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***Review Article***

# *SALVADORA PERSICA* L. (MISWAK): AN ENDANGERED MULTIPURPOSE TREE OF INDIA

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## ABSTRACT
Miswak is an important shrub/small tree of the Indian sub-continent. Due to its multipurpose use it has been exploited ruthlessly by all the sections of the society since decades which has endangered its status. Because of its great medicinal properties it has been in heavy demand in the Indian Herbal Drug Industry. Its branches are commonly used as tooth brush in villages and rural area of the country. Apart from its medicinal benefits it can also be utilized for carbon storage and sequestration for long durations thus, helps in our fight against Global Warming and Climate Change. As the shrub/tree has become endangered all steps need to be taken to conserve this important species otherwise a time would come when we would be devoid of its multiple benefits. Plant Tissue Culture is an excellent technique for large scale propagation of this tree species and at present there are various protocols available in public domain for its mass multiplication but none of the protocols has been utilized to restore the plant status till date. Serious efforts by Government (Central and State) are required for mass multiplication of the species on one hand and conservation of its germplasm on the other. The article is a sincere attempt by the author to present a critical view of the tree species so that it can be saved timely and our society continues to receive the magnificent benefits which it offers.

***Keywords:*** *Miswak, Endangered, Medicinal, Carbon Sequestration, Plant Tissue Culture, Mass Multiplication, Germplasm*

## INTRODUCTION
The demand and supply gap of medicinal plants (mps) has always been a bottleneck as most of the mps are over exploited and appropriate conservation measures are not applied timely and effectively leading to their mass extinction. *Salvadora persica* L. is one such plant which is highly medicinal and is in great demand in India. Like most of the mps, it is also facing the threat of mass extinction (www.iucnredlist.org) and if immediate steps are not taken now then probably its existence in the near future will be in danger.
In the present investigation, the author has tried to present a critical view of the tree elaborating its ecological and floral characteristic apart from its medicinal and commercial benefits. The author has also tried to give an insight about the possible role of the tree in carbon mitigation and management. The last part has been devoted to all possible methods for conservation of its germplasm.

***General Description of the Tree Species:***
*Salvadora persica* L. is a slow growing, evergreen, perennial and a facultative halophyte which belongs to family *Salvadoraceae*. It is a large shrub or a small tree which is under severe threat in India due to its importance in Indian Herbal Drug Industry.
Sufficient literature is available on this plant species in our ancient literature such as "*Charak Samhita*" by *Ayurvesa* (1000-1600 BC) and Rig Ved (4500-1600 BC) too.
*S. persica* is popularly known as Chota- Peelu, Meetha- Jhal, Salt Brush Tree, Siwak or Meswak. In Sanskrit it is called by several names, few of them are *Angahava*, *Sitasaha*, *Stranvsi*, *Dagari*, *Gudaphala*, *Virekaphala*, *Brhatpilu*, *Sahasrangi* etc.
The "*Siwak"* or "*Miswak"* is often mentioned as a symbol for emphasis given in medieval Islam to dental health care. *Siwak* or *Miswak* are the names of the wooden instruments which were used as "*tooth- sticks*" or as an early form of toothbrush to clean the teeth and deodorize the mouth.
It is also known as tooth brush tree and has been used as tooth brush and chewing stick for over 1000

years. It is for this reason that *S. persica* has received the name of "Darakhat- e- misuak" or the tooth brush tree. Branches are cut repeatedly to produce short stems that are harvested for tooth brushes (Darmani *et al.*, 2006).

It is grown in plantations or hedges. The seed has high genetic variability (Peshwae, 1987) mainly because its cultivation is restricted to dry and saline areas of some countries. Cultivated seedlings and trees must be protected from browsing by animals.

