



Biodiversity and Strategies for Conservation of Medicinal Plants

*¹ Kulkarni L. C., ² Patil S Shredevi and ³ Paymalae Shivanand

*¹ Assistant Professor, Department of Botany, KLE'S, P. C. Jabin Science College, (Autonomous) Hubballi, Karnataka, INDIA.

² Assistant Professor, Govt. First Grade College, Hubballi, Karnataka, INDIA

³ Assistant Professor, KLE's, G H College, Haveri, Karnataka, INDIA

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Corresponding Author

Email: lkulkarni92@gmail.com

ABSTRACT

Abstract: The Biodiversity refers to all Different variety, number and variability of living organisms, each of these species or organism work together in an ecosystem. India is one of the world's top 12 mega diversity countries with 10 biogeographic regions. India alone includes two biodiversity hotspots among the world's eight biodiversity hotspots. The medicinal plants are used by various tribal's and local people to cure different ailments. The Medicinal plants occupy a vital sector of health care system in India and represent a major national resource. Some plants are recognized as very commonly used medicinal plants. Globally Medicinal plants are the valuable sources for herbal products and they are disappearing at a high speed. Hence, our study suggested that, there is a need for conservation of medicinal plants wealth for the present and fore coming generations, by adapting the suitable strategic methods of conservation. The strategies for conservation and sustainable use of medicinal plant resources such as in situ and ex situ conservation, cultivation practices, and resource management, sustainable use of medicinal plant resources, biotechnical approaches to improve yield and modify the potency of medicinal plants.

1. Introduction

The Medicine of the Medicinal plants plays an important role in the health care system of most developing countries. The medicinal plants knowledge has been gathered from the traditional medicine practitioners and their experiences inherited over the centuries for future generation. It is important to save these medicinal plants knowledge of biological heritage and explore new resources. Some of the medicinal plant species are traditionally utilized all over the country for health care, as food and other day to day life requirements. The generated traditional and ethnic knowledge played a significant role in the discovery of novel product as well as new ideas about conservation of natural resources. A large number of studies have been conducted with respect to medicinal plants and their possible use by different communities of the society such as ethnobotanical, ethnoveterinary, ethnomedicine etc., The World Health Organization (WHO) estimated that 80% of the population of developing countries rely on traditional medicinal plant drugs, for their primary health care needs. Of which 25% drugs the modern medicine derived from plants.

Demand for medicinal plant is increasing in both developing and developed countries due to growing, recognition of natural products, being non-narcotic, having no side-effects and easily available at affordable prices. Sometime this is only the source available for the health care to the poor people. Medicinal plant sector has traditionally occupied an important position in the sociocultural, spiritual and medicinal arena of rural and tribal lives of India. Around 50% (8000 species) of the higher flowering plant species of India are Medicinal plants. Millions of rural households are using medicinal plants in a self-help mode. Practitioners of the Indian System of Medicine the medicinal plants are used in the oral and codified streams for the preventive, promotive and curative applications. Though India has a rich biodiversity but, In recent years, a very high demand for herbal products on the existing resources for medicinal plants growing. There are 7,800 manufacturing units in India. Therefore, increasing threatened in their natural habitat. So, to meet for the future needs the conservation and cultivation of medicinal plants are to be encouraged.

In spite of this, the medicinal plant biodiversity is being depleted due to man-made and natural calamities. Moreover, the indigenous knowledge associated with the conservation and use of medicinal plants is also disappearing at an alarming rate. The medicinal plant survey carried out by the Ministry of Environment & Forests, Government of India, there are 8000 species of medicinal plants being used by the people of India. The fact that, the medicinal plants could be used as source of revenue for farmers. The Institute of Biodiversity Conservation (IBC) has initiated the development of a project on Conservation and Sustainable Use of Medicinal Plants (CSMPP)¹.

