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Innovative approach for assessing sustainability of the medicinal plant-*Gardenia gummifera* Linn. F.

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Less known medicinal plants were studied in Bhopal and Sehore districts, M.P. India to suggest appropriate strategies for their sustainable management. The study area was rich in medicinal plants but due to their extensive uses and habitat degradation, these were less available. An innovative approach has been developed to assess the status of certain less known medicinal plants among which *Gardenia gummifera* was one. The approach comprise of six categories and 25 parameters namely: habitat (5 parameters), ecology (3 parameters), biology (6 parameters), use/trade (3 parameters), collection (4 parameters), and legal and institutional (4 parameters). These were arrived after study of relevant literature, discussion with the knowledgeable persons and field situation in the study area. All the parameters have been ranked into three scoring levels namely: low, medium and high with scoring of 1, 2 and 4 marks respectively. The species was studied and ranked as vulnerable based on these parameters. The primary source of data was field observations on the selected species and interviewing the stakeholders' that is, herbal practitioners, primary collectors, dealers and manufacturers. Attempts were made to know the degradation of natural habitats, biotic disturbances and exploitation. *G. gummifera* scored minimum marks (46%) which indicate its rareness in the area and over exploitation. Attempts have been made to suggest strategy for the conservation and sustainable utilization including training to build capacity of primary collectors.

Key words: Assessment, categories, parameters, threatened, medicinal plants, value addition.

INTRODUCTION

The people in India have tremendous passion for medicinal plants. In the oral tradition, the local communities in every ecosystem right from the Trans Himalayas down to the coastal plains have discovered the medicinal uses of thousands of plants occurring in their surroundings. They use them for a wide range of health related applications from common cold to memory improvement, treatment of poisonous snakebites as cure for muscular dystrophy and enhancement for general immunity of the body.

There are several traditional rituals (ethno-botany) highlighting the importance of certain plants. On festivals the flowers or fruits are offered to the Gods or Deities. Some of these are- Paradise flower, Plants of Bible,

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worship of Basil (Tulsi) or Lakshmi, the Goddess of prosperity on Lotus. Yet ethno-botany is generally taken as science of relationship of only primitive or aboriginal people with plants (Jain and Mitra, 1997). All traditional systems of medicine had their roots in ethno-botany (Jain and Mitra, 1997). The word ethno botany was applied to such knowledge by Harshberger (1895). India probably has one of the richest plant medicine cultures in the world. It is a culture that is of tremendous contemporary relevance because, it can on one hand ensure health security to millions of people and on the other it can provide new and safe herbal medicines to the entire world.

There are around 25000 plant based formulations used in folk medicine known to rural communities over India. Around 10000 formulations are available in indigenous medical texts, many of which are yet to be sufficiently tapped (Basu and Kirtikar, 1918). The science of traditional medicine flourished in India for quite a long time yet for the while it was subdued under the impact of modern medicine. The coming of chemical revolution in world and boom of synthetic products including the synthetic medicines, the faith in and the popularity of traditional herbal medicines gradually declined but now it is upcoming.

ASSESSMENT OF THREATS ON MEDICINAL PLANTS

Detailed studies on the distribution and utilization pattern of selected medicinal plant species was done in Sehore and Bhopal Districts of Madhya Pradesh, India. Efforts have been made to prioritize medicinal plants of conservation concern beginning with south India, and subsequently for northern and central India also, using conservation assessment and management planning (CAMP) methodology for assessment of threat status in accordance with the IUCN red list categories. The result of these CAMP workshops for South India enlists about 112 medicinal plant taxa under various degrees of threats ranging from “threatened” to “extinct in the wild”. Similar threat assessment exercises were carried out for Northern India’s medicinal plant species also. The CAMP workshops for high altitude Himalayan medicinal plants of Jammu and Kashmir and Himanchal Pradesh have assigned Red list categories to 42 taxa of temperate region.

