



*Final Project Report*  
of  
***In-situ* conservation of *Commiphora wightii***  
**a red-listed medicinal plant species of**  
**Rajasthan state, India**

**Principal Investigator: Dr. Vineet Soni**



## Acknowledgements

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*This survey-cum-conservation campaign was impossible without the overwhelming interest and support from my collaborators (Mrs Neha Verma, Mr. Gopal Swarnkar and Dr. M.S. Rao, Mr. R.N.Verma, Mr. Dilip Sahu), who bear with me during all the hectic, hot and as well as cold days, with very limited facilities. I am also thankful to all the villagers for their warm hospitality during the awareness programs in their areas. Their involvement and participation only made this program a success with meaningful outcome.*

*Last but not least, I would like to thank all the participants, especially the local villagers for their involvement and understanding in making this conservation program a success with meaningful out comes.*



**(Dr. Vineet Soni)**

Date: 30 November 2008



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## OVERVIEW

The erosion of plant biodiversity is a matter of global concern. The problem is more acute in regions of extreme climates; as such regions are poor in biodiversity. Rajasthan is stated to have a large number of species that are endemic to this region. Many of them serve as sources of food, fuel, fibre, timber, medicine etc., and function as an integral part of local agricultural production systems. Disappearance of plant diversity in such extreme regions may be an irreversible loss from socio-economic, scientific and utility.

*Commiphora wightii* (Arnott) Bhandari (Figure: 1) is an important medicinal plant of herbal heritage of India. In Indian languages, it is known by various names like guggul in Hindi, gukkulu and maishakshi in Tamil, guggulu in Sanskrit and Indian bdellium in English. This plant is distributed in arid areas of India, Bangladesh and Pakistan. In India it is found in arid, rocky tracts of Rajasthan and Gujarat.



**Figure-1: Guggul plant growing in natural habitat**

### Systematic position of *C. wightii*

• Kingdom	Plantae
• Phylum	Tracheophyta
• Class	Magnoliopsida
• Order	Sapindales
• Family	Burseraceae
• Genus	<i>Commiphora</i>
• Species	<i>wightii</i>
• Species Authority	(Arnott) Bhandari

*C. wightii* is a small tree or shrub. It is a slow growing plant and takes 8 to 10 years to reach to a height of 3 to 3.5 meters. The plant is dimorphic, one having bisexual and male flowers and the other having female flowers with staminodes. A third category of plant with only male flowers has also been reported (Gupta *et al.*, 1996). The fruits are green berry like drupe. Size of the fruit varies from 6 to 8 mm

in diameter. Fruit parts exposed to sun develop pinkish tinge. Fruits remain on the plant for several months. Seeds show polyembryonic nature.

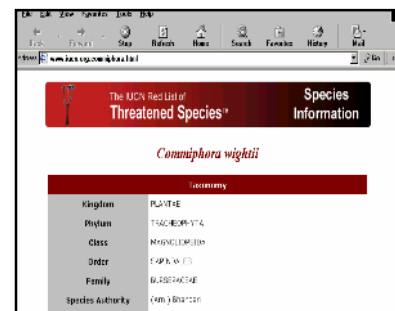
The use of plants in the treatment of diseases occupies an important place in Ayurveda, the traditional medicine system of India. The Atharva Veda, one of the four well-known Holy Scriptures (Vedas) of the Hindus, is the earliest reference to the medicinal and therapeutic properties of guggul. Sushruta Samhita (600 B.C.), a well-known Ayurvedic medical text, describes the usefulness of the gum resin from the tree *C. wightii* in the treatment of a number of ailments, including obesity and disorders of lipid metabolism. The plant *C. wightii* provides oleo-gum resin mentioned by Sushruta (3000 year ago) as being a valuable drug. The oleo-gum resin commonly known as “gum guggul” or “Indian



Figure- 2: Exudation of oleo gum resin from woody stem of guggul plant

myrrh” is the economically important product of Indian bdellium. The oleo-gum is collected as exudates from woody stem (Figure: 2). A plant generally takes 10 years to reach tapping maturity under the dry climatic conditions. The thick branches are incised during the winter to extract the oleo-gum resin. Guggul gum is a mixture of 61% resins and 29.3 % gum, in addition to 6.1% water, 0.6 % volatile oil and 3.2 % foreign matter.

