

## KHEJRI (*PROSOPIS CINERARIA*): A MULTIPURPOSE TREE OF THE THAR DESERT

### Abstract

The *Prosopis cineraria* (L) locally name as Khejri in Rajasthan is an important tree that contributes to rural economy of the North Western arid region of India as mentioned in ancient literature. It is a leguminous and prominent tree component of the agroforestry system practised in the arid and semi-arid regions of India. This is a versatile species providing Fiber, Fuel, Fodder and Food. The tree leaves are considered as good fodder and therefore used for feeding camels and goats. The fresh green pods are used as a vegetable and a dish known as Panchkuta is also prepared from khejri pods, which are locally called as “Sangri” in Rajasthan. The flowers provide nectar and pollen for honey bees thus helps in producing honey. The wood is useful for house construction, making cart and agricultural implements and is ideal for domestic heating. *Prosopis cineraria* improve soil and stabilize sand dunes. The bark infusion of the tree is taken orally as abortifacient and purgative. Khejri is well known for the treating asthma and worm. Therefore, this review is focused to delineate its botany, silviculture, ecology, socio-economic importance, nutritional importance, uses, medicinal importance and photochemicals, precisely.

**Keywords:** *Prosopis cineraria*, Khejri, nutritional importance, phytochemicals, semi-arid regions.

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## I. INTRODUCTION

The Great Indian Desert also known as the Thar Desert consists of arid regions of Rajasthan, Gujarat, Punjab, and Haryana. The Thar desert area in India (in western districts of Rajasthan) carries the 62% of the arid zone, has a distinct rainfall gradient from east (370 mm in Jodhpur district) to west (100 mm in most parts of Jaisalmer district), most of it happens from July to September (Kumar *et al.*, 2009). In this area the bioclimatic and environmental limitations which are high temperatures (mean maximum temperature rises to 45-47° C in summers months), low precipitation (mean annual rainfall ranges from 100-400 mm), high wind speed (average annual wind speed is 8-10 km/h with 30- 40 km/h in hotter months) and high potential evapotranspiration is also one of the obstacles for survival in this environment that would not support the life. (Tewari and Singh, 2006). Important tree species of the region include *Acacia nilotica*, *A. tortilis*, *A. leucophloea*, *A. senegal*, *Azadirachta indica*, *Prosopis cineraria*, *Salvadora oleoides*, *S. persica*, *Tamarix aphylla*, *Tecomella undulate*, and *Zizyphus* species. All the tree species are important as scanty vegetation is there in this region but *Prosopis cineraria* locally known as Jandi or Khejri in India, belongs to the family Fabaceae (Leguminosae) figure prominently in the fragile desert ecosystem because of its myriad benefits and uses. The tree is considered as ‘Kalpvriksha’ of the desert as nearly every component of this versatile tree can be harnessed and it is also known as ‘Pride of the Desert’, ‘King of desert’ and ‘Golden Tree of Desert’ (Mahoney, 1990). It supplies fodder, firewood, gum, medicines, small timber and tannins and improves the fertility of soil and stabilize sand dune (Singh *et al.*, 1998). This tree species is much valued as fodder tree. The fodder from its leaves (long) is nutritive, very rich in crude protein (12- 18 %) and appetizing to the animals (Bhandari *et al.*, 1979; Bohra and Gosh, 1980). The wood is suitable for interior construction work like upright pillars of huts, roofs, doors and windows etc. The small agricultural implements are also made by using the tree wood. The 20-30 years old tree provide 40-70 kg fuel wood and 25 years felling period is suitable in 350-400 mm rainfall zone (Mann and Saxena, 1980). The mature pods are fed to livestock, while the unripe pods are used as a feed supplement (Brown, 1992). Its pods contain 6-16 percent sugar and 9-4 per cent crude protein. The bark is used in the cure of rheumatism and scorpion bite. It is considered as an important tree component in agroforestry land use systems due to its deep root system, effective in recharging the soil with organic matter and atmospheric nitrogen fixing capability (Toky and Bisht, 1992).

