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Medicinal Plants of Indian Thar Desert-Needs Urgent Conservation Strategies

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ABSTRACT: The Great Indian Desert known as the Thar Desert occupies about 60% of the area of Rajasthan – the largest state of India. It is one of the most heavily populated (in terms of both people and cattle) deserts of the world. The animal and human populations exert tremendous pressure on the scant vegetation of the region, making several plants vulnerable to becoming endangered. Inherent biological problems associated with these plants make their survival difficult and have forced adaptation to the harsh environment. The biological activities of these plants range from analgesic, antifungal, antimicrobial, hypolipidemic to hepatoprotective and anticancerous. This chapter reviews the biological problems faced by the medicinal plants of this region, their bioactive molecules, as well as biotechnological approaches aimed at improving and conserving these plants.

KEYWORDS: Thar, desert, Rajasthan, medicinal, conservation, endangered, vulnerable, environment, plants

I. INTRODUCTION

The north-western part of India is occupied by a desert ecosystem, the Thar Desert; having 682 plant species and 390 animal species. Many plant and animal species have become endangered due to zoogenic and anthropogenic activities. Many medicinal plant species is the most important deciduous, ornamental shrub or small tree of the dry regions. It is a multipurpose and vital species for arid-rural poor. It is the main source of timber amongst the tree species of desert regions of Rajasthan and highly valued for making engraved furniture, agricultural implements, carvings, turnery, toys etc.[1,2] It is also used as source of firewood and charcoal also. So, it is heading towards extinction due to indiscriminate felling for timber and fuel by the local population, minimum conservation efforts, coupled with poor regeneration has severely depleted the natural population of this tree, with an associated loss of valuable germplasm. The regeneration rates of such species in natural surroundings is quite low, therefore alternative propagation methods would be beneficial in large scale multiplication, improvement and conservation of its elite clones. Monitoring genetic diversity can help in identifying the candidate populations for in situ and ex situ conservation, and thus lead to proper planning strategy for the conservation of this species. Biotechnology has opened a window for this. Cultivation of medicinal plants is alternative way for conservation of natural resources and fulfills the demand of the market. Cultivation practices help to reduce dependency on natural resources. Although wild-harvested resources of medicinal plants are widely considered more efficacious than those that are cultivated, domestic cultivation is a widely used and generally accepted practice[3]

Good agricultural and collection practices (GACP)- Under the overall context of quality assurance and control of herbal medicines, WHO developed the Guidelines on good agricultural and collection practices (GACP) for medicinal plants, providing general technical guidance on obtaining medicinal plant materials of good quality for the sustainable production of herbal products classified as medicines. These guidelines are also related to WHO's work on the protection of medicinal plants, aiming promotion of sustainable use and cultivation of medicinal plants. In India GACP of medicinal plants is designed by National medicinal plant board in collaboration of WHO.[4]

Conservation through Micro-propagation and Reintroduction - Reintroduction is the deliberate establishment of individuals of an extinct/endangered species into an area and/or habitat where it has become extirpated, while Micro-propagation is the practice of rapidly multiplying stock plant material to produce a large number of progeny plants, using modern plant tissue culture methods. The reintroduction of plants is becoming an increasingly utilized strategy in plant conservation and protected area management as proven successful in a variety of species.

Conservation through in Vitro and Cryopreservation: Cryo-preservation or cryo-conservation is a process where organelles, cells, tissues, extracellular matrix, organs or any other biological constructs susceptible to damage caused by unregulated chemical kinetics are preserved by cooling to very low temperatures (typically -80°C using solid carbon dioxide or -196°C using liquid nitrogen). National Gene bank at Jawaharlal Nehru Tropical botanical garden



and research institute, is one among the four to have an objective of conserving the medicinal and aromatic plants of Southern Peninsular India through biotechnological intervention, including in vitro and cryopreservation techniques.