Unfortunately the plant *Commiphora wightii* has become endangered because of its slow growing nature, poor seed setting, lack of cultivation, poor seed germination rate and excessive and unscientific tapping



for its gum resin by the pharmaceutical industries and religious prophets. This plant is incorporated in Data Deficient category of IUCN’s Red Data list.



## **OBJECTIVES OF PROJECT**

The broad goals and objectives of proposed work were:

- To conserve *Commiphora wightii* in its natural habitat (*in situ* protection) through the development of protected area networks.
- To involve local communities (rural and tribal peoples) as well as local authorities in *in situ* conservation.
- To provide education on the value of medicinal succulent plants, and the need for their conservation and sustainable use.

## **PROJECT SITE LOCATIONS**

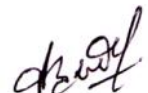
Rajasthan is situated in the northwestern part of India and lies between 23°30'N- 30°11'N latitude and 69°29'E- 78°17' E longitude, occupying an area of 3,42,239 sq. km. The hills of Aravalli range roughly divides Rajasthan diagonally into two physiological zones, namely the Thar Desert in the west and semi-arid to sub-humid eastern and southeastern Rajasthan. Sixty



Figure- 3: Discussion with a traditional healers

per cent of the Thar Desert is located in northwestern part of Rajasthan.

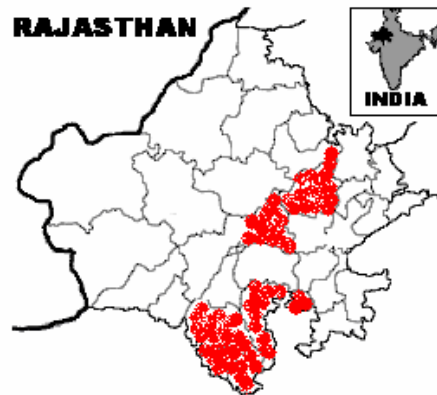
*C. wightii* is naturally found in arid, rocky tracts of Aravalli range. In the first step of project, a brief survey was undertaken for proper assessment of *C. wightii* in Rajasthan state. The survey was conducted from mid January 2008 to



March 2008. The main aim of survey was to know the actual status of *C. wightii* at different geographical locations of Rajasthan and to look into the diversity of plant resources that are used by local rural and tribal folks for curing various ailments. Questionnaire surveys, participatory observations and field visits were planned to elicit information on *C. wightii* and other important plant species. Forest officials from different district headquarters of Rajasthan state were contacted to make inquiries about the present occurrence of *C. wightii*. In addition, responses from the knowledgeable villagers, tribal groups, traditional healers and shepherds were also obtained to have a preliminary knowledge about the presence and population trend of the *C. wightii* plants. People from rural/tribal areas *i.e.* traditional healers, farmers, shepherds were found to have good knowledge of medicinal uses of plants.

**On the basis of survey, southern part (Udaipur, Banswara, Dungarpur, Pratapgarh, Chittorgarh), central-eastern part of Rajasthan (Jaipur, Ajmer) were identified as “Biodiversity Hotspots for *Commiphora wightii*”. Southern part of Rajasthan is facing serious threat of extinction of this plant.**

Conservation cannot work without the involvement of the people who depend on biodiversity. **Therefore, number of educational awareness programs and workshops were held in these areas to make local people aware about the importance and conservation of plants. Local communities were involved to save the species in its natural habitat through large scale propagation and the creation of a network of protected areas.**



Red marks in Rajasthan map showing the areas where *Commiphora wightii* is facing serious threat of extinction





## Why *Commiphora wightii* is in IUCN's Red List? What are causes of endangerment?

On the basis of deliberations with villagers and field survey, following reasons can be attributed for the rarity of *Commiphora wightii*:

### 1. Habitat destruction

Humans cause the majority of threats to species, sites and habitats. These threats are often interconnected and reinforce each other. For example, numbers of plants that are currently threatened by over-exploitation are also affected by the destruction of their habitats. In Rajasthan, agriculture is the principal cause of habitat destruction. Other important causes of habitat destruction include mining and urbanization. Here poor farmers are not capable to invest in farm improvements to increase yield sustainably. Low farm productivity leads to depletion of soil and water resources, and force farmers to utilize additional land that serves as wildlife habitat. Thus lack of alternative income drive them to overexploit the natural resources.