The 1997 IUCN red list of threatened plants published by the IUCN Species Survival Commission presents a shocking picture of nearly 34000 species, or 12.5% of the world’s flora, facing extinction. Using the same proportion for recorded medicinal plants, India’s nearly 10000 native medicinal plant species are expected to fall the into threatened category. This indicates that special conservation measures are required for these plants failing which these are likely to become extinct and the world will be deprived of their usefulness.

The causes of decline

The cause of decline in the distributional area and the population of these plants may be natural such as extreme climatic conditions like drought, flood, cold, hot, diseases, problems in regeneration etc. More useful species are over exploited and become threatened.

Nearly 90% of medicinal plants used by the Indian Industry are collected from the wild. More then 70% of the collections involve destructive harvesting from the wild use of the parts like flowers, fruits, seeds, roots, bark, wood, stem and the entire plant (herbs). These pose definite threats to the sustainable survival of medicinal plants (Kotwal and Bhattacharya, 1999).

Due to popularity, drug companies (under the license) manufacture many of the Ayurvedic medicines. As a result there is increase in global demands for natural products over the last two decades or so. The entrepreneurs were under pressure to meet the demands for which they resorted to unsustainable practices. These include premature harvesting, destructive harvesting, over harvesting, lack of quality control, compromise on quality of raw material etc. All these contribute in making the Ayurveda medicinal practice un-popular.

The trade in medicinal plants

The demand for the raw material is much more than the availability. Due to either unavailability or less availability of some of the medicinal plants, which either have become extinct or have become rare, their cost has become quite high. The manufacturers find it difficult to use such species in formulation as the price of the medicine manufactured from rare/costly plant would be high. This compels the manufacturers to add a substitute, which is not prescribed in the texts. The substituting material may not be beneficial and at times may be harmful. Adulteration makes the medicines either less effective or ineffective (Ram, 2000).

Though Ayurveda specifies usage of 1200 to 1500 medicinal plants, contemporary Ayurvedic Industry consume around 550 to 600 medicinal plants, out of these around 90% are procured from wild areas mostly the forest land. Another category of medicinal plants consists of species which grow in wild as well as in agriculture lands. Some species are grown commercially on large scale to meet the demand of Ayurvedic industry. Medicinal plants procured from cultivated fields amount for less then 10% of total medicinal plants in trade.

The Government of India banned export of some 29 species of medicinal plants. Various studies being done over a period has indicated risk of extinction of valuable species due to high industrial demand. The results of a series of conservation assessment and management planning workshops (CAMP) held in various parts of the country to assess the threat status of important medicinal

plants are alarming. Several species were found in endangered category. This signifies that the distribution range and population of most of the useful plants have critically reduced and if conservation efforts are not strictly implemented then these are likely to become extinct. The turnover of the Indian herbal drug industry was Rs. 2300 crore during 1997 and reached around Rs. 4000 crore by year 2000. The total estimated quantity of exports was 36200 tones in the year 2000. It is estimated that this can be raised to Rs. 3000 crore by 2005 and to Rs. 10000 crore by 2010 as per estimates of Planning Commission (2000). At present the share of India in world Herbal Market is quite insignificant due to the lack of organizations both at cultivator / collector as well as industry level (Bisen, 2001).

Sustainable harvesting

Sustainability is very important aspect particularly in production and harvesting of medicinal plants. Most of the medicinal plants growing in nature are over exploited. Without doubt some of the high value herbs are threatened with extinction in the wild. There are several medicinal herbs, which are considered as economically profitable in harvesting from the wilderness. Some are relatively abundant, whereas many others are moderately available and few important species are concentrated only in certain pockets, which are mostly threatened. Several species are in high demand by the traders. Competition has resulted in the early and over harvest of few species from the more accessible sites. The bulk is picked when plants are only 2/3 or even half of their potential age and size. The optimal time of harvest for most species is immediately after the seeds reach maturity. Harvesting of mature plants in appropriate extent and by proper method would result in more yield of better quality. Despite these benefits, collection frequently takes place much earlier. Competition between collectors is one of the main causes of pre mature harvesting on open access land that is, forest. Large scale harvesting before maturity reduces the size of population (density) of exploited species.