- 1. Botanical Details:** *Prosopis cineraria* (L.) Druce is a thorny, evergreen, small sized tree having irregular branches belongs to family Leguminosae and subfamily Mimosoideae. Bark is rough, thick grey in colour having deep fissures and crown is open. The thorns have conical base, straight and scattered through the length of the branches. The thorns start to appear in 6-8 weeks old seedlings. *Prosopis cineraria* have thorns at internodes but it differs from *Prosopis juliflora* which have thorns in pairs at the nodes. The leaf flushing occurred just prior to summer and leaves are alternate bipinnately compound. The type of inflorescence is racemous, the 5-23 cm spike have many small yellow-green flowers (0.6 cm in diameter) (Mahoney, 1990). Flowers have yellow corolla, attracting large number of wild bees and numerous insects like *Apis florea* in April and December (Gorain *et al.*, 2012). The light yellow cylindrical, narrow (0.4-0.7 cm) and long (8-19 cm) pods, each pod consists of 25 seeds having 0.3- 0.8 cm length and light brown in colour. *Prosopis* has a typical tap root system, which grows vertically downwards up to 20 m or more deep (Mahoney, 1990).

- 2. Silviculture:** *Prosopis cineraria* seeds have long viability period, can be stored for several years without losing its viability in dry storage and 80-90% germination was obtained after establishment (Mahoney 1990). The viability of seeds is 3-4 years when stored in dry conditions. The seeds are soaked for 24 h in moderately warm water before treatment. The scarification treatment is also given; the seed (round end) may be scarified by giving a small cut in surface or scratched with a file or knife.

In *Prosopis cineraria* poor seed setting and hard seed coat is there due to which natural regeneration is very difficult. *Prosopis cineraria* is hard to propagate via stem cuttings, although rooting hormone treatment is found to be effective in India. Vegetative propagation methods like air layering and root suckers have been adopted. Recently micropropagation method is also done in this species but it was reported that in vitro propagation is easier in other *Prosopis spp*s but it was difficult to do in *Prosopis cineraria*. The tree also grows slow in comparison to other *Prosopis spp*s.

Seedlings are raised in a nursery and transplanting of nursery raised seedlings is done at the onset of the rainy season after 2-3 months. The spacing maintained between the trees is 1 m and they are planted in close lines as a hedge (Mahoney, 1990) and for alternate land use systems like silvopastoral and agroforestry, 50-100 trees/ha are considered favourable. The initial growth rate is slow so one or two weedings are required during the first year of growth. Early pruning is essential to promote straight growth (NAS, 1980). The tree responds positively to irrigation and can survive in 50% sea water.

The tree is suitable for coppicing (NAS, 1980). Pollarding is done on a three-year-rotation in *Prosopis cineraria* to obtain maximum yields of fodder. Rural people traditionally follow the practice of lopping in winter season and naturally dried the leaves, which they store and used as fodder in the dry season.

- 3. Ecology:** *Prosopis cineraria* is confined in the dry regions of India, Afghanistan, Iran, Pakistan, and Arabia where arid climate and less rainfall (less than 500 mm) is there. It is a crucial species found on the older alluvium (bhangra) and higher alluvium (Indus river valley).

The tree is hardy enough to survive drought, light frost and tolerates high temperatures (upto 50° C), it grows at an elevation 600 m above sea level. The tree commonly found growing on almost all type of soils; in alkaline, alluvial, sandy, but soil which considered best for its growth is alluvial soil. It is moderately salt tolerant as its growth reduces considerably in very saline soil. It was grown in agricultural, pastures and village community lands. Through experience, farmers have understood that khejri tree does not adversely affect crop yields but it increases the yield (Kaul, 1967). Now Khejri is incorporated in the existing farming/cropping system in the arid regions of India.

*Prosopis cineraria* trees exist isolated in some areas in Oman. It also found growing together with *Acacia tortilis* under less favourable conditions forming open dry, woodlands which are major desert communities. The phenotypic variation is found in growth rate, branching habit and crown shape between individual trees.