### 2. Desertification and Overgrazing

A major impact of desertification is biodiversity loss and loss of productive capacity. The main climatic factors responsible for desertification in Rajasthan are -- the high temperature, low rainfall and high wind velocity. Biotic causes include overgrazing by livestock, intensive crop cultivation, forest removal for the purpose of mining and general indiscriminate deforestation and exploitation of natural resources. Socio-economic factors include poverty, illiteracy and tradition-bound cultural practices.





### 3. Overexploitation and faulty tapping techniques

Demand supply gap of gum guggul is increasing very fast. According to an estimate, the domestic demand of gum guggul is to the tune of 300 tonnes, while the supply is only 75 tonnes. In Rajasthan, generally the oleo-gum resin of the plant is collected by the tribal people using the traditional methods i.e. they give several deep incision on the stem to get maximum amount of the guggul gum. Further they apply a paste around the incision consisting of horse or wild ass urine, oleo-gum resin and copper sulphate. This crude method increases the amount of guggul gum three to four times over that obtained under normal tapping procedures, but the shrub ultimately dies due to injurious effect of copper sulphate. **It is now believed that unscientific tapping methods to increase yield of oleo-gum resin causes mortality of plants leading to the extinction-danger of the species.**

During the deliberations with villagers and field survey, elder rural people told us that during 1960-70, some peoples from companies came and employed them to collect oleo-gum resin of *Commiphora wightii*. They provided them `mitchie golledge` knife coupled with ethephon (2-chloroethyl phosphoric acid, an ethylene releasing synthetic chemical). Its now proved that application of ethephon on the cuts enhances guggul gum production several times over that obtained in control. But in the long run excessive production through this technique exhausts and kills the plant.

### 4. Slow growing nature and poor seed germination rate

Slow growing nature associated with poor seed germination is also the major cause of endangerment of *Commiphora wightii*.



## **METHODOLOGY**

### **1. Field Survey and Collection of Oleo-gum resin:**

The proposed project was for duration of 10 months. In first two months, general survey was carried out in Rajasthan state to collect data regarding the occurrence, habitat, causes of depletion and medicinal importance of *C. wightii*. During this survey the oleo-gum resin of *C. wightii* was also collected from different geographical locations of Rajasthan to determine the variations in its bioactive compounds (E and Z- guggulsterones) to detect the suitable (high guggulsterone yielding) habitats for large scale cultivation of *Commiphora wightii*.

### **2. Educational awareness programs and works hops**

Conservation of any organism in human dominated area is directly depended on the involvement of locals, at every stage of protection. For achieving this target, we approached to village level community groups and long discussions were held to involve them in this program. To aware local rural and tribals about the importance and conservation of plants, number of awareness programs and workshop were organized in different villages of Rajasthan state.

### **3. Vegetative propagation and Restoration of *Commiphora wightii* in natural habitats**

Guggul plants were propagated in plastic bags through stem cuttings in green shade nursery. Plant growth regulators were used to induce the rootings. Fully developed plants were then transferred and plotted in their natural habitats with the help of local communities.



# OUTCOMES

OF  
AWARENESS PROGRAMS  
&  
WORKSHOPS  
A COMMUNITY-BASED APPROACH  
TO CONSERVE *COMMIPHORA*  
*WIGHTII*



## **OUTCOMES AWARENESS OF PROGRAMS AND WORKSHOPS**

Community-based approaches to decision-making in the management of protected areas are increasingly being implemented in many areas. Awareness and participation of the local community in conservation efforts are key to saving the Guggul plants. Our **Guggal Bachao Abhiyan** (Save Guggal Movement) in collaboration with villagers and friends has received warm appreciation from the local villagers and tribes.

