the village and performed the roles of priest, sorcerer, and physician. Apart from the treatment of wounds and broken bones tribal medicine was probably the most ancient aspect of the art of healing for primitive vaidyas (physicians) showed their wisdom by treating the whole man or woman, soul as well as body.

Similarly the ancient peoples in Mesopotamia, Egypt, Babylonia, Greece, and Rome all developed their respective indigenous medicines along the same lines of belief, religion, and experience from exploration of various medicinal plants. The ancient medicine of Mesopotamia was magico-religious, while Egyptian medicine was empirico-rational.

Ethnobotany

The study of the association, interaction, and interrelationships of ethnic human societies (especially tribal communities) with the surrounding flora is termed 'ethnobotany' or aboriginal botany. The term ethnobotany was coined in 1896 by Harshberger, one of the fathers of economic botany of America. Ethnobotany has more recently been defined as the study of the interrelationship of plant environment and primitive societies. There are many subdisciplines of ethnobotany dealing with various aspects of tribal plants such as ethnoagriculture, ethnotaxonomy, ethnomedicobotany, ethnoecology, ethnomycology, ethnogynaecology, ethnotoxicology, ethnopharmacology, ethnopharmacognosy, ethnophytotaxonomy, ethnoveterinary medicine, etc.

Ethnography and the Ethnobotanical Knowledge of Tribes

Plants have profoundly influenced the culture and civilization of tribes in many countries. Many wild plants are in use by tribes for various purposes and most of them have found a place in rituals and ceremonies and some have been accorded sanctity (sacred plants). Many of the practices developed by indigenous tribes are the result of novel experimentation and innovation by people from observing the medicinal herbs and animals.

India has an immense wealth of biodiversity. According to estimates there are about 45 000 species of wild plants, of which 7500 species are in medicinal use in indigenous health practices. The tribal peoples (some 60 million people in India) who depend on forest wealth are the custodians who have safeguarded the medicinal plants till now. The real danger for biodiversity is from the urban elite who destroy the forests for industrialization and for their own needs. In any country, forests should cover one-third of the total land, for the maintenance of biodiversity. Forest cover is far below the desired level in India; it is about 19.5% and the protected area in that is only 10%. Rapid deforestation caused by overharvesting and the exploitative trade in medicinal plants have significantly reduced the availability of medicinal plants. With deforestation the tribal peoples who live in harmony with nature are the most threatened, and the wonderful tribal medicine is also disappearing slowly.

Tribal medicine is not a codified system. Through experience the disease is identified and treated. Even the primitive surgery the tribal practitioners make is their own and is performed in their home setting. There is a strong belief in tribal medicine that the efficacy of the therapy is lost if it is revealed to strangers who have no belief and sympathy on nature and medicine. In the modern sense there seems little scientific or experimental basis to these claims. But the use of a plant for the same purpose in several societies or regions has been taken as one of the criteria for greater credibility in terms of Western science.

Tribal medicine has assumed a new significance in the field of science in the last three decades and has emerged into a new branch of ethnobotany called ethnomedicobotany. This deals with tribal medicine, methods of preparation, mode of administration and their values. The Botanical Survey of India (BSI) and the Council of Scientific and Industrial Research (CSIR) started organized fieldwork and other studies on this subject through their regional centers all over India. Ethnomedicobotanical studies have been

established in some universities, and field study results, herbarium collections and literature are being built up (see Further Reading).

Types of Tribal Medicine

Not all the tribals are vaidyas (doctors). Only the people who are interested learn and practice this. In India, tribal therapy is of three types: (1) Raja vaidya (medical therapy), (2) Bhuta vaidya (Witch therapy), and (3) Rakshasa vaidya (fire therapy). These three types of treatments very often overlap and the third type is applicable to animals as well as human beings. The second type is called magico-religious medicine which in modern parlance can be equated with psychotherapy. Elderly members of the community are well versed in the knowledge of different herbs, roots, and plants and their practices i.e., materia medica of tribal medicine. Some of them also maintain small herb farms. Even the scientists depend upon them for the identification and supply of medicinal plants for their research and preparation of medicines. Whenever epidemics such as chicken pox, cholera, and flu breakout the bhuta vaidya who employs sorcery, magic formulae, talismans, and amulets for outward consumption, also uses herbal medicines secretly for arresting these epidemics. These practices become a boon not only to the patient but also to the entire village, as prophylactic measures. The talismans and amulets also contain some powerful herbs or minerals. These practices are in vogue for human beings as well as livestock, which are more important and valuable to the rural people. Mankind developed his own pharmacopeias by making his body as laboratory to experiment. The gradual process might have taken thousands of years to evolve but one thing is certain; this is passed on from one generation to other with refinement.

