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Commiphora wightii (Guggal): An Endangered Medicinal Plant of Rajasthan Needs Attention of Biotechnologists for Its Conservation-A critical analysis and review

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Commiphora wightii belonging to family Burseraceae of class Magnoliopsida in the plant kingdom is of paramount importance since ancient times because of its medicinal value in order to cure number of serious and chronic diseases in one or the other form. It is evident that during last 3-4 decades this endangered plant species has been an important research material which is being drawn attention of chemists, pharmacist, tissue culturists and biotechnologists in particular and number of world organizations, survey reports, international magazines and other newspapers in general.

Habit and Distribution: The guggul plant prefers arid and semi-arid climates and is tolerant of poor soil. It may be found from northern Africa to central Asia, but is most common in Rocky tracks of Western India and Eastern Himalayas. It's a shrub or small tree, reaching a maximum height of 4 m, with thin papery bark. The branches are thorny. The leaves are simple or trifoliate, the leaflets ovate, 1–5 cm long, 0.5–2.5 cm broad, irregularly toothed. It's gynodioecious, with some plants bearing bisexual and male flowers, and others with female flowers. The individual flowers are red to pink, with four small petals

Medicinal uses: Traditionally guggul lipid has been used to treat arthritis, rheumatism, haemorrhids, urinary disorder, obesity, skin diseases and high cholesterol. Guggul (aka guggulu) is a gum resin, historically used for its antiseptic and deep penetrating actions in the treatment of elevated blood cholesterol and arthritis. Guggul is effective as a weight-loss and fat burning agent. It increases white blood cell counts and possesses strong disinfecting properties. Often used as a carrier and combined with other herbs to treat specific conditions

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Guggal has been a key component in ancient Indian Ayurvedic system of medicine, and now's widely used in modern medicine for treatment of heart ailments. But Guggal (Commiphora wightii), as it's locally known, has become so scarce because of its overuse in its two habitats in India where it's found — Gujarat and Rajasthan that the World Conservation Union (IUCN) has enlisted it in its Red Data List of endangered species.

The extract, called gugulipid, guggulipid or guglipid, comes from the guggal or guggul tree and has been used in Ayurvedic medicine, a traditional Hindu medicine, for nearly 3,000 years in India.

Today, its existence is threatened because of low seed production in an adverse natural condition and recent environmental changes due to change in rainfall pattern and increasing level of atmospheric pollution. This plant species is fighting for its survival in the natural habitat since a long time.

Attempts have been made in this direction by number of researchers including under present investigation towards its natural populations, germplasm collection, cultivation techniques, phytosociology and regeneration potentialities etc. at different sites of western Indian Thar desert.

Biochemical Composition of Commiphora Wightii

The seeds of Commiphora wightii (Arnott) Bhandari contain 9.8 ± 0.7% oil. The fatty acid composition and chemical properties of the extracted oil were determined. Gas liquid chromatography of the methyl esters of the fatty acids shows the presence of 46.62% saturated fatty acids and 51.40% unsaturated fatty acids. The fatty acid composition is as follows: capric acid 3.50%, myristic acid 14.51%, palmitic acid 6.68%, stearic acid 4.70%, arachidic acid 3.18%, behenic acid 14.05%, myristoleic acid 1.34%, palmitoleic acid 12.07%, oleic acid 14.15%, eicosenoic acid 0.11%, linoleic acid 22.34% and alpha linoleic acid 1.37%.

Present status of Commiphora wightii

Commiphora wightii has become an endangered species due to its overexploitation for its gum-resin. Guggulsterones present in gum-resin are potent lipid and cholesterol lowering natural agents. Drugs based on these are currently used clinically in India and Europe. The plant is endemic to Indian subcontinent; therefore major contributions on its biology, chemistry, pharmacology and biotechnology have been made by Indian scientists. Biotechnological approaches made for guggulsterone production by cell cultures and for its micro propagation still needs an immediate attention for further research work in this direction,

Erosion of plant biodiversity

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, fiber, 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. Unfortunately the plant Commiphora wightii has become endangered because of its slow growing nature, poor seed setting, and 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. The various causes of its endangerment are

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 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 tones, while the supply is only 75 tones. 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.

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. 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 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.

Commiphora wightii resin (guggul) Conservation status

As already mentioned above the plant Commiphora wightii has become endangered because of its slow growing nature, poor seed setting, and 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.

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The extract, called gugulipid, guggulipid or guglipid, comes from the guggal or guggul tree and has been used in Ayurvedic medicine, a traditional Hindu medicine, for nearly 3,000 years in India. Several of these species produce fragrant resins used for incense, perfume, and medication, including Myrrh (Commiphora myrrha) and Balsam of Mecca (C. opobalsamum).