Poor people, especially those living in areas with low agricultural productivity, rely heavily and directly on genetic, species and ecosystem biodiversity to support their livelihoods. Therefore, a number of activities have been identified and conducted through the close co-operation of the village level communities, who depend on biodiversity. For awareness students, village community groups and tribes of Rajasthan state were trained. They were taken into confidence and a network of people of different age groups was formed, that will help in long term monitoring of wild growing *Commiphora wightii* plants beyond the project duration. Community groups were prepared of different age, to disseminate conservation message. A campaign was started with series of local workshop, with a motive to conserve the Guggul plants and their habitat, their relationship with other wildlife and roll in daily life of locals, and also highlighted as a key indicator of desert ecosystem.

### **Engaging local people in conservation**

Through meetings, talks and discussions, the local community are now more aware of the threats faced by Guggul plants and how endangered they are. The project has received favorable response and strong support from the local villagers and tribes. A series of activities under the theme 'Save Guggal' was conducted targeting at local school children. Subsequently, several smaller workshops were conducted which includes slide shows and poster exhibitions at different villages and in local schools.





List of villages where awareness programs were organized

**District: Jaipur (Rajasthan)**

S. No.	Name of Village/Tehsil	Number of meetings organized
1.	Ajabgarh	1
2.	<u>Andhi</u>	3
3.	Bhimpura	2
4.	Chapradi	4
5.	<u>Chimanpura</u>	2
6.	Kikhad	3
7.	<u>Ghasipura</u>	2
8.	Gopalgarh	2
9.	Gulta	4
10.	Jagatpura	2
11.	Jaisingh Pura	3
12.	<u>Jamwa Ramgarh</u>	3
13.	Lakher	2
14.	Lalwas	2
15.	<u>Natata</u>	3
16.	Neem Ka Thana	2
17.	Padasoli	2
18.	<u>Patheredi</u>	2
19.	Ramgarh	2
20.	Rundal	2
21.	Sental	2
22.	Samod	3
23.	Shahpura	4



**Figures: Rural/tribal people understanding the value of medicinal plants, and the need for their conservation and sustainable use.**

List of villages where awareness programs were organized

**District: Udaipur (Rajasthan)**



S. No.	Name of Village/Tehsil	Number of meetings organized
1.	Akola	1
2.	Bedla	1
3.	Bhetewer	1
4.	Bhinder	2
5.	Dabok	2
6.	Daroli	1
7.	Gogunda	4
8.	Jaswantgarh	3
9.	Jharol	2
10.	Kanore	3
11.	Karanpur	1
12.	Kheirwara	1
13.	Kotra	1
14.	Lasadia	2
15.	Lunda	1
16.	Maharaj Ki Kheri	2
17.	Manpur	2
18.	Modi	1
19.	Paraoli	1
20.	Phalasia	2
21.	Pipalwara	1
22.	Rishabdev	1
23.	Salumber	1
24.	Taravaligarh	1
25.	Tarawat	1
26.	Thur	1
27.	Tripal	3
28.	VallabhNagar	1



**Figures: Rural/tribal people understanding the Importance of plants and their conservation at various rural areas of Udaipur**





List of villages where awareness programs were organized

**District: Pratapgarh (Rajasthan)**



S. No.	Name of Village/Tehsil	Number of meetings organized
1.	Amarpur	1
2.	Arnaud	3
3.	Baria	2
4.	Bhabrana	1
5.	Bori	2
6.	Chupna	2
7.	Datiyar	3
8.	Devgarh	3
9.	Dhariawad	2
10.	Gopalpura	1
11.	Gyaspur	2
12.	Jawahar Nagar 1	1
13.	Jawahar Nagar 2	1
14.	Limri Khera	1
15.	Magri	2
16.	Mohera	2
17.	Mungana	3
18.	Ninor	3
19.	Parel	2
20.	Parsola	3
21.	Pratapgarh main	2
22.	Rathana	1
23.	Vajpura	3
24.	Anuppura	1