***Distribution and Ecology:***

The shrub is a native of Arabic, Middle East countries and India (Kamel *et al.*, 1992). In India, it is distributed in the dry and arid regions of Gujarat, Rajasthan and to some extent in UP, Punjab and Delhi also. It is further present in states like Maharashtra, Andra Pradesh, Karnataka and Kerela. It is found where ground water is readily available on river banks, on perimeters of water holes, in seasonally wet sites and along drainage lines in arid zones. The altitude ranges from 0- 1,800 m and rainfall from 300-1000 mm. This plant is adapted to alkaline or very saline soils usually clay rich but it is also found on loams, black soils and sands.

It is extremely well adapted to drought conditions and is salt tolerant also. The shrub has a very deep tap root system hence used extensively as wind breaks and shelter belts to protect crops in agro forestry system.

*S. persica* is considered as an important crop plant for marginal coastal areas of arid and semi arid regions, where the salt concentration of the soil would inhibit the growth of most other crops (Zodape and Indusekhar, 1997). It can tolerate salinity up to 635 mm and it performs well in temperatures up to $45^0$ C. Moreover, it exhibits remarkable flexibility since it can be cultivated in saline and non saline soils with varying texture from sandy to clay soils. Therefore, it can be considered a drought and salt tolerant species.

In its natural habitat *S. persica* is associated with trees like *S. oleoides*, *Prosopis juliflora*, woody species like *Capparis* and *Acacia jacquemontii* etc. Succulents and halophytic communities are also found associated with the shrub (Gupta and Saxena, 1968). At certain places in the Indian Desert, *Salvadora* species is the only one having green foliage. The plants have deep tap roots, fleshy and drooping leaves vertical in position which lessens the heat effects of the hot environment.

***Floral Characteristic and Phenology:***

The plant is a much branched, evergreen small tree or a long straggling shrub with spreading or drooping, glabrous, terete or more or less angle of $45^0$ to the main axis. Leaves are opposite, decussate, elliptic-lanceolate or ovate, obtuse and often mucoronate at the apex, petioles 1-2 cm long; stipules minute, flowers greenish yellow, in axillary and terminal, compound, lax panicles which are 5-15 cm long; branches slender, opposite, ending in minute scattered flowers, pedicles 1.5-3.0 mm long; bracts beneath the pedicles, ovate, cadecous. Calyx less than 1 mm long, glabrous; cleft half way down; lobes rounded, corolla very thin, 3 mm long, deeply cleft, persistent; lobes 2.5 mm long, oblong, obtuse, much inflexed. Stamens 4, smaller than corolla, exerted, ovary minutely pedicellate. Fruit a berry, 6-7 mm in diameter, globose, smooth, red when ripe supported by persistent yellow cups of calyx. The pulp in the fruit of *S. persica* has a pungent odour and hence, was known as Mustard of the Bible in earlier times (David *et al.*, 1969).

The tree is approximately 10 m high maturing in 8-12 years i.e. long life cycle and slow growth. Seeds are dispersed by birds. Plant produces three types of fruits i.e. pink, purple and white. The purple fruit bearing plants shows better seed traits via seed weight, size, thickness, volume, density, viability and germination percentage as compared to other two types of fruit bearing plants.

Leaves of the plant are shed twice in a year i.e. October-November and February-March but plant never becomes leafless throughout the year. New leaves appear twice in a year, first during April- May and second during September-December and thereafter new leaves develop slowly. During winter season (cold stress) anthocyanin pigments have also been noticed in leaves. Moreover, gall formation has been commonly observed on every plant part except roots. These galls have been reported to possess some growth promoting substances. The plant bears flowers in September- October and produces fruits with

**Figure 1: *S. Persica* L. Growing in Natural Habitat at Rambagh Circle, Jaipur (Photo: Vineet Soni, 2008)**

and without seeds. The fruits are formed in autumn and takes three months to increase in size and mature during April-May. In natural conditions, the germination of seeds takes place in rainy season i.e. July and August.

***Climate and Soil:***

Plant grows well under arid environment, salt stress condition and low moisture with high temperature. Soil mixture of 1:2:1 ratio of sand, clay and FYM is best for its growth.