Herbal medicines occupy a vital sector of health care system in India and also in rest of the world medicinal plants represent a major resource. With the increasing demand for herbal drugs, natural health products, and secondary metabolites of medicinal plants, a loss and fragmentation of natural habitats, overexploitation, and lack of regulations and standards for sustainable harvesting, medicinal plants have been so far assessed as under threat in the wild. So it is important to ensure their conservation for sustainable utilization. Conservation of natural resources of medicinal plant and its sustainable use is need of hour. For this proper strategies should be followed. In-situ conservation is the best option for conservation of natural resources but ex-situ conservation protocols are also good alternatives. The in vitro propagation protocols developed for medicinal plants are satisfactory in laboratory scale, but their use in commercial scale needs further field cultivation trials in the Thar desert area of Rajasthan.[5,6]

II. DISCUSSION

In India, the Thar, the smallest desert in the world, occupies nearly 385,000 km² and about 9 per cent of the area of the country. The only river that crosses through region is Luni, joining the Arabian Sea through the Rann of Kutch in Gujarat. It extends from Punjab through Haryana and Rajasthan to Gujarat. The Aravalli Mountains, starting from northern Gujarat and extending up to Delhi state, form the eastern boundary of the Thar. In the west it joins with the Thar Desert of Pakistan and in the south it extends into the Kutch of Gujarat This Desert is the eastern extension of the vast PersioArabian desert, which joins the great Sahara deserts. It is the most populous desert in the world, with human density of around 84 persons per km². Population growth is also very high. For instance, between 1901 and 2011 decadal population growth in whole of India was 17.70 per cent; it was 23.56 per cent in the Thar. More than 80 per cent of the people live in villages or scattered settlements called dhanis, but urbanization is increasing fast. This is an important bio-region of Rajasthan comprising about 61 percent of the state's total geographical area. It is one of the most biologically and culturally diverse Deserts of the world and houses distinct and unique ecosystems, landscapes and species of plants and animals. It is characterized by geomorphic forms and landscapes such as dunes, magras, dhands and bhakars, each with a distinct ecology of its own. This Desert results from the dryness of the prevailing monsoon winds, which do not bring sufficient rain to keep the region moist. The sand cover is of early Pre-Cambrian gneiss (granite-like metamorphic rocks formed in the oldest geologic era, which began 3.8 billion years ago), sedimentary rocks from about 2.5 billion to 570 million years old, and more recent material deposited by rivers (alluvium). The surface sand is aeolian (wind deposited) sand of the Quaternary Period (the most recent geologic period, which began about 1.6 million years ago). The desert presents an undulating surface, with high and low sand dunes separated by sandy plains and low, barren hills, or bhakars, which rise abruptly from the surrounding plains. The dunes are in continual motion and take on varying shapes and sizes. Older dunes, however, are in a semi-stabilized or stabilized condition, and many rise to a height of almost 500 feet (150 m). Several saline lakes, locally known as dhands, are scattered throughout the region. Comprehensive studies on faunal diversity in the Thar Desert have been documented. Three types of major terrestrial habitats are recognized in the Indian desert in relation to flora and fauna. [7,8]

The sandy habitat occupies the largest area of the desert. Depending upon the soil type and topography, it can be further subdivided into (i) Younger alluvial plain, (ii) Older alluvial flat plains, (iii) Older alluvial hummocky plains, (iv) Saline flats, and, (v) Sand dunes. Mixed xeromorphic medicinal vegetation with trees such as *Tecommela undulata*, *Prosopis cineraria*, *Acacia nilotica* and *Salvadora oleoides*; shrubs like *Calligonum polygonoides* and *Haloxylon salicornicum*; forbs like *Tephrosia purpurea*, *Indigofera spp.*, *Crotalaria burhia*, *Aerva tomentosa*, *Aerva persica* and grasses like *Cenchrus biflorus* and *Crotalaria ciliaris*, *Aristida spp.*, are common. Hills and Rocky Outcrops: Such outcrops are scattered all over the desert region. *Anogeissus pendula*, *Acacia senegal*, *Euphorbia caducifolia*, *Maytenus emarginatus*, *Commiphora wightii* and *Cordia garaf* are common trees, and *Sehima nervosum*, *Cymbopogon jawarancusa*, *Hackelochloa granularis*, and *Dichanthium annulatum* constitute the ground flora

Ruderal: This habitat is associated with villages which are scattered all over the desert, over rocky medicinal outcrops, sandy plains, sand dunes, saline flats and river banks. The luxuriant trees such as *Azadirachta indica*, *Tamarindus indica*, *Prosopis cineraria*, *Acacia spp.* *Ficus spp.* and *Salvadora oleoides* are the major species found in these regions.[9]

