



EVALUATION AND CONSERVATION OF BIODIVERSITY OF PLANTS USED FOR MEDICINAL PURPOSE

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ABSTRACT

India is a very rich hub of plant biodiversity, many of those are therapeutically and medicinally useful. The rich resources are disappearing at an alarming state because of over-exploitation. Some of the endangered medicinal plants are *Saussurea lappa*, *Picrorrhiza kurroa*, *Swertia chirata*, *Holostemma annularis*, *Rauwolfia serpentina*. Normally there are two methods of conservation: in situ and ex situ conservation. Many techniques were also followed in ancient times to conserve or cultivate plants. There is a need to conserve the medicinal plants to prevent their total extinction from the natural flora. The expanding trade in medicinal plants has implications for the survival of several plant species. Growing demand for therapeutic products from indigenous medicinal plants, itself has positive effect of increased interest in cultivation, which seems a perfect option for improving smallholder farmers' livelihoods, as well as sustaining the availability of these resources for future generations. Cultivation of medicinal plants provides feasible solutions to pharmaceutical organization, while effectively conserving threatened indigenous biodiversity. The purpose of this paper is to justify and emphasize the need for the evaluation and cultivation of medicinal plants.

Keywords: Cultivation, Endangered species, Ex-situ, In-situ

INTRODUCTION

India is a depository of biodiversity which stores a large variety of plants. The average amount of various living things existing in a certain habitat or on the entire planet is known as biodiversity. Genes, species, and ecosystems are the three separate levels at which it exists. Each component is unique in its makeup, structure, and purpose.^[1] We are all inherently reliant on biodiversity, which serves as the foundation for ecosystems and the services they give. With an estimated 49,000 plant species, 4900 of which are endemic, India contributes 8% of the world's biodiversity. Traditional medicine places a specific emphasis on the ecosystems of the Himalayas, the Khasi and Mizo hills of north-eastern India, the Vindhya and Satpura ranges of northern peninsular India, and the Western Ghats because they are home to over 90% of the country's higher plant species.^[2]

Human actions such as habitat destruction, pollution, climate change, exotic species invasion, population pressure, agricultural practices, lifestyle changes, etc. are the main causes of biodiversity loss.^[3] Because of these factors, a report by the United Nations Food and Agricultural Organization (FAO) estimates that the world's population will reach 9.1 billion in 2050, necessitating a 70% increase in food production.^[4] In addition, approximately twenty-five percent of all commercially available medicines in wealthy nations are derived from plants. In underdeveloped nations, this might reach around 75%.^[5]

Increasing interest in medicinal and aromatic plants makes conservation and cultivation an ideal choice for producing new sources of income and enhancing the standard of living for smallholder farmers. Herbal medicines which are cost effective and have a high perception of safety demand is rising drastically. In India, it has been estimated that approximately 80% of medicinal plants are collected from the wild, leading to an increasing pressure on natural resources^[6]. Due to overharvesting and habitat loss, approximately 15,000 species (or 21%) used in the global medicinal plant species are now endangered^[7]. With the current level of deforestation, by year 2100 only about 10% of the land area of the Indian Himalaya will be covered

by dense forest. The uncontrolled over-exploitation of wild plants, their habitat-loss and alteration are the main reasons why medicinal plant study, evaluation, utilization, and conservation have become essential parts of the programs of expanding market. The purpose of this paper is to provide information and evidence for evaluation and conservation of biodiversity of medicinal plants.

MATERIAL AND METHODS

In this paper, we have collected information from various articles, official websites of international organization like WHO, IUCN etc., various classical texts i.e., *Vrikshayurveda* of Parashara, *Surpalavirachit Vrikshayurveda*, *Krishi Parashara*, Persian manuscript - "*Nushka Dar Fanni-Falahat*" etc. We have compiled all the information and present it in this paper in a systemic manner. We have compiled brief information showing the current condition of plants which have high medicinal importance and are under threatened condition and described the data of red data book regarding threatened or vulnerable species. We have tried to find out reasons for losing biodiversity at a huge level and methods to overcome it. We highlighted both ancient and advanced techniques for better cultivation and better growing of plants. The only intention is to enhance the yield of plants and save the vulnerable or threatened species by applying ancient established knowledge and invention or techniques which will finally save biodiversity.