**Figures: Awareness programs at various rural areas of Pratapgarh district**



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List of villages where awareness programs were organized

**District: Dungarpur (Rajasthan)**

S. No.	Name of Village/Tehsil	Number of meetings organized
1.	Amilia	1
2.	Aspur	3
3.	Baroda	1
4.	Dewal	3
5.	Dewla	1
6.	Gamri	2
7.	Gandlara	1
8.	Ganeshpur	2
9.	Indora	1
10.	Limri	2
11.	Mandli	2
12.	Nawagaon	2
13.	Ora Bara	1
14.	Pal Bassi	2
15.	Rampur	2
16.	Sara	1
17.	Som	4
18.	Talaiyan	2
19.	Balota	1
20.	Sagwara	1



**Figures: Participation of local communities in awareness programs**






List of villages where awareness programs were organized

**District: Banswara (Rajasthan)**

S. No.	Name of Village/Tehsil	Number of meetings organized
1.	Ashapura	1
2.	Badi Saredi	2
3.	Bagidora	1
4.	Bhopatpura	1
5.	Bori	1
6.	Dewda	1
7.	Dungra	1
8.	Dungria	1
9.	Ghatol	4
10.	Jagpura	3
11.	Khemera	2
12.	Kushalgarh	2
13.	Lahoria	2
14.	Malpura	1
15.	Mirchghati	2
16.	Mor	2
17.	Motagaon	2
18.	Ravatpura	1
19.	Sarwa Kalan	1
20.	Tejpur	2



List of villages where awareness programs were organized  
**District: Chittorgarh (Rajasthan)**

S. No.	Name of Village/Tehsil	Number of meetings organized
1.	Badisadri	1
2.	Bansi	4
3.	Basi	1
4.	Begun	1
5.	Bhadesar	1
6.	Bhadsoda	2
7.	Boheda	2
8.	Dungla	1
9.	Gangrar	1
10.	Gosunda	2
11.	Kapasan	1
12.	Mangalwar	5
13.	Nagri	1
14.	Nangawali	1
15.	Nimbahera	2
16.	Pahoona	1
17.	Parsoli	2
18.	Rashmi	2
19.	Singhpur	1



**Figures: Participation of local communities in awareness programs at various areas of Chittorgarh**



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List of villages where awareness programs were organized

**District: Ajmer (Rajasthan)**

S. No.	Name of Village/Tehsil	Number of meetings organized
1.	Ajabgarh	2
2.	Mangliawas	3
3.	Kharwa	2
4.	Raipur	2
5.	Shahpura (Bhilwara-Ajmer Road)	2



**Figure: Rural people and children watching the pictures of *Commiphora wightii* and understanding the importance of plants and their conservation**



**Figure: Villager with *Commiphora wightii* plant**



**Figure: Field Survey**



**Awareness programs for guggul conservation at different rural areas of Rajasthan state**







**Awareness programs for guggul conservation at different rural areas of Rajasthan state**







**Awareness programs for guggul conservation at schools and rural areas of Rajasthan state**



## Awareness programs for guggul conservation at different rural areas of Rajasthan state

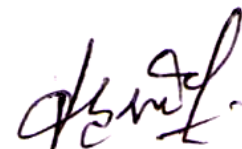


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**Awareness programs for guggul conservation at different rural areas of Rajasthan state**





**Awareness programs for guggul conservation at different rural areas of Rajasthan state**







**Awareness programs for guggul conservation at different rural areas of Rajasthan state**





# OUTCOMES

OF

## Propagation & Restoration of *Commiphora wightii* in Natural Habitats



In tropical countries, there are several problems with the production of quality planting stocks of important plant species, such as irregularity of seed supply due to irregular flowering and fruiting, short viability period of seeds, poor-quality seeds, and lack of seed storage and



**Figure- 4: Collection of stem cuttings for vegetative**

handling facilities. These problems have hampered the development of forest plantations and the enrichment planting activities of over-logged forests. Therefore, it is very difficult to predict the yield of quality seeds and seedlings for reforestation programs.