Medicinal Trees: *Acacia leucophloea*; *Acacia nilotica*; *Acacia senegal*; *Acacia tortilis*; *Azadirachta indica*; *Ailanthus excelsa*; *Balanites aegyptiaca*; *Dichrostachys cinerea*; *Ficus benghalensis*; *Ficus religiosa*; *Holoptelea integrifolia*; *Prosopis cineraria*; *Prosopis juliflora*; *Tecomella undulata*; *Ziziphus mauritiana*; *Maytenus emarginata*; *Phoenix sylvestris*; *Ricinus communis*; *Terminalia alata*; *Terminalia arjuna*; *Cassia fistula*; *Cassia auriculata*; *Tamarix aphylla*; *Pithecellobium dulce*; *Acacia catechu*; *Zizyphus glaberrima*; *Terminalia bellirica*; *Emblica officinalis*; *Anogeissus pendula*; *Anogeissus latifolia*; *Prosopis cineraria*; *Garuga pinnata*; *Madhuca indica*; *Pongamia pinnata*; *Salvadora oleoides*; *Salvadora persica*; *Jatropha curcas*; *Balanites aegyptiaca*; *Sapindus emarginatus*; *Mimusops elengi*; *Aegle marmelos*; *Bauhinia racemosa*; *Boswellia serrata*; *Bombax ceiba*; *Buchnaniania latifolia*; *Butea monosperma*; *Leucaena leucocephala*; *Lannea coromandelica*; *Moringa oleifera*; *Mangiferaindica*; *Miliusa tomentosa*; *Pterocarpus marsupium*; *Sterculia urens*; *Nyctanthes arbortristis*; *Wrightia tinctoria*; *Morinda tinctoria*; *Helicteres isora*; *Cordia gharf*; *Erythrina suberosa*; *Phoenix sylvestre*; *Cordia oblique*; *Ficus religiosa*; *Morusalba*; *Diospyros melanoxylon*; *Diospyros tomentosa*; *Diospyros montana*; *Santalum album*.

Medicinal Shrubs: *Carissa carandas*; *Punica granatum*; *Lawsonia inermis*; *Rhus mysurensis*; *Mallotus philiphinensis*; *Capparis deciduas*; *Abutilon indicum*; *Sida cordifolia*; *Waltheria indica*; *Commiphara wightii*; *Hibiscus ovalifolius*; *Ziziphus nummularia*; *Acacia jacquimontii*; *Crotalaria burhia*; *Grewia tenax*; *Crotalaria medicaginia*; *Verbesina encelioides*; *Xanthium strumarium*; *Calotropis procera*; *Leptadenia pyrotechnica (Forsk.) Decne.*; *Sericostoma pauciflorum*; *Withania somnifera*; *Lantana indica*; *Aerva tomentosa*; *Salsola baryosoma*; *Suaeda maritime*

Medicinal Perennial herbs: *Tephrosia hamiltonii*; *Tephrosia purpurea*; *Farsetia hamiltonii*; *Indigofera linnaei Ali.*; *Trianthema portulacastrum*; *Zaleya govindia*; *Borreria articularis*; *Echinopsechinatus*; *Launaea resedifolia*; *Launaea procumbens*; *Oligochaeta ramose*; *Pulicaria crispa*; *Catharanthus roseus*; *Convolvulus microphyllous*; *Datura metal*; *Solanum nigrum*; *Solanum surattense*; *Lepidagathis trinervis*; *Boerhavia diffusa*; *Achyranthes aspera*; *Amaranthus caudatus*; *Pupalia lappacea*; *Croton bonplandianum.*; *Euphorbia hirta*.

Medicinal Annual herbs: *Argemone mexicana*; *Fumaria indica*; *Sisymbrium irio*; *Portulaca oleracea*; *Portulaca suffruticosa*; *Alysicarpus monilifer*; *Medicago laciniata* , *Melilotus indica*; *Fagonia cretica*; *Trigonella. polycerata*; *Trianthema triquetra*; *Acanthospermum hispidum*; *Artemisia scoparia*; *Gnaphalium indicum*; *Pulicaria angustifolia*; *Sonchus asper*; *Vernonia cinerea*; *Anagallis arvensis*; *Arnebia hispidissima*; *Heliotropium ellipticum*; *Heliotropium marifolium*; *Heliotropium subulatum*; *Datura innoxia*; *Leucas aspera*; *Gomphrena celosiodies*; *Indigofera cordifolia*; *Indigofera hochstetteri*; *Tephrosia strigosa*; *Ocimum canum*; *Chenopodium album*; *Chenopodium murale*; *Phyllanthus asperulatus*. [10,11]