4. **Nutritional Importance:** Protein deficiency can have an impact on the physical and emotional health of the people and due to lack of protein-rich food consumption so many people around the world unable to meet their body's requirements. Legumes contain 18-35% protein (Jahreis *et al.*, 2016) and cereals contain 10-15% protein (Breene *et al.*, 1988). Leguminous tree *Prosopis cineraria* contain 16.5-18.25% protein. Therefore, *Prosopis* seeds are used in industries as a cheap source of protein and to be considered for resolving problems related to food like protein-energy-malnutrition problem (PEM), particularly in Afro-Asian countries. *Prosopis cineraria* contain 5.34% of ash and 20.93% fiber (Gangal, 2009; Joshi, 2011; Chandra and Mali, 2014). The *Prosopis cineraria* seed have 10.6% oil (68.3% unsaturated fatty esters, 28.6% saturated fatty esters and 3.1% methyl hydroxy fatty ester). Moringa seed oil consists of oleic acid (31.3%) and linoleic acid (32.1%). Oil and seeds of *Prosopis cineraria* does not shows presence of keto, cyclopropenoid and epoxy fatty acids or trans-unsaturation or any presence of conjugation. Chemical composition of pods is affected by a number of environmental factors so it is varied between individual trees. The *Prosopis cineraria* pods have good shelf-life as they have low moisture content (8.55%) and consists of 20.93% fiber, 18% protein, 1.89% oil, and 5.34% ash (Joshi *et al.*, 2011). In addition, the tree leaves provide sufficient macro nutrients such as calcium (2.43%), potassium (0.41%) and phosphorus (0.16%) and so, mineral deficiency can be cured through their consumption (Ghazanfar *et al.*, 2011).
5. **Socio-Economic Importance:** *Prosopis* play a significant part in the livelihood of the rural people due to its capacity to increase soil fertility, provide fuel, food and timber. *Prosopis* Pods locally known as “Sangri” used as dry fruit in the desert areas of western rajasthan, pods hang in the groups of upto 12 from the tree and have brownish colour. Dried pods used as Marwari Mewa are called as “Khokha” have 13.16% sucrose, 9-15% protein and 45-55% carbohydrate (Rathore, 2009). The green leaves of *Prosopis cineraria* locally known as “Loong” provide nutritive fodder to the animals like camels, goats and cattles (Bohra, 2008).

#### Uses

- **Wood:** The wood is hard and reasonably durable, so can be used for a variety of purposes like construction of tool handles, houses, posts and boat frames, but wood is not used as timber if obtained from poor tree form. *Prosopis cineraria* produces excellent firewood (calorific value, ca. 5,000 kcal/kg) and charcoal. Its wood is used for domestic heating and cooking (Mahoney 1990).
- **Fodder:** The leaves provide very palatable and nutritious fodder for camels, goats, and donkeys. When most other trees are leafless during the extremely dry summer months, new flush of leaves are produced by the tree. The leaves contain crude fiber (20%), crude protein (13.8%) and calcium (18%) (FFN 1991). The pods dry sweet pulp so considered as good fodder.
- **Food:** The pods are eaten as vegetable and form a part of human diet in some regions. The green pods like beans are known as sangri in Rajasthan are boiled and dried (FFN 1991). Bark and flowers also have medicinal value (NAS 1980). During famine, the bark is powdered and combined with flour before being eat as cakes (Bhandari 1978). The bark is used to tan leather in leather industries and bark can also be utilised to make an edible gum. The flowers are excellent honey sources.

**6. *Prosopis Cineraria* as an Agroforestry Tree:** *Prosopis cineraria* can withstand periodic burial and effectively stabilizes sand dunes (Gates and Brown 1988). The trees do not compete with nearby crops for moisture or nutrients as they have a deep taproot. The tree canopy is not dense so it casts only light shade during the growing season and light is available for agricultural crops and is therefore suitable as an agroforestry tree. The tree improves soil fertility in crop fields in semi-arid parts of India. Millet or sorghum yields improves when grown under *Prosopis cineraria*, as it lower soil pH and enhanced the amount of total nitrogen, available phosphorus, soluble calcium and organic matter content (Mann and Shankarnarayan 1980). Wheat, maize and mustard crops are also typically grown under Khejri based agroforestry systems.

In India, the Khejri based agroforestry system have been considered as one of the most successful and well-known agroforestry system as it helps in preservation and conservation of environment and meeting present and future needs of food, fodder, fuel and timber. The lopping practice is followed by rural people of western Haryana and Rajasthan, the trees of *Prosopis cineraria* are constantly lopped by them to get the leaves to feed the livestock. Its leaves are excellent fodder for cattle, camels and goats (Arya *et al.*, 1995).