Medicinal plants are globally valuable sources of new drugs, up to 75 % of people in developing countries are totally dependent on herbal drugs for their primary healthcare, and over 25 % of prescribed medicines in developed countries are derived from wild plant species². With the increasing demand for herbal drugs, natural health products, and secondary metabolites of medicinal plants, the use of medicinal plants is growing rapidly throughout the world³.

A conservative estimation states that, the current loss of plant species is between 100 and 1000 times higher than the expected natural extinction rate, the Earth is losing one potential major drug every 2 years⁴. According to the International Union for Conservation of Nature and the World Wildlife Fund, there are between 50,000 and 80,000 flowering plant species used for medicinal purposes worldwide. Among these, about 15,000 species are threatened with extinction from overharvesting and habitat destruction and 20 % of their wild resources have already been nearly exhausted with the increasing human population and plant consumption. Although this threat has been known for decades, the accelerated loss of species and habitat destruction worldwide has increased the risk of extinction of medicinal plants, especially in China and India⁵.

The conservation and sustainable use of medicinal plants have been studied extensively. The various sets of recommendations have been compiled regarding their conservation, establishment of systems for species inventorying, status of monitoring, and the need for conservation strategies on both in situ and ex situ. In China and South Africa, the situation is critical because of the high demands of large populations.

2. Literature search

We collected systematic literature from the ISI Web of Science, PubMed and CNKI databases using search terms (e.g. "medicinal plant", "herbal drug", "herbal medicine", "aromatic plant", and "Chinese medicine") and keyword combinations (e.g. "in situ conservation", "ex situ conservation", "sustainable use", and "cultivation practice") to retrieve the abstracts of relevant articles. The carefully reviewed all retrieved abstracts to find articles on the conservation and sustainable use of medicinal plants, we retrieved full articles from full-text databases (Science Direct, Wiley, Biomed, Springer, Medline, Scopus, Elsevier, Highwire, Mcgill, Cogprints, Emedicine, Nature and Science online). From the initial search, abstracts, research articles, reviews, commentaries and letters were collected. A systematic screening was carried out for further evaluation.

2.1. Diversity of medicinal plants used worldwide

More than one-tenth of plant species (50,000 Sps) are used in drugs and health products. However, the distribution of medicinal plants is not uniform across the world⁵. For ex. China (11,146) and India(7500) have the highest numbers of medicinal plants used, followed by Colombia, South Africa, the United States, and another 16 countries ranging from 7 % in Malaysia to 44 % in India versus their total numbers of plant species. Some of the families have numbers of medicinal plants are high, but also have higher proportions of threatened species than others⁶. Only a portion of medicinal plants that suffer from genetic erosion and resource destruction have been listed as threatened.

2.2. Conservation strategies

The increasing volumes of Medicinal plant resources are being harvested by tribal populations. Indeed, in recent decades demand for wild resources has increased by 8–15 % per year in Europe, North America, and Asia. There is a threshold below which species reproductive capacity becomes irreversibly reduced. Various sets of recommendations relating to the conservation of medicinal plants have been developed, such as providing both in situ and ex situ conservation. Natural reserves and wild nurseries are typical examples to retain the medical efficacy of plants in their natural habitats, the botanic gardens and seed banks are important paradigms for ex situ conservation for future replanting. The geographic distribution and biological characteristics of medicinal plants must be known to guide conservation activities, e.g. to assess whether species conservation should take place in nature or in a nursery.

2.3. In situ conservation

Most of the medicinal plants are endemic species, their medicinal properties are secondary metabolites that respond to stimuli in natural environments and that may not be expressed under culture conditions⁷. In situ conservation of whole communities allows us to protect indigenous plants and maintain natural communities, along with their intricate network of relationships. Additionally, in situ conservation increases the amount of diversity, strengthens the link between resource conservation and sustainable use. In situ conservation efforts worldwide have focused on establishing protected area, approach is ecosystem-oriented, rather than species-oriented. Successful in situ conservation depends on rules, regulations, and potential compliance of medicinal plants within growth habitats.