Medicinal Ephemerals: *Cleome gynandra*; *Cleome viscosa*; *Polygala erioptera*; *Polygala irregularis*; *Indigofera astragalina*; *Polycarpaea corymbosa*; *Sida ovata*; *Corchorus tridens*; *Triumfetta pentandra*; *Tribulus terrestris*; *Cassia tora*; *Cassia occidentalis*; *Alysicarpus vaginalis*; *Indigofera linifolia*; *Indigofera sessiliflora*; *Gisekia pharnaceoides*; *Mollugo cerviana*; *Mollugo nudicaulis*; *Bidens biternata*; *Blainvilleaacmella*; *Trichodesma indicum*; *Evolvulus alsinoides*; *Physalis minima*; *Pedaliium murex*; *Sesamum indicum*; *Martynia annua*; *Peristrophe bicalyculata*; *Rostellularia procumbens*; *Anisomeles indica*; *Amaranthus spinosus*; *Digeramuricata*; *Euphorbia prostrata*; *Commelina benghalensis*; *Commelina forskalaei*.

Medicinal Climbers and twiners: *Cocculus pendulus*; *Celastrus paniculata*; *Tinospora cordifolia*; *Blastania fimbriatipula*; *Citrulluscolocynthis*; *Cucumis callosus*; *Mukia maderaspatana*; *Pergularia daemia*; *Ipomoea eriocarpa*; *Ipomoea pes-tigridis*.

Medicinal Grasses: *Bulbostylis barbata*; *Cyperus arenarius*; *Cyperus bulbosus*; *Cyperus triceps*; *Aristida funiculata*; *Brachiariaramose*; *Brachiaria reptans*; *Cenchrus biflorus*; *Cenchrus ciliaris*; *Cenchrus pennisetiformis*; *Chloris virgata*; *Dactyloctenium indicum*; *Vetiveria zizanioides*; *Typha elephantine*; *Eragrostis ciliaris*; *Eragrostispilosa*; *Eragrostis tremula*; *Saccharum bengalense*

Prosopis cineraria provides wood of construction class. It is used for house-building, chiefly as rafters, posts scantlings, doors and windows, upright posts of Persian wheels, agricultural implements and shafts, spokes, fellows and yoke of carts. It can also be used for small turning work and tool-handles. Container manufacturing is another important wood-based industry, which depends heavily on desert-grown trees. It is a valuable fodder as well. The trees are heavily lopped particularly during winter months when no other green fodder is available in the dry tracts. There is a popular saying that death will not visit a man, even at the time of a famine, if he has a *Prosopis cineraria*, a goat and a camel, since the three together are somewhat said to sustain a man even under the most trying condition. The forage

yield per tree varies a great deal. On an average, the yield of green forage from a full grown tree is expected to be about 60 kg with complete lopping having only the central leading shoot, 30 kg when the lower two third crown is lopped and 20 kg when the lower one third crown is lopped. The leaves (Loong) are of high nutritive value. Feeding of the leaves during winter when no other green fodder is generally available in rain-fed areas is thus profitable. The pods (Sangar or Sangri) have a sweetish pulp and are also used as fodder for all categories of livestock viz., cattle, sheep, goat and camel. The dried pods (Kho-Kha) are also fodder. They are also used as famine food and known even to prehistoric man. Even the bark, having an astringent bitter taste, was reportedly eaten during the severe famine of 1899 and 1939. Pod yield is nearly 1400 kg ha⁻¹ with a variation of 10.7% in dry locations. *Prosopis cineraria* wood is reported to contain high calorific value and provide high quality fuel wood. The lopped branches are good as fencing material. Its roots encourage nitrogen fixation leading to higher crop yields. Quite a number of health benefits of this tree are also reported.

Tecomella undulata is another important tree species, locally known as Rohida, which is found in this region, northwest and western parts. It is a medium sized tree of great value in agroforestry that produces quality timber and is the main source of timber amongst the indigenous tree species of desert regions. The trade name of the tree species is Desert teak or Marwar teak. Its wood is strong, tough and durable. It takes a fine finish. Heartwood contains quinoid. The wood is excellent for firewood and charcoal. Camels, goats and sheep consume leaves, flowers and pods. It acts as a soil-binding tree by spreading a network of lateral roots on the top surface of the soil. It also acts as a windbreak and helps in stabilizing shifting sand dunes. It is considered as the home of birds and provides shelter for other desert wildlife. Shade of tree crown is shelter for the cattle, goats and sheep during summer days. It has medicinal properties as well. The bark obtained from the stem is used as a remedy for syphilis. It is also used in curing urinary disorders, enlargement of spleen, gonorrhoea, leucoderma and liver diseases. Seeds are used against abscess.[12,13]