In our ancient texts different types of methods are mentioned to increase the yield of plants. They have mentioned the best time, best season for cultivation of medicinal plants, method of plowing, method of transplanting big trees, to dry up a tree, grafting and natural insecticide they prefer etc. At present time various types of advanced methodology are playing a huge role in increasing the yield, in conservation and in cultivation of endangered species of plant. Here we have tried to give detailed description about in-situ, ex-situ, and ancient methods of conservation.

DISCUSSION

Conservation aims at supporting sustainable development of biological resources in such a way that it does not deplete variety of species and ecosystem. Conservation is a planned process of careful preservation and protection of natural resources. Better knowledge of the earth's biodiversity is vital for future medical and pharmacological discoveries that will keep us away from death and disease. International Union for Conservation of Nature (IUCN) has said that both in-situ and ex-situ methods are well known and applied for the conservation of Red listed plants^[8]. The global concern of biodiversity conservation initiated either by in-situ or ex- situ methods.

In situ conservation

The conservation of a species in its natural habitat and the maintenance and recovery of viable population of species in their original place. In-situ methods protect plants as well as their natural habitat. Being a naturally adopted process of conservation, in-situ conservation faced several problems due to restricted and fragmented habitat, climate change, unsustainable use of plant resources, attack of pathogenic organisms and invasive species in natural environment.

It deals with on-site conservation. Here are some examples -

1. **Natural parks** - are protected areas of important wild resources created to preserve and store biodiversity.
2. **Wild nurseries** – There are many wildlife sanctuaries which protect variety of medicinal plant e.g.- periyar wildlife sanctuary, Bandipur wildlife sanctuary in Karnataka and Dandeli wildlife sanctuary in south India.^[9]
3. **Biosphere reserve** - there are three biodiversity rich spot which situated in India amongst 34 biodiversity rich spot in the world. which is the Western Ghats, the Eastern Himalayas and Indo-Burma region. There are 18 biosphere reserves in India. All of these aims at stopping irresponsible interference of humans with the ecosystem and to conserve the endemic and endangered species.

4. **Sacred groves** – These are the places of vegetation either of small or large patches which is got protected by cultural and traditional practices.
5. **On-Farm Conservation** – It is method of conservation which involves maintenance of traditional crops with traditional agriculture system. Traditional farmers use land races, which are well adapted to the local environment. Farmers have been using this method for centuries, but it has been gaining importance in recent years. Systemic documentation of farmers' knowledge of diversity and usages is needed.
6. **Home Gardens** – It is the same as on-farm conservation, but the scale is small. In rural conditions, home gardens contain a wide spectrum of species such as vegetables, fruits, medicinal and spice plants.

Ex-situ conservation

This method involves preservation and maintenance of plant species or plant parts (such as seeds, cuttings, rhizomes, tubers etc.) outside their natural habitat for developing seed banks or gene banks following classical / advanced methods of plant propagation.

Methods of plant propagation-

- 1) Sexual propagation – old, easy, and widely used for propagation.
- 2) Asexual propagation – it is also called vegetative propagation. It consists of cuttings, layering, division, budding and grafting.

Classical methods of plant propagation have certain limitations in terms of rapid production of plants or plant propagules and their long-term conservation. So, the biotechnological methods (advanced) such as plant tissue culture, plant cell culture, another culture, embryo culture, cryopreservation, germplasm banking, gene banking etc. are quite applicable and useful techniques for ex situ conservation. For conservation of rare and endangered plant species highly accepted biotechnological approach is plant tissue culture technique in which conservation of plants, seed, pollen, vegetative propagules, tissue, or cell are done.^[10]

Plant tissue culture is a collection of techniques used to maintain or grow plant cells, tissues, or organs

under sterile conditions on a nutrient culture medium of known composition.