The study site

The study was conducted in Bhopal and Sehore districts of Madhya Pradesh, India. Bhopal is capital of the state and situated on 23° 16' north latitude and 77° 25' east longitude. The total area of the district is 2778.0 sq. km and the reported human population is 1836784. Sehore is the parent district of Bhopal, which was formed much later, then its formation as the state capital. It is about 35 km West of Bhopal. The area of Sehore district lies between latitudes 23° 33' to 23° 38' 52' N and longitudes 76° 36' to 76° 59'. The total area of the district is 6563.68 sq. km. Both districts have tropical dry deciduous forests (Gazetteer, 1999).

Objectives of the study

1. To study the traditional uses of less known medicinal plants.
2. To suggest appropriate strategies for research development and sustainable management.

METHODOLOGY

At the initial stage it was very difficult to precisely decide the names of less known plants of the study area from which detailed studies were made.

A list of important medicinal plants of the study area was prepared. This was based on frequent field visits, study of literature (Hains, 1916) and discussion with herbal practitioners. Thereafter the species for detailed studies were selected. The criteria for selection were based on occurrence of the species in different habitats, their importance and relatively less known for traditional uses in the area. The web site of Google (Internet web site) was searched on the internet for all the important medicinal plants of the study area. The number of searches was categorized in three categories namely:

1) Less known = up to 1000
2) More known = 1001 to 3000
3) Most known ≥ 3000

The "rapid vulnerability assessment" (RVA) method (Jennifer et al., 2001) collects information to identify species, resources and sites that may be at risk of over exploitation. Although it was very difficult to elicit the required information from the local herbal practitioners, still attempts were made to get some information on various aspects of relatively less known medicinal plants of the study area. A questionnaire and data format was specially developed for the study covering following aspects: Local, vernacular and botanical names, description, geographical distribution, habitat suitability and habitat specificity, biotic disturbances, distribution and abundance of selected medicinal plant, growth, flowering, fruiting, regeneration, pests and diseases, use and trade, collection related aspects, legal and institutional aspects. Suggestions are given for research development and sustainable management. For assessing sustainability of medicinal plant, the following six categories were recognized (Table 1).

A. Habitat - 5 parameters (Habitat suitability, habitat specificity, climate (rainfall, temperature), biotic disturbances (Grazing, fire), protection level).
B. Ecology - 3 parameters (Occurrence, distribution and abundance).
C. Biology - 6 parameters (Growth, flowering, fruiting, seeding, regeneration, pests and diseases.
D. Use/trade - 3 parameters (Plant parts used, other uses (wood, tannin, fiber etc.), Use/trade).
E. Collection - 4 parameters (Collection stage, collection extent, collection method, collecting people).
F. Legal and institutional - 4 parameters (Legal protection, institutions (Societies), awareness, capacity building).

Thus a total of 25 parameters were identified covering all aspects to assess the sustainability. These were arrived after study of relevant literature, discussion with the knowledgeable persons and field situation in the study area. All the parameters have been ranked into three levels of scoring namely: low, medium and high with

Table 1. Parameters for assessing sustainability of *Gardenia gummifera***.** Scoring: Low = 1, Medium = 2 and High = 4.

S/N	Parameters	Low (1 mark)	Medium (2 marks)	High (4 marks)
A. Habitat				
1	Habitat suitability	Less suitable	----	----
2	Habitat specificity	Specific	----	----
3	Climate (Rainfall, temperature)	----	----	Normal
4	Biotic disturbances (grazing, fire)	---	Frequent	----
5	Protection level	----	Good	----
Sub-Total		2	4	4
Habitat 10 marks out of maximum 20 (50.0%)				
B. Plant ecology				
6	Occurrence	Wild	----	----
7	Distribution	Fragmented	----	----
8	Abundance	Scanty	----	----
	Sub-Total	3	----	----
	Scoring 3 marks out of 12 (25.0%)			
C. Plant biology				
9	Growth	Poor	----	----
10	Flowering	----	Good	----
11	Fruiting	----	Good	-----
12	Seeding	Poor	----	-----
13	Regeneration	Poor	----	----
14	Pests and diseases	----	----	Few
Sub- Total		3	4	4
Scoring 11 marks out of 24 (45.8%)				
D. Use/Trade				
15	Plant parts used	----	Gum –Bark , terminal buds	-----
16	Other uses (Wood, tannin, fiber etc.)	----	----	1use
17	Use/trade	----	Localised	---
Sub-Total		----	4	4
Scoring 8 marks out of 12 (66.7%)				
E. Collection				
18	Collection stage	----	Sub- Mature	----
19	Collection extent		----	Least
20	Collection method	----	Partly destructive	----
21	Collecting people	----	Un-Organised	---
Sub-Total		----	6	4
Scoring 10 marks out of 16 (62.5%)				
F. Legal, institutional				
22	Legal protection	Poor	----	----
23	Institutions (Societies)	Few	----	----
24	Awareness	Scanty	----	----
25	Capacity building	Least	----	----
Sub-Total		4	----	----
Scoring 4 marks out of 16 (25.0%)				