Contribution to Biodiversity

The concept of sacred groves and thereby preservation of biodiversity is another of the great contributions of the primitive people to modern world. In the same way, the belief that the misuse of nature results in punishment and curse became boon to conservation, in helping to preserve the snakes and other minor animals. Tribal people believe that if any one kills a snake he or she will become sterile and will suffer from chronic skin infections. Tribals never uproot trees and many trees are considered sacred.

Herbal Remedies

Tribal population have learnt to utilize local herbs in different ailments after centuries of trials. Some of

the folklore medicines have proved efficacious after detailed pharmacological and clinical trials. *Rauwolfia serpentina* roots are a classical example. This is now prescribed as a remedy of high blood pressure and certain forms of insanity. The seed kernel of *Hydnocarpus kurzii* from the Assam and Tripura hills has proved useful in the treatment of leprosy and skin diseases. The roots of *Nardostachys grandiflora* have provided a safe sedative after detailed clinical trials. The kernel of *Entada pursaetha*, bark of *Premna latifolia*, base of rachis of *Angiopteris evecta* as subsidiary food; the use of powdered dry fruits of *Brucea mollis* in malarial fever; the leaf juice of *Clausena excavata* in muscular pain; and the root decoction of *Ixora acuminata* as a galactagogue by karbis of Assam are interesting. The traditional knowledge of Asurs of Netarhat plateau (Bihar) is significant. They have many herbal cures such as *Andrographis paniculata* for fever with chills, *Schleichera oleosa* for gout, *Iphigenia indica* for cough and asthma, *Anisomeles* sp. For snake bite and poisoning, *Grewia* spp. for debility, and *Celastrus paniculata* as an abortifacient. The tribes such as Kol, Saora, and Koudh from the state of Orissa use more than 100 plant species for various ailments. The Mundas, Orans, Santhals, Lodhas, Kondhs, Bhumjis, Hos, and Mechs of Eastern India have vast knowledge about the treatment of cattle and birds using locally available plants. The tribal peoples residing along the hilly region of the western Ghats in Maharashtra use more than 100 wild species as food. The Todas, Kotas, Irulas, Kurumbas, the Paniyars and the Kattu nayaks of Tamilnadu have rich traditional knowledge and hundreds of plants are used for various ailments. The Jarawas, the Sentinelese, the Onge, the great Andamanese, the Nicobarese, the Shompen, and the Burmans of the Andaman Islands knew many plants, though most of the tribes themselves have not been explored by Western scientists.

The tribal repository contains many medicines for the treatment of one ailment. The medicine varies according to the symptoms and secondary effects and with the tribe and place. For one disease many plants are used basing on the availability. Some therapies recorded during the survey of Herbal Folklore Research Centre, Tirupati, Chittoor district, Andhra Pradesh, India are given in Table 1.

Medicinal Plants Research

We already know that traditional medicine developed from clues from forest-dwellers and herders. Documentation of such knowledge has been going on for centuries, e.g., *Hortus Malabaricus* (seventeenth century). The earliest scriptures (4500–1600 BC) of