Another culture is an artificial technique by which the developing anthers at a precise and critical stage are excised aseptically from unopened flower bud and are cultured on a nutritive medium.

Embryo culture is a laboratory method for producing plant leaves from a fertilized or unfertilized embryo in invitro condition.

Cryopreservation is a non-lethal storage of biological material at ultra-low temperature. At -196-degree temperature of liquid nitrogen all metabolic activities of cells are ceased, and the sample can then be preserved for long period.

The Ex-situ method is more effective and more scientific because of its way of conservation, which is governable with rules, regulation and adopted methodology in artificial way^[11], although it hampers plant evolution. Ex-situ method promotes advance research to introduce new genetic modification in the existing population, reinforcement of existing population and reintroduction into the wild controlled environments^[12] Ex-situ method can solve some problems related to in situ preservation techniques.

Plant biotechnology (Advance method used for ex-situ preservation)

Plant biotechnology can be defined as the use of tissue culture and genetic engineering techniques to produce genetically modified plants that exhibit new or improved desirable characteristics. It enhances the production of high-quality seeds. So, it offers new means of improving biodiversity conservation. Moreover, various bio-techniques offer the possibilities of faster multiplication of clones for genotype conservation, provide the power of modification at genetic level by changing their expression level.^[13] Biotechnological methods are reliable and can provide continuously safe, higher quality natural products for food, pharmaceuticals and cosmetic industries, similarly, they are applicable in preserving biodiversity in many ways.^[14]

Germplasm conservation by bio techniques

The main objective of germplasm conservation is to make it available at any time. In nature, propagation

by seed germination is usual, but sometimes seeds fail to germinate due to incomplete and rudimentary embryos or environmental reasons.^[15] In general, most of the seeds of different plant species can be dehydrated down to low water content and thus can be stored at low temperature for long time without the loss of seed viability.^[16] Many forest tree species, especially tropical forest trees, produce recalcitrant seeds; which cannot be dried of sufficiently low moisture level to allow their storage at low temperatures.^[17] Moreover, there are large number of plants produce very few rudimentary, incomplete, heterozygous seeds and their conservation in seed forms are problematic, those are categorized as intermediate plants.^[18] Conservation of these plant species by traditional ex-situ procedure has several drawbacks, which limit its efficacy and threaten the safety of the growing plants genetic resources in the field. Different modified techniques have been applied to preserve different categories of plant species by using both in-situ and ex-situ methods as they are complementary to each other.

Examples of ex-situ conservation - It deals with off-site conservation.

1. **Field gene banks** – It conserve plants by using biotechnology. E.g. – In-vitro propagation, germplasm conservation and cryopreservation, tissue culture methods.
2. **Botanical garden** – It is a better alternative for plant variety or species conservation, which cannot be stored in seed bank as well as by in-situ method.

Legislation: There are no separate policies or regulations for conserving medicinal plants growing in forests in India, their conservation is covered under existing laws pertaining to forestry, Forest Act 1927. Despite from the conservation methods, Govt. of India formulated rules, acts and laws for conservation of forests which directly or indirectly protects the wild herbal flora.

- a. Wildlife (Protection) Act 1972 and Wildlife (Protection) Amendment Act 1991
- b. Forest (Conservation) Act, 1980
- c. Environment Protection Act, 1986
- d. National forest policy, 1988

e. National biodiversity act, 2002

The scheduled tribes and other traditional forest dwellers act, 2006

Agriculture techniques mentioned in ancient classical text for conservation and cultivation of endangered medicinal plants.

In *Krishi Parashar*, basic rules for general management of agriculture are eloquently expressed. Detailed instructions to farmers regarding procuring and preserving seeds, plowing, sowing, water management, weeding, plant protection, harvesting, threshing, measuring food grains and storing them are given in a scheduled form along with precautions to be taken from time to time^[19]

The detailed description of the agricultural tool, the Plow along with the measurements of the various parts is also mentioned there.