The plant *Commiphora wightii* has become endangered because of its slow growing nature, poor seed setting, lack of cultivation, poor seed germination rate and excessive and unscientific tapping for its gum resin by the pharmaceutical industries and religious purposes. In case of *C. wightii*, stem cuttings offer several advantages over seeds. They save time and labor, and produce genetically superior and uniform planting materials from superior parent stocks. Stem cuttings are also inexpensive and easier to practice than other vegetative-propagation methods, such as tissue culture. In addition, stem cuttings can continuously supply planting stocks throughout the year for reforestation activities.



**Figure-5: Stem cuttings of Guggul plant**





Stem cuttings were collected from mature plants of *Commiphora wightii* growing at natural habitats (Figure: 4) during March- April 2008. These stem cuttings (Figure: 5) were first pretreated with different concentrations of auxins (IBA and NAA). These cuttings were planted in plastic bags containing soil and manure in the ratio of 1:3 and then transferred in green-shade house (Figure: 6).



Figure-6: Vegetative propagation of *C.wightii*

The sprouting was achieved within one month (Figure: 7). High frequency of sprouting was observed

in plantlets developed from 0.6-0.8 mm diameter stem cuttings. Auxins



Figure-7: Sprouting in vegetative propagated stem cuttings

triggered/enhanced rooting of cuttings; NAA (0.5 mg/L) and IBA (0.5 mg/L) were found to be the most effective. Higher concentrations of auxins in general inhibited or slowed down the rooting ability of cuttings.

In July- August, the well developed plantlets were transported and planted at the natural habitats. Local rural and tribals were also motivated to participate in plantation programs. Local villagers and shepherds participated actively in guggul plantation programs.





**Restoration of  
*Commiphora  
wightii* in natural  
habitats**



# **OUTCOMES**

of

## **Detection of geographical variations in guggulsterone contents**

Production and storage of metabolites in plants vary when they grow in different types of soils and growth conditions. Effect of physical, geographical conditions and locality factors on the accumulation of both the primary and secondary metabolites are well known. The screening of guggulsterone contents in plants growing in different part of the state is very helpful in obtaining high yielding planting material for mass propagation and selection of suitable localities for large-scale cultivation of medicinal plants.

To determine the geographical variations in guggulsterones, oleo-gum resin samples were collected from 14 plants growing naturally at 6 different geographical locations of Rajasthan (Figure 8). The collection was done between January 2008 to March 2008 from 4 to 8 widely spaced mature plants per sites and the samples were sent to laboratory for analysis as soon as possible after collection.

The oleo-gum resin collected from different geographical locations of Rajasthan were analyzed separately for quantitative estimation of E and Z guggulsterones using following chromatographic techniques: -

### **Column chromatography**

Column chromatography was used for the purification of oleo-gum resin samples collected from 6 different geographical locations of Rajasthan. The oleo-gum resin ( $100 \pm 0.1\text{mg}$ ) was accurately weighted and placed in a 10 ml volumetric flask, dissolved with 2 ml of ethyl acetate, and the final volume 10 ml adjusted with methanol. It was then chromatographed over silica gel column (60-120 mesh, 5.0 X

60 cm.) using ethyl acetate: methanol (3:1) as eluent (Agarwal *et al.*, 1999).. Twenty fractions of 10 ml each were collected. The fractions thus collected were subjected to thin layer chromatography (TLC) for screening the positive fractions containing the E- and Z- guggulsterones.

### **Thin Layer Chromatography**

Thin layer chromatographic method (Roy, 1989) was used was used to identify the fractions containing the E and Z guggulsterones. The TLC was performed on 20 X 20 cm pre-coated aluminum oxide F<sub>254</sub> neutral plates (Merck, Germany). Twenty microliter each of 20 fractions along with reference E and Z guggulsterones were spotted onto the TLC plate. The TLC plate was developed in a solvent system containing 3 volume of light petroleum (boiling range 60 °C to 80 °C) and one volume of ethyl acetate. The plate after removal from the solvent was allowed to dry until the odour of the solvent vanished. The chromatogram was visualized under UV<sub>254</sub> light. Identification of guggulsterones was made by comparison of the R<sub>f</sub> values with those of known standards.