2.4. Natural reserves

The degradation and destruction of habitats is a major cause for the loss of medicinal plant resources. Natural reserves are protected areas of important wild resources created to preserve and restore biodiversity. Around the

world, more than 12,700 million km² protected areas have been established, accounting for 13.2 million km², or 8.81 % of the Earth's land surface. Conserving medicinal plants by protecting natural and the individual habitat contribute the ecosystem functions.

2.5. Wild nurseries

It is impossible to designate every natural wild plant habitat as a protected area. A wild nursery is established for species-oriented cultivating, domestication of endangered medicinal plants in a protected area, natural habitat, or a place where the plants naturally grow. Although the populations of many wild species are under heavy pressure because of overexploitation and habitat degradation. So, the wild nurseries can provide an effective approach for in situ conservation of medicinal plants that are endemic, endangered, and in-demand.

2.6. Ex situ conservation

Ex situ conservation is not always sharply separated from in situ conservation, but it is an effective complement to it, especially for those overexploited and endangered medicinal plants with slow growth, low abundance, and high susceptibility to replanting diseases¹. Ex situ conservation aims to produce large quantities of planting material used in the creation of drugs and it is often an immediate action taken to sustain medicinal plant resources. Many species of previously wild medicinal plants they retain high potency when grown in gardens far away from the habitats where they naturally occur, but can have their reproductive materials selected and stored in seed banks for future replanting¹.

2.7. Botanic gardens

Botanical gardens play an important role in ex situ conservation, they can maintain the ecosystems to enhance the survival of rare and endangered plant species. Botanical gardens have multiple unique features. They involve a wide variety of plant species grown together under common conditions, contain taxonomically and ecologically diverse flora. Botanic gardens can play a further role in medicinal plant conservation through the development of propagation and cultivation protocols, as well as undertaking programs of domestication and variety breeding.

2.8. Seed banks

Seed banks offer a better way of storing the genetic diversity of medicinal plants ex situ than through botanic gardens, they are recommended to help preserve the biological and genetic diversity of wild plant species. The most noteworthy seed bank is the Millennium Seed Bank Project at the Royal Botanic Gardens in Britain. Seed banks allow relatively rapid access to plant samples for the evaluation of their properties, providing helpful information for conserving the remaining natural populations. The challenging tasks of seed banking are how to reintroduce the plant species back into the wild and how to actively assist in the restoration of wild populations.

2.9. Cultivation practice

Although wild-harvested resources of medicinal plants are widely considered more efficacious than those that are cultivated. The domestic cultivation is a widely used and generally accepted practice. Cultivation provides the opportunity to use new techniques to solve problems encountered in the production of medicinal plants, such as toxic components, pesticide contamination, low contents of active ingredients, and the misidentification of botanical origin⁸. Cultivation under controlled growth conditions can improve the yields of active secondary metabolites compounds and ensures production stability. Cultivation practices are designed to provide optimal levels of water, nutrients, optional additives, environmental factors including temperature, light and humidity to obtain improved yields of target products. Moreover, increased cultivation contributes to decreases in the harvest volume of medicinal plants, benefits the recovery of their wild resources, and decreases their prices to a more reasonable range.

Price and harvest volume variation in the transition from wild-harvesting to cultivation of medicinal plants. As wild resources decline with overharvesting, the price of raw material increases accordingly. Therefore, cultivation becomes economically feasible for price stabilization and resource recovery of medicinal plants⁵.

2.10. Good agricultural practices (GAP)

Good agricultural practices (GAP) for medicinal plants have been formulated to regulate production, ensure quality, and facilitate the standardization of herbal drugs⁹. A GAP approach ensures high quality, safe and pollution-free herbal drugs (or crude drugs) by applying available knowledge to address various problems. GAP include

comprehensive items, such as the ecological environment of production sites, germplasm, cultivation, collection, and quality aspects of pesticide detection, macroscopic or microscopic authentication, chemical identification of bioactive compounds, and inspection of metal elements. Many countries actively promote the implementation of GAP. For example, Chinese authorities have promoted GAP for the growth of commonly used herbal drugs in regions where those medicinal plants are traditionally cultivated¹⁰.