Biotechnological approaches to save Commiphora wightii

Efforts have also been made to conserve Commiphora wightii a highly valued endangered medicinal plant species using conventional in vivo propagation methods. Plants in natural surroundings suffer from poor seed setting, poor seed viability and harsh arid conditions [17]. The plants bear seeds from April to May and August to October. The seed germination percentage is only 15-18 % [15]. Rooting response of stem cutting was shown to be improved by application of plant growth regulators such as Indole butyric acid [19], by selection of cuttings of suitable length and diameter [14, 16] and treating them with potassium salts [12].Oleo gum resin production was enhanced in Commiphora wightii by improved tapping technique as reported by [10].

Biotechnological research on Commiphora wightii has been supported by various central funding agencies since 1979 but nothing concrete has come out of these programmes. This only goes to show the difficult nature of the material due to its slow growing and woody nature. Resin makes the sterilization of explants difficult. Very little information is available on tissue culture studies of the plant. Role of tissue culture in preserving the threatened and endangered medicinal plants have been discussed [9, 17, 23] used nodal explants of the plant and did not get any multiple shoot proliferation in vitro [17] reported the somatic embrogenesis in the plant through immature zygotic embryos.

Similarly [13] established embryonic cultures and somatic embryogenesis in callus cultures of Commiphora wightii. Biotechnological approaches were also being applied to conserve and evolve methods for micro propagation of this plant [20, 21]. Callus was formed from node, leaf and embryos of Commiphora wightii on MS medium supplemented with 24D +Kn and subsequently biosynthesis of guggulsterone in the callus cultures has also been reported [22]. Efficient method of micro popagation from cotyledonary node of Commiphora wightii (ARN) Bhandari has been recently reported [11].

In vitro morphogenetic study was undertaken in this respect under the present investigation and various explants excised from seedling as well as mature plants were subjected to auxin, cytokinin containing MS medium individually and in combination with each other, Response in cultures were regularly observed and recorded, The explants used in this respect includes shoot tip, nodal segments, leaf and embryos. Leaf explants showed the formation of very little white friable callus after six weeks of culture on MS medium supplemented with BAP(3mg/l)plus Kn(0.5mg/l)and 24D (5 mg/l).

This white friable callus turned black during subsequent subcultures. Similarly mature as well as immature embryos also showed the callus formation in the initial stage after 4-5 weeks under different physical factors like light and temperature. This callus remained viable for more than two months and ultimately turned black. Shoot tip and nodal segments responded well when these were cultured on MS medium containing various concentrations of Kn, BAP and IAA. Highest frequency of Shoot bud formation was recorded in shoot tip cultures on MS medium with BAP (1.5 mg/l) and IBA (5 mg/l) and zeatin (1 mg/l) after 6 weeks of culture.

Multiple shoots were observed in the cotyledonary node cultures on MS medium supplemented with IBA (1.0mg/l) plus NAA (1.5mg/l) plus BAP (2.5 mg/l). On subsequent subcultures of these multiple shoots it was observed that the number of shoots enhanced considerably when activated charcoal (5%) and amino acids like glutamine and thiamine were added in various combinations.

These multiple shoots when further sub cultured on MS medium containing IBA (2mg/l) and BAP (3mg/l) increased in length and such elongated shoots were subjected to culture medium containing various concentrations of IBA and NAA. Efficient root formation was observed in these elongated shoots when these were cultured on MS medium containing NAA(5 mg/l) and IBA(3.5 mg/l).In view of this a survey was planned in different parts of

Rajasthan for the purpose of collecting important information regarding this important medicinal plant specially to suggest different ways and means to check unscientific exploitation of the plant on one hand and to conserve and evolve methods for its clonal propagation by applying various tissue culture techniques. Hence in view of the aforesaid review of research work carried out in the past few years including our present efforts in this direction to conserve this medicinally important plant through tissue culture techniques reveals that this plant needs much more attention especially of biotechnologists as well as other experts like biochemists, pharmacist. Experimental morphogenetisist and molecular biologists in order to protect this national wealth which is known for its value since ancient time. On the basis of our survey made in different parts of Southern Rajasthan during our present study and available literature about this plant following recommendations are made in order to take necessary steps for the conservation of this endangered medicinally important plant.

Recommendations

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 local people should be appreciated at the higher level and some sort of incentive 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 programmes must be conducted to conserve the biodiversity

5. Effective research programmes under the leadership of scientists working in various fields as cited above is required to be launched for establishing reproducible and regenerable protocol for the micro propagation of Commiphora wightii.

6. Multidisciplinary approach is to be applied in this respect after providing suitable funding by the funding agencies of state as well as Central Government.

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