The fractions containing E- and Z- guggulsterones were combined and concentrated under vacuum to get yellowish gummy extract. This extract was subjected to high performance liquid chromatography (HPLC) for quantification of E and Z guggulsterones.

### **High performance liquid chromatography**

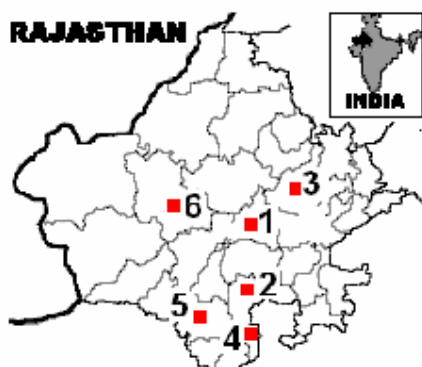
E- and Z- guggulsterones were quantified by HPLC using an acetonitrile – water gradient method (Mesrob *et al.*, 1998). Samples were analyzed in triplicate and a 10 minutes re-equilibration period was used between individual runs.

### **Results**

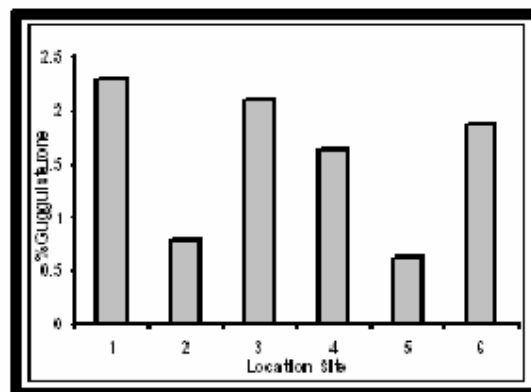
High performance liquid chromatographic analyses of guggul-gum collected from 14 mature plants of *C. wightii* growing naturally at 6 different geographical



locations of Rajasthan showed a great deal of variations in guggulsterone contents ranging from 0.61 % to 2.29% (Figure 9). The present findings demonstrated that guggulsterone biosynthesis alters significantly on geographical basis . In the present study, identification of higher guggulsterone yielding plants of *C. wightii* has paved the ways for mass propagation of these elite plants through tissue culture and vegetative propagation methods as well as selection of suitable geographical localities for large-scale cultivation of this high valued medicinal plant.



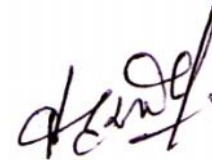
**Figure-8: Map of Rajasthan state showing the locations from where oleo-gum resin samples were collected**



**Figure-9: Guggulsterone content (%) in oleo-gum resin collected from different geographical locations of Rajasthan**

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## **RECOMMENDATIONS**

Based on the experiences gained while executing this project, following recommendations are made for the conservation of *Commiphora wightii* and other important plant species of Rajasthan, India:

1. Southern part of Rajasthan is facing serious threat of extinction of this plant. This area should be monitored on priority basis for conservation of this plant.
2. The protection measure taken by locals should be appreciated at the higher level and some sort of prize can be given to motivate them.
3. Awareness programs must be conducted time to time at schools, rural/tribal areas of Rajasthan to make aware about the importance and conservation of plants.
4. Conservation cannot work without the involvement of the people; therefore community based conservation programs must be conducted to conserve the biodiversity.



## NEXT STEPS

In the next phase of project the following work will be taken up :

- Based on the experiences gained while executing this project, it was observed that southern part of Rajasthan is facing serious threat of extinction of *Commiphora wightii* Plants. This area will be monitored on priority basis for conservation of this plant.
- Awareness programs will be conducted time to time at schools, rural/tribal areas of Rajasthan to provide education on the value of medicinal succulent plants, and the need for their conservation and sustainable use.
- Community-based-conservation-programs will be conducted to conserve the valuable plant species of Rajasthan state.