Plowing is the process of breaking, loosening the soil, and turning it over for uprooting weeds and aerating the soil.

Sowing is the process of planting seeds.

Weeding is the removal of unwanted crops from the field. It is a method of crop protection and crop production management.

Harvesting is a process of gathering useful parts of a plant when all the nutrients have developed, and the edible part has reached the appropriate degree of maturity.

Threshing is an operation of separating the grains from the plant.

Knowledge of climatic conditions largely dependent on astronomical theories, vigilance, hard work, and love for the agricultural profession are stated to be the essential qualities of a successful farmer. Geographical and climatic conditions can help farmers in planning and managing the activity of farming spread over several months. General management of agriculture is then briefly described followed by detailed directions for cattle management. Most of the farming operations such as procuring seeds, plowing, sowing, levelling, transplanting, water management, weeding, plant protection, harvest and the harvesting festival are described in detail. Threshing, and measuring and

storage of food grains are also briefly dealt with. In ancient times they worship Laxmi, the goddess of wealth, seeking her blessings for the farmers. "Farms yield gold if properly managed but lead to poverty if neglected," said *Parashara*, Other saga has said that "Agriculture, cattle, business, women, and royal families if left unattended even for a short while, perish in no time". It also described good plowing practices, seed collection and preservation.^[20] This type of description in classical text about plant conservation and agriculture methods shows their concern about farming and plant protection.

Ancient literature "*Nuskha Dar Fanni-Falahat*" describes that best time for cultivation is when sun is in the sign of libra, but seed should not be sown when north wind is blowing for in that case seed will not be yield good crop. The best time for sowing the seed is the first half of sowing season. To avoid weeding, pull out them from roots when the sun is in Gemini. Best time for planting tree is when sun is in the sign of libra, and they can also be planted from the end of the sign of Pisces till the beginning of the sign of arise.^[21]

Vrkshayurveda which literally means 'the science of plant life' is known to have existed in ancient India as a special branch of knowledge. Clear references to the *Vrkshayurveda* are in the *Arthashastra*, the *Brhat-samhita*, and in the *Agnipurana*, generally dealing with the Agricultural practices; rules for planting trees - their proper seasons, and specific location for aesthetic and hygienic improvement of the home stead; as well as diseases of plants and their treatments. There also exists a separate text on the *Vrkshayurveda* attributed to *Surapala*, which bears an elaborate account only on the treatment of plant disease^[22] Hence, we can say that a strong concern about plant and their yield was also there in ancient time.

The classical text *Surpala virachit Vrikshayurveda* contains methods for better growing of seeds.

- When the fruit naturally takes full duration and dries after ripening, only at that time seed should be obtained. Sprinkle milk on them and keep it dry for five days. After this, *Dhoopana karma* (*Rakshoghna karma* to maintain disease free and

hygienic environment) should be done with mustard and *Vidang*.^[23]

- Sprinkle milk on the seeds and rub it in cow dung and treat it with honey and *vidang* powder. The seed treated in this way grows well.^[24]
- Soak the seeds in milk and let it dry well in the shade. It has been said that if we sprinkle *Brihati*, *Sarshapa*, *Nal*, *Kamaladanda* powder on it, then it gives good results.^[25]
- *Varahamihira* has said that if we want to transplant a plant then apply a paste of ghee, sesame, honey, *Gomaya*, milk and *Vidanga* from the root to its branch to gain better growing results.
- The gap between two trees at the time of planting is said to be 14, 16 and 20 cubits. This interval is half, medium and good cognitive respectively.^[26]

Natural insecticide or pesticide in ancient time (for protection)

Ancient text (*Surapala Virachita Vrikshayurveda*) has described that we should apply paste of sesame and *vidang* on the plants for insect destruction. They should also be treated by doing *Dhoopana karma* with ghee as much as necessary. It has been proven that *Kunapa jala* (various types of faces, bone marrow, flesh and blood are mixed with water. This mixture is called *kunapa jala*) is considered very nutritious for plants. Horse bones, dead pigs, fish meat, sheep, and goat horns, *upla* etc. should be collected.^[27]

State-wise list of threatened medicinal plants of India from state with highest number of species to state with lowest number of species under different threat categories^[28] (a) Critically endangered (b) Endangered (c) Vulnerable. (Table no. 1).