Biodiversity loss is here expressed as the percentage of original species abundance as found in undisturbed controls or information about the diversity in the original state of the land use category in question. Currently, the desert biome holds an average abundance of original species of 68 percent. Most of it is concentrated in hotspots or in transition zones between arid rangelands and true deserts. In 1700, mean abundance of original species was approximately 93 per cent (range 89–96%), dropping to 87 percent in 1900 (range 83–91%). Given a proportional decline in abundance with either (a) population growth or (b) change in cropland, the rate of loss in original species abundance has been about 0.17 percent per year (range 0.13–0.21%) in the last century in deserts. This compares to the decline of 0.8–2.4 percent of intact wilderness ecosystems per year. Declines are greatest in desert margins and mountainous areas within deserts. Future loss scenario of biodiversity in deserts shows that the rate of biodiversity loss in deserts may be as much as double in the coming decades. These results are fairly similar compared to the global regime. All four scenarios project a further decline in mean original species abundance from about 65 percent in deserts in 2000 to a mean of 62.8 percent by 2030 (range 60–65%) and 58.3 percent by 2050 (range 53–62%). Over a period of 50 years, the current global desert species abundance may thus drop by as much as 15 percent - a dramatic decline given the relatively short time-span. The projected decline in biodiversity varies greatly among the scenarios. Remarkably, even a slowing of the rate of biodiversity loss to that of the middle of 20th century would still mean a continued decline in the abundance of wildlife in desert regions. As for the scenarios in which the effect of land use and infrastructure development is modelled, the degree of decline varies greatly among and within the regions[14,15]

III. RESULTS

Sustainable development of Deserts needs to reflect social and ecological realities and provision of a framework against which policies and investments can be assessed. Such a vision should include at least four components based on the intersection between sustainable land management and biodiversity conservation viz., adapting green economic growth to the desert; conservation and sustainable management of desert biodiversity with special emphasis on agrobiodiversity in particular; land health as the basis for secure food and water provision; resilience and risk management in uncertain environments. Green economic growth in the deserts can play a prominent role in ensuring that ecosystems are protected as the foundation of life and prosperity, but green growth strategies need to be tailored to the environmental conditions of desert. The ecologically-sensitive farming practices, such as agroforestry, pastoralism or conservation agriculture should be promoted in a way that incorporates indigenous knowledge and participation of local institutions and public. [18] Resilience is at the heart of desert livelihoods but is poorly reflected in public decision making or development investment. A greater understanding of resilience in desert social-ecosystems is needed to inform policy making and institutions need to be strengthened to provide the foundation for resilience. To realize such an ambitious vision in the desert requires a strategic and broad suite of actions and investment to



strengthen innovation, science, knowledge and collaboration. Research and investment need to be more responsive to new and evolving understanding of desert ecology and there is need for greater consensus on how to protect and regenerate soil through land management. Greater investment is needed in extension services that provide relevant technical advice to land users in the desert. Incentives and investment are required to promote sustainable land management and biodiversity conservation in the desert and this includes significant multi-sectorial investments to establish conditions for sustainable growth. Policies that favor less sustainable land use options need to be revised. Payments for ecosystem services and other incentives for environmental custodianship have an important role to play in conserving desert biodiversity. Governance, from local to international levels, needs strengthening in desert in order to enable sustainable growth and conservation. Role of Community Conserved Areas (ICCA) is particularly important in conserving desert biodiversity. However, conservation strategies are needed to combine a variety of protected area approaches so that exclusionary forms of protection are complemented by widespread community-conserved areas like ICCAs.[16]

IV. CONCLUSIONS

Human well-being depends on biological diversity and ecosystems and the goods and services they provide. Unprecedented loss of biodiversity and degradation of ecosystems over the past few decades pose new and urgent challenges.[16] Addressing these challenges necessitates the strengthening of existing models of biodiversity governance and formulating new ones. The strategic goals like preventing the extinction of endangered species, halving the loss of forests and natural habitats and also reclaim 15 per cent of degraded lands, move from conservation to restoration as well. The desert region is considered more sensitive to changing climate. A concerted effort is required to mainstream desert biodiversity and coordinate actions between all government sectors. The practices related to conservation, restoration and sustainable use with a blend of traditional knowledge and modern scientific interventions will lead to sustainable agriculture in the region. Some of the larger grasslands and Orans in this region should be put under multiple use protected areas alongwith traditional but controlled grazing and avoiding canal irrigation to these areas will be required for sustainable agriculture in future as well. The better deployment of agricultural biodiversity in this region will be essential to improve productivity, enhance ecosystem functions and adaptability.[19]