***Chemical Constituents:***

Farooqui and Srivastava (1968) reported the isolation of trimethylamine from the roots of *S. persica*. Various phytochemical studies also report the presence of *salvadourea*, *β-sitosterol* and the isolation of new *indole* alkaloid from the leaves of *S. persica* (Sohail *et al.*, 1987). Moreover, a preliminary investigation reported the presence of several salts, mostly as chlorides and a fairly large amount of alkaloidal constituents (Farooqi and Srivastava, 1968). Furthermore, plant extracts have recognized antifungal, antibacterial and antiviral properties that have a variety of medicinal use (Zodape and Indusekhar, 1997).

Based on chemical research the seed oil i.e. kinkanial oil and the bark contains trimethylamine, chlorine, fluorides, saponins, tannins, sulphur, vitamin C, silica and sterols (Rispler- Chaim, 1992). The seeds further contain fats (45-48 %), albumnoids (18-94 %), carbohydrates (23-98%), fiber (5-8 %) and ash (3-5 %).

Beside these, seeds also have $N_2$ (4.8%), potash (2.8%) and phosphoric anhydride (1.05%). Processed seed protein has the following composition in percentage – *glycine* (8.9%), *alanine* (6.6%), *aspartic- acid* (8.5%), *glutamic –acid* (14%), *serine* (8.3%), *theronine* (6%) *valine* and *methionine* (5.8%), *leucine* (14.5%), *arginine* (6.6%), *histidine* (3.9%), *lysine* (5.5%), *proline* (5.6%), *tyrosine* (3.8%), and *cystein* (2.4%). The root bark contains resins and traces of alkaloids called *Salvadorine*.

***Medicinal Uses:***

Almost every part of the plant is used to treat human ailments. Its young twigs and root bark have been used in folk medicine for the treatment of wide range of medical problems such as cough, asthama, scurvey, piles, rheumatism, leprosy, treatment of cancer, gonorrhoea, headaches, hepatic and other diseases (Farooqi and Srivastava, 1968; Kerharo and Adam, 1974). In addition, pharmacological data indicate antibiotic, anti- inflammatory and hypoglycaemic activities (Ezmirly *et al.*, 1979). Chlorine is

used to remove stains, silica as teeth cleaner, rennin as enamel protective coating preventing the tooth from decay problem. Vitamin and trimethylamine helps to cure and support gingival tissues. Sulphur, alkaloids and fluorides protects the teeth from cariogesic bacteria. A Swiss pharmaceutical company researched the nature of the Miswak and concluded that it contained chemicals active against oral bacteria that killed pathogens which cause gingival inflammation and caries. Consequently, the company produced a tooth paste from the Miswak extract. The tannic acid acts as an anti- coagulant. The twigs are beneficial in dental care (Dagar *et al*., 2004). It absorbs unwanted filth, bacteria and moisture so gums become fresh. It creates dryness as it reduces excessive watering and saliva in the mouth. The "kinkanial" oil from the seeds is used for joint pains, polio, piles and gorrorrhea. The oil is also used to kill intestinal worms and also helps to cure gall bladder. Leaves are used for the treatment of headache, joint pains, leprosy, itching mouth and gum problems, boils or ulcers. Leaves also has anti- cancer properties and is also used extensively as mouth wash. This compound is compared to "chlorohexidine" gurgle solution. Dry flowers are used to cure ulcers of intestine and for kidney treatment as well. Root bark is used for general body pain, gorrorrhoea, back pain, blisters, chest disease and stomach aches. Latex from the bark is used for treating sores.

Seeds of *S. persica* contain 30-40 % of greenish yellow, non-edible oil that has over 50 % lauric and myristic acid (Makwana *et al.*, 1988). It has a high melting point and a disagreeable odour that appears on purification. The most important aspect of the oil is the presence of low percentage of $C_8$ and $C_{10}$ fatty acids that are of great significance. Seeds are used as tonic and seed oil is used on skin for rheumatism. It is said to contain an antibiotic which suppresses growth of bacteria and the formation of plaques in the mouth, also used as stimulant.