Table 1. State-wise list of threatened medicinal plants of India.

S.no.	State	Critically Endangered	Endangered	vulnerable
1.	Rajasthan	<i>Commiphora wightii</i> , <i>Chlorophytum borivillianum</i> , <i>Pterocarpus marsupium</i>	<i>Boswellia serrata</i> , <i>Gymnema sylvestre</i> , <i>Leptadenia reticulata</i> , <i>Oroxylum indicum</i>	<i>Barleria acanthoides</i> , <i>Buchanania lanzan</i> , <i>Plumbago zeylanica</i> , <i>Pueraria tuberosa</i>
2.	Himachal Pradesh	<i>Aconitum heterophyllum</i> , <i>Gentiana kurroo</i> , <i>Rauvolfia serpentina</i> , <i>Swertia chirayita</i>	<i>Berberis aristata</i> , <i>Betula utilis</i> , <i>Dioscorea deltoidea</i>	<i>Ephedra gerardiana</i> , <i>Valeriana jatamansi</i>
3.	Madhya-Pradesh	<i>Commiphora wightii</i> , <i>Grewia asiatica</i>	<i>Acorus calamus</i> , <i>Clerodandrum serratum</i> , <i>Drosera indica</i>	<i>Bacopa monnieri</i> , <i>Dioscorea bulbifera</i> , <i>Barleria prionitis</i>
4.	Uttarakhand	<i>Aconitum heterophyllum</i> , <i>Picrorhiza kurroa</i> , <i>Nordostyichys grandiflora</i>	<i>Dioscorea deltoidea</i> , <i>Ephedra gerardiana</i> , <i>Swertia chirayita</i>	<i>Rauvolfia serpentina</i> , <i>Valeriana jatamansi</i>
5.	West Bengal	<i>Picrorhiza kurroa</i> , <i>Swertia chirayita</i> , <i>Taxus wallichiana</i>	<i>Aconitum ferox</i> , <i>Celastrus paniculatus</i> , <i>Mucuna pruriens</i>	<i>Berberis aristata</i> , <i>Gymnema sylvestre</i>
6.	Andhra Pradesh	<i>Pterocarpus santalinus</i> , <i>Rauvolfia serpentina</i>	<i>Butea monosperma</i> , <i>Acorus calamus</i>	<i>Aegle marmelos</i> , <i>Gymnema sylvestre</i>
7.	Maharashtra	<i>Rauvolfia serpentina</i>	<i>Operculina terpathum</i> , <i>Oroxylum indicum</i> , <i>Santalum album</i>	<i>Aegle marmelos</i> , <i>Mucuna monosperma</i> , <i>Pueraria tuberosa</i>
8.	Meghalaya	<i>Smilax glabra</i> , <i>Taxus wallichiana</i>	<i>Citrus macroptera</i>	<i>Rauvolfia serpentina</i> , <i>Swertia chirayita</i>
9.	Odisha	<i>Saraca asoca</i> , <i>Symplocos raecemosa</i>	<i>Mesua ferrea</i> , <i>Piper longum</i> , <i>Pterocarpus marsupium</i>	<i>Embelia ribes</i> , <i>Celastrus paniculatus</i>
10.	Karnataka	<i>Coscinium fenestratum</i> , <i>Pueraria tuberosa</i>	<i>Cinnamomum wightii</i> , <i>Drosera indica</i> , <i>Dipterocarpus indicus</i>	<i>Aegle marmelos</i> , <i>Embelia ribes</i> , <i>Santalum album</i>
11.	Jammu and Kashmir	<i>Aconitum chasmanthum</i> , <i>Aconitum heterophyllum</i> , <i>Betula utilis</i> , <i>Gentiana kurroo</i>	<i>Angelica glauca</i> , <i>Podophyllum hexandrum</i> , <i>Picrorhiza kurroa</i>	<i>Colchicum luteum</i> , <i>Rauvolfia serpentina</i>