scoring of 1, 2 and 4 marks respectively. The species were studied and ranked according to these parameters. Based on these considerations 10 species were selected for detailed study among which *Gardenia gummifera* was one.

***Gardennia gummifera Linn. F.* (Family Rubiaceae)**

Other names for *G. gummifera Linn. F.* are *Hing patri*, *Dikamali, Gurudu*, *Cambi gum tree*, *Kamarri*, *Manchi bikki*, *Tella – manga*, *Kambili ppicin*, and *Cittubikke* for Sanskrit, Hindi, Oriya, English, Gujarati, Telgu, Tamil and Kanada, respectively. Distribution of *G. gummifera Linn. F.* occurs throughout India in Tropical Natural Forests. In Madhya Pradesh state it is one of the constituent species of natural forests and found in almost all the districts. In the study area it was observed in Samardha, Berasia, Budni and Bhopal forest ranges.

Habitat

The plant is a small tree or shrub and grows in rocky areas in slightly undulating terrain along with other species. It occurs in specific habitats having well drained shallow soil with exposed rocks at places usually on plateaus, which are not too dry. It has specific habitat requirements as mentioned previously. Normal range of maximum and minimum temperature and rainfall in the area is quite suitable for the species. The deficit rains has resulted in drying of some plants during peak of summer. Some plants were partly dried and re-sprouted during rainy season. The plant grows only in natural forests, which are mainly managed by Government. The biotic disturbance in the form of accidental forest fires, livestock grazing and illicit cutting of trees is of common occurrence in the study area. Since the species grows only in natural forests and therefore it gets some protection better then those growing in wastelands.

Plant ecology

Under this heading are three parameters of occurrence, distribution and abundance of the species are considered. The plant grows only in the natural forests and not cultivated. However it has a very good potential for growing in gardens because of its beautiful white fragrant flowers beside medicinal value for its gum after which it derives its scientific name. The distribution of the species is fragmented at least within the study area. It can be seen in specific areas only and not found for a considerable distance indicating its fragmented distribution. The extent of occurrence is scanty because it can be seen only at few places.

Plant biology

A large handsome shrub with white bark, sub-sessile shining simple leaves which are apposite and decussately arranged. Leaf size is 3 to 8 cm long, and 12 to 16 pairs of secondary nerves. Flowers are large (2 to 3 cm) with white fragrant. Fruit is ovoid (2 to 4 cm) with fleshy mesocarp, and is edible. Flowering occurs during June to July. The plant flowers every year during onset of monsoon rains. However sporadic flowering takes place during other months of the year. Fruiting is during August to October. The fruiting medium has 20 to 40 fruits per bush.

Seeding is medium in extent. Some fruits dry pre-maturely owing to very hot and dry weather conditions. The regeneration is usually by seeds, which are spread by birds that feed on the fruits. Some times mature fruits fall on the ground releasing seeds, which germinate under favorable conditions. Growth is slow. In the study area most of the plants were in bushy form.

Use/ trade

Only gum resin is medicinally useful which comes on the tip of the branches. Other parts of the plant do not have any specific use except the flowers. However, the local people along with other similar material collect the dried plants as fuelwood.