Table 1 Tribal treatments for various ailments

<i>Ailment</i>	<i>Plant</i>	<i>Part</i>	<i>Mode of administration</i>
Fever	<i>Asparagus racemosus</i>	Root tuber	Decoction
	<i>Cyperus rotundus</i>	Root tuber	Decoction
	<i>Tinospora cordifolia,</i>	Stem	Decoction
	<i>Allium sativum,</i>	bulb	
	<i>Zingiber officinale</i>	dried rhizome	
	<i>Andrographis paniculata,</i>	Whole plant	The decoction of garlic is mixed with the two herbal powders and given to drink
	<i>Morinda tinctoria,</i> <i>Allium sativum</i>	Root bulb	
Head ache	<i>Catunaregum spinosa</i>	Fruit	1–2 drops of the juice instilled in the eyes
Indigestion and dyspepsia	<i>Trachyspermum ammi,</i> <i>Carum copticum</i>	Seed Seed	Seed powder of the two in equal proportions mixed with a pinch of rock salt is given
	<i>Ricinus communis/</i>	Seed oil	If the problem is chronic, seed oil is given on empty stomach or fruit juice mixed with a pinch of cumin powder is given
	<i>Tamarindus indica</i> <i>Cassia senna</i>	Fruit Leaf	For chronic cases two to three teaspoons of leaf powder mixed with a pinch of salt are administered on empty stomach
	<i>Cassia occidentalis</i>	Leaves	Tender leaves are made into curry and used along with food
	Eye infections	<i>Citrus limon</i>	Fruit
<i>Allium cepa</i>		Bulb	Juice of the bulb is put in the eyes
<i>Curcuma longa</i>		Rhizome	One to two drops of fresh rhizome juice is instilled in the eyes
<i>Martynia annua</i>		Leaf	Leaf juice is put in the eyes
<i>Acorus calamus and</i> <i>Zingiber officinale</i>		Dried rhizome Fresh rhizome	Rhizome made into ash is mixed with ginger extract and two to three drops are instilled in the eyes
Liver disorders		<i>Cuscuta reflexa</i>	Plant
	<i>Azadirachta indica</i>	Gum	Gum mixed with opium is given
	<i>Phyllanthus niruri</i> <i>Boerhavia diffusa</i>	Tender twigs with leaves Whole plant	Paste or powder is given with buttermilk Decoction is given with toddy jaggery
	Cough and cold	<i>Pongamia pinnata</i>	Fruit
<i>Datura metel</i>		Leaves	Inhalation of fumes
<i>Solanum surrattense</i>		Root	Powder mixed with honey is given to lick
<i>Adhatoda vasica</i>		Leaves	Decoction
<i>Ocimum sanctum</i>		Leaves	Juice is given with long pepper powder
<i>Coleus aromaticus</i>		Leaves	Leaves eaten directly or juice with black pepper
Cuts and fractures	<i>Ficus bengalensis</i> <i>Dodonaea viscosa</i>	Leaves Leaves	Leaves warmed under fire are bandaged Pounded leaves are bandaged on the fractured part using bamboo sticks
	<i>Cassia spp.</i>	Leaves	Leaf paste mixed with white yolk of the egg is applied and bandaged using bamboo sticks
	Sexual potency	<i>Mucuna prurita</i>	Seed
<i>Asparagus racemosus</i>		Root tubers	Powder mixed with honey/jaggery is given
<i>Pedaliium murex</i>		Whole plant	Juice with sugar candy
<i>Corollocarpus epigeus</i>		Root tuber	Powder with goat's milk