**7. Medicinal Importance:** *Prosopis cineraria* flowers are crushed and mixed with sugar and fed to pregnant ladies to lower their risk of miscarriage. The soluble potassium salts (31 percent) present in the wood ash may be used as a source of potash. The bark can also be used as source of food as it is sweet in taste. It is reported that many people consume the bark as food to save their life during Rajputana famine of 1869. It was ground in to flour and breads are prepared. The bark is dry, acrid, and bitter with a sharp taste used as cooling anthelmintic, tonic and used for the treatment of asthma, bronchitis, dysentery, leprosy, leucoderma, piles and tremors of the muscles (Kirtikar and Basu, 1984). The bark is also used for leather tanning. Leaf infusion of *Prosopis cineraria* is applied on open sores on the skin and leaf paste on boils and blisters, including mouth ulcers in livestock (Nandkarni, 2000). The smoke of the leaves helps in treating eye problems. The pods are nutritious so they are utilized as a raw material for food industry and also considered astringent. The bark helps in treating rheumatism, in asthma, cough colds. The plant is prescribed for the treatment of snakebite. The bark is recommended for treating scorpion sting (Chopra *et al.*, 1956).

**8. Phytochemical Contents:** *Prosopis cineraria* (L.) Druce is an important medicinal plant as mentioned in ancient literature. It is used traditionally for the treatment of various ailments like asthma, bronchitis, dysentery, leprosy, leucoderma, muscular tremors, piles and rheumatism etc.

- **Phenolic compounds:** The presence of polyphenolic components accounts for the antioxidant activity of *Prosopis cineraria*. The significant wound healing activity was showed by the *Prosopis cineraria* ethanolic extract (Gupta *et al.*, 2015).
- **Flavonoids and tannins:** The presence of flavonoids and tannins are responsible for the antibacterial activity in *Prosopis* (Jayshree *et al.*, 2014). The stem and bark in methanolic extract of the plant part was utilized to evaluate the antidiarrheal activity (Naik *et al.*, 2012).

- **Alkaloids, tannins and steroids:** The root of *Prosopis cineraria* was extracted using ethanol, which revealed the presence of alkaloids, steroids and tannins that are responsible for its analgesic activity (Kumar *et al.*, 2011).

*Prosopis cineraria* has been observed to contain glucosides in its flowers and flavones in its seeds, in addition to fatty acids, alkaloids, glycosides and sterols (Gangal *et al.*, 2009). The hydrocarbons and phenolic acid derivatives are found in the leaves after phytochemical investigations (Khan *et al.*, 2006; Malik and Kalidhar, 2007). The leaves also contain a significant amount of unsaturated fatty acids including linoleic acid and oleic acid (Malik and Khalidar, 2007). The unripe pods of *Prosopis cineraria* contain tannins, alkaloids, flavonoids and dried unripe pods contain glycosides (Sharma *et al.*, 2012).

Numerous bioactive compounds such as alkaloids, amino acids,  $\beta$ -sitosterol, diketones, free pterin, flavonoids, lipids, phenolic contents, prosogerin A,B,C,D, vitamins, spicigerin, sugars and have been extracted from different tree components (Purohit *et al.*, 1979; Rhoades, 1979).

- **Agroforestry and land Restoration:** Explanation of how Khejri plays a pivotal role in agroforestry systems, helping to improve soil quality and crop productivity. Discussion of its potential in combating desertification and contributing to land restoration efforts.
- **Challenges and Conservation:** Identification of challenges faced by Khejri populations, including overexploitation, habitat degradation, and invasive species. Exploration of conservation efforts and strategies to protect and sustainably manage Khejri populations.
- **Prospects and Research Opportunities:** Discussion of the potential of Khejri in climate change adaptation and mitigation strategies. Exploration of research avenues, including genetics, propagation techniques, and improved management practices.

## II. CONCLUSION

It is concluded from numerous investigations that the *Prosopis cineraria* is a multipurpose tree of dry region with a wide range of applications. The different parts of tree have various phytochemicals and are used for medicinal purposes. The numerous chronic disorders *can be* successfully treated using *Prosopis cineraria*. It is useful in improving soil fertility, stabilizing sand dunes and also helpful to find water index in the Thar Desert.

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