Collection

The gum resin at the tip of branches is collected by breaking the terminal bud usually by hand. In the study area the collection was negligible. In the event of collecting the gum resin, the terminal buds are affected. The gum resin from main stem is also collected.

The method of collection is partly destructive affecting the terminal buds and sometimes the main stem in case of collection on large scale. Only some local people sponsored by local herbal practitioners collect gum resin. Un-organised local people make collections. In the study area commercial collection does not take place probably because of less availability of plants.

Legal, institutional

The species has no specific legal protection as in case of other species listed in Wildlife (Protection) Act, CITES, negative list of export etc. However, the habitat has some level of protection because it grows in Government forest. Most of the people are not much aware about the importance and use of this species. There are no societies specifically for collection of this or any other medicinal plant. At present there are no efforts towards any capacity building measures for sustainable collection and utilization of medicinal plants.

Therapeutic properties and uses (Parts used- gum)

Local use

It is useful in excretion of intestinal parasitic worms. When given orally with local cow urine for hook worms, 1 g of gum + 6 g cumin + 20 g and cow urine excretes the worms.

Other uses

The gum locally known as Dinkamali (*G. gummifera*) is used to treat stomach ailments in humans. In the market it costs 50 rupees for 100 g. Dinkamali is also used as spray on soybean crops to combat *Heliothis armigera* and on vegetable crops such as cauliflower, tomato and cabbage to combat other small insects. The process of preparation is the same as for asafetida, except that the mixture is boiled for 25 to 30 min (CSIR, 1986) (Figure 1).

Gardenia flowers are not raised by the Indian floriculturists, although some species are found in gardens. The young shoots of *G. gummifera* are the source of Dikamali gum, used to rub on the gums of infants when teething. The gum is antiseptic, carminative, expectorant, sore, spasm, stimulant, vermifuge, repellant (Figure 2).

RESULTS AND DISCUSSION

Detailed observations on 25 parameters of medicinal plant are given in Table 2.

The species has scored 46 marks out of 100. It has scored fewer marks under habitat, plant ecology, collection, use and legal, institutional parameters based on the scoring it is ranked as vulnerable.

Habitat

Habitat is the home of living organisms. The medicinal

Figure 1. Gardenia gummifera – A plant.

Figure 2. Gardenia gummifera – A flower.

plants are affected by the habitat. The *G. gummifera* has scored 50% marks, which indicates the causes of it being so rare. Because of its medicinal values, it is in demand, due to which it is over exploited. It is difficult to meet the demand only from the wilderness. Cultivation of the species is the alternative but standard methods of commercial cultivation not readily available.

Plant ecology

A minimum of 41.7 marks were scored by *G. gummifera*. The species occurs only in wilderness areas and not cultivated in the study area. It has fragmented distribution and scanty occurrence in specific habitats.

Plant biology

The intrinsic factors within the plant body play important role in growth. These are flowering, fruiting, seeding, regeneration and resistance to pests and diseases. The species under reference was studied in respect of these parameters. *G. gummifera* scored 45.8% marks. The

Table 2. Scoring of marks for sustainability of *Gardenia gummifera* under various parameters.

Category	Parameters	Total marks	Marks scored	%
A	Habitat	20	10	50.0
B	Plant ecology	12	5	41.7
C	Plant biology	24	11	45.8
D	Use/Trade	12	8	66.7
E	Collection	16	10	62.5
F	Legal, institutional	16	4	25.0
Total	---	100	46	---

Ranking; Critical = 25, Vulnerable = 25 to 50 and Not vulnerable = > 50.

species has poor regeneration due to different reasons. The species occurs only in wilderness areas and not cultivated. Only few mature fruits fall on ground and the natural regeneration is poor.

Use/trade

Various parts of plants have different uses. In some species only one part is useful while in others more parts are useful. The species has scored a 66.7% marks due to use of only one part on local scale only.

Collection

Useful plants and plant parts are collected. There are three main aspects under this. These are stage of collection, extent of collection and method of collection. The score of the species is 62.5%, which is slightly more, then limits of vulnerability. It is because of less availability of the required material and collection at local level only.