continued

Table 1 Continued

Ailment	Plant	Part	Mode of administration
	<i>Curculigo orchioides</i>	Root tuber	Powder with goat's milk
	<i>Holostemma adakodein</i>	Root tuber	Powder with goat's milk
	<i>Portulaca tuberosa</i>	Whole plant	Powder with honey/jaggery
	<i>Pueraria tuberosa</i>	Root tuber	Powder with jaggery
Toothache	<i>Calotropis procera</i>	Latex	Topical application
	<i>Achyranthes aspera</i>	Root	Paste for topical application
	<i>Zanthoxylum armatum</i>	Stem	Powder mixed with alum is applied on the affected part
	<i>Azadirachta indica</i>	Stem	For brushing teeth
	<i>Pongamia pinnata</i>	Stem	For brushing teeth
	<i>Tridax procumbense</i>	Leaf	Paste mixed with camphor is put on the affected part
For easy delivery	<i>Achyranthes aspera</i>	Root	Root paste applied on the abdomen and navel region
	<i>Ricinus communis</i>	Seed	Seed oil is applied on the abdomen and navel region
	<i>Zingiber officinale,</i> <i>Piper nigrum,</i>	Dried rhizome Seed	Decoction made by mixing the ingredients in equal proportions is given to drink to hasten the pains
	<i>Brassica nigra,</i> <i>Coriandrum sativum</i>	Seed Fruit	
	<i>Bambusa arundinaceae</i>	Leaves	Decoction of the leaves is given
	<i>Boerhavia diffusa,</i>	Root	A wick dipped in the root paste or seed oil or fruit juice is inserted into the vagina to hasten the pains
	<i>Ricinus communis,</i> <i>Sapindus emarginatus</i>	Seed oil Fruit	
	<i>Moringa oleifera</i>	Leaves	Juice mixed with a pinch of salt is given
	<i>Calotropis gigantea</i>	Flowers	Flowers fried in ghee is given at half an hour interval
To ensure complete discharge of the placenta after delivery	<i>Tephrosia purpurea</i>	Root	Extract is given two to three times for complete discharge
	<i>Azadirachta indica</i>	Leaf	Leaf extract
	<i>Caesalpinia bonduc</i>	Root	Decoction is given along with rice gruel
For expulsion of dead baby from the womb	<i>Bambusa arundinaceae</i>	Leaves	Leaf decoction with asafetida, salt, and rice gruel is given; this facilitates the expulsion within half an hour
	<i>Prosopis cineraria</i>	Leaf	Decoction prepared by mixing with garlic, millets and black pepper
Snakebite	<i>Aristolochia indica,</i>	Root	Paste/powder given internally
	<i>Andrographis paniculata</i>	Whole plant	
	<i>Alangium salvifolium</i>	Bark	Paste/powder, given internally
	<i>Corallocarpus epigeus</i>	Root	Paste is applied on the part and given to lick/instilled in the nostrils if the patient is unconscious
	<i>Strychnos colubrina</i>	Bark	Paste/powder given to drink or instilled in the nose
	<i>Marsedinia volubilis</i>	Leaf	Paste/powder
	<i>Cryptostegia grandiflora</i>	Root	Paste/powder
	<i>Celastrus paniculata</i>	Root	Juice/paste, given to drink or two to four drops instilled in the nose
	<i>Acalypha indica</i>	Leaf	Leaf paste is given

the Hindus, the *Rigveda*, mentions the use of plants for curing various ailments. The history of early Indian medicine is covered elsewhere in this Encyclopedia (see **Medicinal, Food and Aromatic Plants: Medicinal Plants and Human Health**).

Importance of Tribal Drugs

Many drugs discovered recently are taking the lead from tribal medicine. The discovery of ephidrin from the Chinese herbal drug *mahuang* has attracted the attention of many. Egyptians have long used the fruit of *Ammi majus* in the treatment of leucoderma. Rutin, now a well-known glycoside originally obtained from *Ruta graveolens*, has been reported from 40 different species of plants and is now increasingly employed in the treatment of capillary fragility. Documentation of such knowledge is needed. Most of the primitive tribes do not accept any other medicine except the ones prescribed by their medicine men. Information on all such knowledge should be recorded, preserved, and scientifically tested for blending into modern-style health systems. More efforts are needed towards establishing an evidence-based approach to promote traditional medicine practitioners into community-based health activities (Table 2).

Recent Efforts Made to Document Traditional Knowledge

A new resource database on traditional knowledge has been developed at the University of Illinois at Chicago named 'Natural Products Alert' (NAPRALERT). This new resource contains the world literature on natural products. Comprising data from more than 80 000 scientific articles, abstracts, and books, the database contains a wealth of information primarily on the ethnomedicine, pharmacology (experimental), and chemistry of plants.

Institutional Roles in Protecting Traditional Knowledge

Coordinated efforts to preserve the rare and endangered genetic wealth are required. Not only preservation of plant wealth but also a knowledge base and natural pockets of vegetation such as sacred groves is necessary. If the tribal communities are involved in such activities, they may open up their thinking on positive lines and help in conservation of native plants and knowledge. The programs of tree planting and medicinal plants regeneration need vast quantities of seeds. Tribal peoples could be engaged in selection of the seed, trees, and seed production areas. They could also be engaged for collection of seeds from these known sources.