12.	Assam	<i>Smilax glabra</i>	<i>Garcinia pedunculata, Citrus macroptera</i>	<i>Oroxylum indicum, Hydno-carpus kurzi</i>
13.	Chhattisgarh	<i>Rauvolfia serpentina</i>	<i>Acorus calamus, Clerodandrum serratum</i>	<i>Boswellia serrata, Celastrus paniculatus</i>

Conservation of medicinal plants through communication and cooperation-

Increased demand of medicine of plant origin and shortage of original plant species due to over exploitation give rise to the use of adulterants or alternate species which sometimes costs our health. The Government can reserve some areas strictly for medicinal plants and prevent encroachment by undesirable plant species. Individual small-scale cultivation of medicinal plants should also be encouraged. Medicinal plants should be incorporated in agroforestry and reforestation programs. Mini forests on individual farms should be maintained to increase biodiversity. Governments should also have reserve stocks of medicinal plants and encourage community actions to collect, retrieve and plant seeds of medicinal plants. The removal and export of rare and scarce medicinal plants should be discouraged/prohibited by legislation. The intellectual property rights of practitioners with great discoveries in medicinal plants should be protected to encourage them. To ensure that any collection from the wild is sustainable, there is no regulation on the collection of medicinal plants (except geophytes) from the wild or no control on trade in medicinal plants and their products. Solution suggestions in this area can be planned in two parts; Primarily, organizing collections under control from nature, and training about sustainable collecting by official authorities and increased the awareness of local people who collect the medicinal plants. The second and more sustainable way, instead of collecting from nature, these plants can be cultivated in accordance with ecological and social interests. From an ecological ethnobotanical point of view, an economic system should be created based on community interactions and human behavior- conservation, genetic preservation. Cultivation, harvesting, production and trading of these plants should be organized by a single authority, although it is under the jurisdiction of different ministries such as agriculture, forestry or

health. The Ministry of Agriculture and Forestry improves the techniques for harvesting and storing medicinal plants and preparing products by Horticultural Research Institutes.

CONCLUSION

There is a great need to conserve medicinal plants because they contain highly bioactive components which can be developed into pharmacologically active agents that will keep us away from disease and death. Medicinal herbs as potential source of therapeutics aids has attained a significant role in health system all over the world for both humans and animals not only in the diseased condition but also as potential material for maintaining proper health. For Conservation, Development and Sustainable Management of Medicinal Plants In-situ conservation and Ex-situ conservation techniques are supported. Livelihood linkages with various committee like - Joint Forest Management Committees (JFMCs) / Panchayats / Van Panchayats / Biodiversity Management Committees (BMCs), Various Training / Workshops / Seminars/ Conferences on conservation techniques etc. are also beneficial. The choices of one or the other technique, or a combination of both (In-situ and ex-situ), depend on the case and both are complementary to each other based on the necessity of conservation policy for the particular species. In situ conservation method is the most valuable method, as it is natural and totally depends on the plants in their living forms in their natural habitat and allowing natural evolution. The ex-situ conservation of wild, rare and endangered plant species through in vitro plant tissue culture techniques are very useful for conserving biodiversity. In-situ conservation involves the maintenance and protection of natural habitats, while ex situ conservation involves the conservation or propagation of a species variety, clone or genetic material of plant species either in botanical garden, or in the process of seed banks or using some semi-natural habitat

environment. The techniques which were used in ancient times have their own importance in preserving and conserving the flora.

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