Legal institutional

This is also a very important parameter that affects various aspects of the medicinal plants. Certain species that come under threatened categories of IUCN, in appendices of CITES, listed in negative list of export and in Wildlife (Protection) Act have legal protection with provisions of punishment. *G. gummifera* has no such legal status. The species has scored 25% marks due to no effective legal protection.

RESEARCH DEVELOPMENTS

The natural regeneration of the species is poor. It has slightly specific type of habitat requirements. Very little can be practically done in its natural habitat on these aspects except reduction of biotic disturbances:

1) The species has slow growth because of intrinsic factors. It produces few mature seeds, which are the only means of regeneration. The fruits are eaten by birds and thus an attraction for them. It does not propagate in nature by vegetative means. Looking to the medicinal importance and also aesthetic value the plant has the potential for growing in gardens and in that eventuality other means of propagation can be developed.

2) Some awareness can be created among the people about its use and importance. It will be worthwhile to organize the local people in the form of societies for sustainable utilization of medicinal plants.

Conservation and sustainable utilization

It is necessary to develop appropriate programme for conservation and sustainable utilization of medicinal plants particularly for the health care of rural poor and also to help in their livelihoods. For the state of Madhya Pradesh 35 species of medicinal plants and 16 species of aromatic plants has been prepared as priority list and a business plan has been developed for these species (Government of Madhya Pradesh, 2002).

Attempts have been made to suggest strategy for the conservation and sustainable utilization. Suggestions for training to build capacity of primary collectors in terms of time, methods and quantity to be collected. It has been observed that poor returns to dependant population also accelerate over exploitation of the useful species. Ethical approach may lead to sustainable utilization.

The medicinal plants are the principle health care resources for majority of the people living in rural areas. Their demand is increasing day-by-day. Most of the material is harvested from wilderness areas, mainly the forests. Only few species are cultivated. The unregulated collection and trade of medicinal plants has serious implications on the survival of many species, which are threatened. Beside, it is also important to develop appropriate harvesting standards based on scientific studies (FRLHT, 1997, 1999).

Techniques for commercial cultivation of prioritized species that are in high demand but short supply from wilderness also need to be developed and the technology should be transferred from lab to the land for wider use. There is need to emphasize *in-situ* conservation of

medicinal plants and their sustainable harvesting involving local people. Some of the Joint Forest Management Committees may be motivated for this.

It is very important to impart necessary training to the concerned local people for technical issues pertaining to conservation, cultivation, value addition and marketing of medicinal plants. Value addition is very important aspect for fetching better returns to primary collectors. The values of processed products may increase by 8 to 10 times than the raw products.

Marketing a medicinal plant is ticklish due to poor storage, poor transport and lack of definite consumers/purchasers. Due to uncertainty of marketing, some medicinal plants are not collected. Some of the manufacturers do not prefer to purchase processed material due to apprehension of adulteration. The buyers dictate marketing.

The deterioration in quality leads to poor marketing. The manufacturers and other stakeholders in the sector need to ensure “quality standards” in collection, value addition, transport, storage and processing of end products to ensure the efficacy of Ayurvedic medicines. Attempts should be made to develop standards for certification of medicinal plants as “Organic or Natural products”. Similarly, cultivation of medicinal plants should also be done without use of pesticides or chemical fertilizer so as to ensure their medicinal properties and standard quality.

Conclusion

The utilization of medicinal plants in the remote past was sustainable. The traditional ethics were followed which imposed several restrictions on time of collection, method of collection, extent of collection etc. The practitioners followed the traditional ethics, and as such, the natural habitats were maintained and the natural regeneration was ensured with continued availability of medicinal plants.

But in the recent times the traditional ethics are not followed possibly due to high demand and the greed. This has reversed the situation from plenty to scanty. This is the situation with respect to most of the natural resources. Therefore appropriate strategies covering aforementioned parameters need to be developed and implemented. The innovative approach of assessment of all parameters for each species is quite holistic covering all the aspects. This has the potential to assess weaknesses and gaps in the present position and practices with definite indications for sustainable management of medicinal plants.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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