Organic farming has received increasing attention for its ability to create integrated, human, environmentally and economically sustainable production systems for medicinal plants. The aims of organic farming of medicinal plants include producing material with better quality, high productivity, ensuring the conservation and sustainable utilization of those plants (Table 1).

The defining characteristic of organic farming is the non-use of synthetic fertilizers, pesticides and herbicides, which are not allowed according to many current organic certification standards in Europe and North America. Organic farming is benign to the environment, relies upon farm-derived renewable resources to maintain biological processes of medicinal plants and ecological balance of habitats. The use of organic fertilizers continuously supplies soil nutrients, improves soil stability, significantly affecting the growth of medicinal plants and the biosynthesis of essential substances. For example, when organic fertilizers were applied, the biomass yield of *Chrysanthemum balsamita* was increased and its essential oil content was high relative to those free from organic fertilizers. Organic farming of medicinal plants is becoming increasingly important in the long-term development and sustainability of medicinal plants.

Table-1
The characteristics and advantages of organic farming of medicinal plants

Subjects	Characteristics and advantages of organic farming
Medicinal plants	To produce material in optimal quality and sufficient quantity
	increase growth rate and biomass yield of medicinal plants
	To enhance the biosynthesis of efficacious substances
	maintain the genetic diversity of medicinal plants
	protect medicinal plants against pests and disease
Environmental effects	prohibit the use of synthetic pesticides and fertilizers
	promote sustainable use and proper care of production systems
	enhance plant diversity and biotype conservation
	To protect wildlife habitats (e.g. micro-organisms, soil fora and fauna)
	enhance soil rich in macro and microelements
	conserve soil properties, fertility, productivity and system stability
	use organic fertilizers and renewable resources to minimize all forms of pollution
Economic prospects	increase market opportunity
	To maintain high market price
	achieve optimal quality and economic returns
	secure economic growth and social stability

2.11. Sustainable use

For medicinal plants with limited abundance and slow growth, destructive harvesting as results in resource exhaustion and even species extinction¹¹. Therefore, the sustainable use of medicinal plants should be considered, good harvesting practices must be formulated. Root and whole-plant harvesting is more destructive to medicinal plants (e.g. herbs, shrubs and trees) than collecting their leaves and flowers or buds (Table-2). For herbal drugs made of whole plants or roots, using their leaves as a remedy can be a benign alternative. For example, Wang et al. discovered that extracts from ginseng leaf-stems and roots have similar pharmacological activities, but ginseng leaf-stem has the advantage of being a more sustainable resource.

Table-2.
Susceptibility of species to overharvesting regarding life forms and plant part used.

Life form	Percent (%)	Leaf	Flower/bud	Fruit/seed	Bark	Root	Whole plant
Herb	52	Medium	Medium	High	None	High	High
Shrub	16	Low	Low	Low	High	High	High
Tree	22	Low	Low	Low	High	High	High

Prospects

The development of genetic engineering has led to the feasibility of large-scale biosynthesis of natural products, advancements in tissue culture and fermentation of medicinal plants have opened new avenues for the large-scale and highly efficient production of desirable bioactive compounds. Tissue culture (including plant cell and transgenic hairy root culture) is a promising alternative for the production of rare and high-value secondary metabolites of medical importance. Micropropagation via tissue encapsulation of propagules can not only facilitate storage and transportation, but also promotes higher regeneration rates. When the amounts of normal seeds are insufficient for propagation, synthetic seed technology, defined as artificially encapsulated somatic embryos (or other tissues) could be used for cultivate in vitro or ex vitro, is a feasible alternative. Furthermore, breeding improvements can be carried out using molecular marker-based approaches applied at the genetic level, and the time required for breeding may be significantly shortened¹².

Conclusion

Despite the existence of various sets of recommendations for the conservation and sustainable use of medicinal plants, only a small portion of these have achieved adequate protection of medicinal plant resources through conventional conservation in natural reserves or botanic gardens.

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