Patents

Traditional knowledge is easily available in the public domain through gene banks and digital databases. Hence biopiracy/bioprospecting cannot be prevented using the Access and Benefit Sharing (ABS) provisions of International Convention of Biological Diversity and its well-intentioned mandate of prior informed consent (PIC) of traditional practice contributors. Thus ABC conditions must now be imposed before granting intellectual property rights (IPR) to traditional innovations.

The CBD convention recognizes that traditional knowledge, innovations, and practices are of importance to the convention of biological and intellectual heritage in this age of biopiracy and require ownership. If the knowledge is novel, based on innovations and a product of biodiversity it comes under recognition and protection.

Areas that Need Attention

- The concept of the naming (local names) of the plants and any expression of such knowledge related to disease.

Table 2 Contributions of tribal medicine to modern medicine

Modern drug	Ethnomedicinal use	Plant source
Aspirin	Reduces pain and inflammations	<i>Filipendula ulmaria</i>
Codeine	Eases pain, suppresses cough	<i>Papaver somniferum</i>
Ipecac	Controls vomiting	<i>Psychotria ipecacuanha</i>
Pilocarpine	Reduces pressure in the eyes	<i>Pilocarpus jaborandi</i>
Pseudoephedrine	Reduces nasal congestion	<i>Ephedra sinica</i>
Quinine	Combats malaria	<i>Cinchona pubescens</i>
Reserpine	Lowers blood pressure	<i>Rauwolfia serpentina</i>
Scopolamine	Eases motion sickness	<i>Datura stramonium</i>
Theophyllin	Opens bronchial passages	<i>Catharanthus roseus</i>
Disogenin	Contraceptive	<i>Dioscorea floribunda</i>
Digitoxin	Dropsy, relieves heart congestion	<i>Digitalis purpurea</i>
Taxol	Wound healing	<i>Taxus brevifolia</i>

- Conservation practices of the tribe, the taboos associated with certain plants, and their impact on the ecosystem.
- Tribal peoples have some rules and regulations regarding the medicine practice such as age, gender, and background relating to plants and the reasoning behind the practice.
- The tattooing, painting, dancing, customs, foods need thorough local study for the development of ecocenters.
- Tribes have specific plants for various uses, and their use differs with the tribe; this needs greater attention where the cross-cultural study may lead to many revelations.

Conclusion

There is need for documentation of all tribal health practices and the plants used by them. Deforestation seriously affects the life of tribals who are the 'forest children.' Their health, wealth, and culture depend on the forest and no one can alienate them from nature and it is a crime to deprive their resource base. The elite society that thinks that these people are illiterate and ignorant and need modern medication and education should understand first the dynamic element of the systems before introducing any reform.

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Forest Biodiversity Prospecting

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Introduction

Forests have long been an invaluable source of medicines, foods, crops, and other products based on genetic resources. A wide range of commercial sectors is involved today in 'biodiversity prospecting' as part of research and development programs aimed at developing new products, processes, and ingredients. Although scientific and technological advances have changed the role of natural products in many industry research programs, they continue to contribute significantly to existing sales and new product development. Biodiversity prospecting takes place within a legal and ethical framework that has transformed in the last decade, in part as a result of the Convention on Biological Diversity and the International Treaty on Plant Genetic Resources for Food and Agriculture. Biodiversity prospecting partnerships must now incorporate requirements for prior informed consent, mutually agreed terms, and benefit-sharing with source countries and communities.

Sectors Involved in Biodiversity Prospecting

The collection and trade in genetic resources is as old as human civilization, but the term biodiversity prospecting (bioprospecting) was first defined in 1993 as 'the exploration of biodiversity for commercially valuable genetic resources and biochemicals.' Biodiversity prospecting involves a wide range of commercial industries including the pharmaceutical, biotechnology, seed, crop protection, horticulture, botanical medicine, cosmetic and personal care, and food and beverage industries. These sectors vary significantly in terms of size, and the role of genetic resources in research and development, and markets (Table 1).

In some sectors, such as the botanical medicine, horticulture, and agricultural seed sectors, commercial products are 100% natural products. In others, the contribution of genetic resources might be more indirect. For example, in the pharmaceutical, crop protection, and sometimes the cosmetic industry, genetic resources are screened for active compounds. The final commercial products might be chemically identical to the pure natural product, might start with a natural product that is then chemically modified, or