## CONCLUSIONS

*Commiphora wightii* (Arnott) Bhandari is an important medicinal plant of herbal heritage of India. Unfortunately, the plant *Commiphora wightii* has become endangered because of its slow growing nature, poor seed setting, lack of cultivation, poor seed germination rate, Habitat destruction and excessive and unscientific tapping for its gum resin by the pharmaceutical industries and religious purposes.

*C. wightii* is naturally found in arid, rocky tracts of Aravalli range. In the first step of project, a brief survey was undertaken for proper assessment of *C. wightii* in Rajasthan state. The survey was conducted from mid January 2008 to March 2008. The main aim of survey was to know the actual status of *C. wightii* at different geographical locations of Rajasthan and to look into the diversity of plant resources that are used by local rural and tribal folks for curing various ailments. Questionnaire surveys, participatory observations and field visits were planned to elicit information on *C. wightii* and other important plant species. Forest officials from different district headquarters of Rajasthan state were contacted to make inquiries about the present occurrence of *C. wightii*. In addition, responses from the knowledgeable villagers, tribal groups, traditional healers and shepherds were also obtained to have a preliminary knowledge about the presence and population trend of the *C. wightii* plants. People from rural/tribal areas *i.e.* traditional healers, farmers, shepherds were found to have good knowledge of medicinal uses of plants.

**On the basis of survey, southern part (Udaipur, Banswara, Dungarpur, Pratapgarh, Chittorgarh), central-eastern part of Rajasthan (Jaipur, Ajmer) were identified as “Biodiversity Hotspots for *Commiphora wightii*”. Southern part of Rajasthan is facing serious threat of extinction of this plant. Conservation cannot work without the involvement of the people who depend on biodiversity. Therefore, number of educational awareness programs and workshops were held in these areas to make local people aware about the**

**importance and conservation of plants. Local communities were involved to save the species in its natural habitat through large scale propagation and the creation of a network of protected areas.**

Awareness and participation of the local community in conservation efforts are key to saving the Guggul plants. Our **Guggal Bachao Abhiyan (Save Guggal Movement)** in collaboration with villagers and friends has received warm appreciation from the local villagers and tribes.

Poor people, especially those living in areas with low agricultural productivity, rely heavily and directly on genetic, species and ecosystem biodiversity to support their livelihoods. Therefore, a number of activities have been identified and conducted through the close co-operation of the village level communities, who depend on biodiversity. For awareness students, village community groups and tribes of Rajasthan state were trained. They were taken into confidence and a network of people of different age groups was formed, that will help in long term monitoring of wild growing *Commiphora wightii* plants beyond the project duration. Community groups were prepared of different age, to disseminate conservation message. A campaign was started with series of local workshop, with a motive to conserve the Guggul plants and their habitat, their relationship with other wildlife and roll in daily life of locals, and also highlighted as a key indicator of desert ecosystem.

For restoration of *Commiphora wightii* in their natural habitats, stem cuttings were collected from mature plants growing at natural habitats during March- April 2008. These stem cuttings were first pretreated with different concentrations of auxins (IBA and NAA). These cuttings were planted in plastic bags containing soil and manure in the ratio of 1:3 and then transferred in green-shade house. In July-August, the well developed plantlets were transported and planted at the natural habitats. Local rural and tribals were also motivated to participate in plantation programs. Local villagers and shepherds participated actively in guggul plantation programs.



The present findings demonstrated that guggulsterone biosynthesis alters significantly on geographical basis. The plant *Commiphora wightii* shows a great deal of variation in its bioactive constituents (guggulsterones).

**Based on the experiences gained while executing this project, it is concluded that threatened plants can be conserved through the involvement of local people. There are many threatened plants, which can be propagated easily through vegetative propagation. Efforts should be done to propagate these plant species in their natural habitats. Community based approaches are highly effective for conservation of threatened/endangered plants.**

A handwritten signature in black ink, appearing to be 'A. S. S. S.' followed by a period.