REFERENCES

1. Bhattacharyya R, Bhattacharya S, Chaudhary S. Conservation and documentation of the medicinal plant resources of India. *Biodiversity and Conservation*. 2006; 15:2705-2717
2. Shi- Lin Chen, Hua Yu, Hong- Mei Luo, Qiong Wu, Chun- Fang Li, André Steinmetz. Conservation and sustainable use of medicinal plants: problems, progress, and prospects. *Chin Med*. 2016; 11(37):1-10
3. Sustainable Harvest of Medicinal Plants in India. WWF Fachbereich Biodiversität, Artenschutz und TRAFFIC; February, 2007, 1-2.
4. UNU-IAS Working Paper No. 160 Conservation and Sustainable Use of Medicinal and Aromatic Plants: A Case Study in Köprülü Kanyon National Park, Turkey Gulay Cetinkaya March, 2009.
5. Bhattacharyya R, Bhattacharya S, Chaudhuri S. Conservation and documentation of the medicinal plant resources of India. *Biodiversity and Conservation*. 2006; 15:2705-2717
6. Raina R, Chand R, Sharma YP. Conservation strategies of some important medicinal plants. *Int. J Med. Arom. Plants*. Dec. 2011; 1(3):342-347
7. Khan TI. Conservation of biodiversity in western India. *The Environmentalist*. 1997; 17:283-287
8. Dhir Richa, Shekhawat GS. Critical review on *Tecomella undulata*: A medicinally potent endangered plant species of Indian Thar desert. *International Journal of Current Research*. 2012; 4(6):036-044.
9. Sharma PC, Yelne MB, Dennis TJ. Editors. Rohitaka. In: Database on Medicinal Plants used in Ayurveda, New Delhi: Central Council for Research in Ayurveda and Siddha 2002; 6:321-324
10. Kalia Rajwant K, Rai MK, Sharma R, Bhatt RK. Understanding *Tecomella undulata*: an endangered pharmaceutically important timber species of hot arid regions. *Genet Resour Crop Evol*. 2014; 61:1397-1421
11. Khatri A, Garg A, Agrawal SS. Evaluation of hepatoprotective activity of aerial parts of *Tephrosia purpurea* L. and stem bark of *Tecomella undulata*. *J Ethnopharmacol*. 2009; 122(1):1-5.
12. <http://apps.who.int/medicinedocs/en/d/Js4928e/>
13. <https://www.google.co.in/search?q=micropropagation&oq=micropropagation+&aqs=chrome.69i57.12328j0j7&sourceid=chrome&ie=UTF-8#>
14. Peringattulli Narayanan Krishnan SW, Decruse RK, Radha. Conservation of medicinal plants of Western Ghats, India and its sustainable utilization through in vitro technology. *In Vitro Cell. Dev. Biol.-Plant*. 2011; 47:110-122



15. <https://www.google.co.in/search?q=cryopreservation+techniques&aq=chrome.69i57.1839j0j7&sourceid=chrome&ie=UTF-8#>
16. Rathore TS, Singh RP, Shekhawat SN. Clonal propagation of desert teak (*Tecomella undulata*) through tissue culture. *Plant Science*. 1991; 79:217-222
17. <https://www.google.co.in/search?q=cultivation+of+Tecomella+undulata&aq=chrome.0.69i5913j69i57.6914j0j7&sourceid=chrome&ie=UTF-8#>
18. Kumari Suman, Singh N. Micropropagation of *Tecomella undulata* (Sm.) Seem and genetic fidelity testing of in vitro raised plants. *AsPac J Mol. Biol. Biotechnol*. 2014; 22(2):191-198
19. Tyagi HS, Choudhary GR, Tomar UK. Clonal Propagation of an Economically Important Woody Tree of the Arid Zone-*Tecomella undulata* (Sm.) Seem. *Expanding Frontiers of Forestry Sciences*. Conference Paper · November 2011. 1st Indian Forest Congress, 2011, 356-362. Available at https://www.researchgate.net/profile/Uttar_Tomar/publication/240918272_



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