***Commercial Aspect:***

The shrub is also used in commercial sector also. Peelu oil has great potential for making soaps and candles and can be used as a substitute of coconut oil. The seed contains about 40 % of the oil with fatty acid composition (*Lauric acid*- 2%, *Myristic acid*- 55%, *Palmatic- acid*- 20%, and *oleic- acid*- 5%) which makes an excellent soap.

***Climate Change Mitigation Options:***

In the present scenario, with the imbalance of carbon in the natural ecosystems especially urban environment, trees are often evaluated for their potential role in carbon storage and sequestration as anthropogenic $CO_2$ is one of the most prominent GHGs effecting our environment globally and trees are considered as the most potent carbon sinks. The carbon sequestration capacity of tree species depends upon its age, height, girth, size, biomass accumulation rates, canopy diameter wood density (Rathore and Jasrai, 2013) and rotation lengths (Baral and Guha, 2004). Long lived, slow- growing and high density hardwood trees store more carbon than short- lived, low-density and fast growing trees. Thus, apart from its unique medicinal properties *S. persica* can also be utilized for carbon-di-oxide mitigation and management as it can store carbon for long durations due to its slow growing nature. Literature reveals that the average height of a fully grown tree is 10 m with an average girth between 90- 100 cm and wood density of 0.59 gm/cm$^3$ which makes the tree fairly valuable for carbon offsetting. Recently, a PhD thesis submitted to Gujarat University evaluated an average carbon stock value of 2.93 Tons by 9 trees of *S. persica* growing in Gujarat University Campus (Rathore, 2013). Moreover, tree response to biomass accumulation was also reasonable under saline conditions (Sahu *et al*., 2016). Further, responses of nutritional treatments on the growth and biomass of *Salvadora persica* was found to be positive (Prakash and Kasara, 2003). Thus, it can be concluded that by improving the agro-techniques under field conditions the carbon accumulation and storage capacity of Miswak can be increased considerably.

***Conservation Aspect:***

Under natural conditions the tree regenerates freely by root suckers and natural layering. Though, seed viability is only 30% but the tree germinates readily from seeds and also coppices well. Seeds exhibit no dormancy but the fruit pulp contains germination inhibitors that should be removed before sowing. Soaked and de pulped seeds of *S. persica* germinate in 24 hours. Since, *S. persica* is a cross- pollinated species, the seeds do not produce true to the mother plant. Clonal fidelity of plants selected for particular

character cannot be maintained if propagated through seed as segregation of characters occurs in seed-raised progenies. Vegetative propagation is not a good option as stem cuttings failed to root (Kumara *et al*., 2000). At present, quite a few number of micropropagation protocols are also available for the regeneration of the tree species (Mathur *et al*., 2002; Mathur *et al.*, 2002; Mustafa, 2003; Phulwaria *et al*., 2011; Juleri *et al*., 2014) but serious work on mass multiplication of this valuable species has not been done till date.

Under field conditions, 15 gm of seeds are required for planting 1 ha area at a spacing of 5 × 5 m which yields around 200 kg of roots after 2 years at a cost of Rupees 6800/- per ha. Roots are extensively used for preparation of Meswak toothpaste. Fortnightly irrigation schedule improves the overall growth of the plantation in terms of collar diameter, biomass, bark and root yield whereas monthly irrigation is required for growth of plant height.

## CONCLUSION

*Salvadora persica* L. is a large shrub or a small tree of the arid zone which also thrives well under high salt stress conditions. The plant is highly medicinal; its stems are used as tooth brush in rural parts of India. Moreover, trees are often cultivated for roots as it is extensively used in preparation of Meswak tooth paste. The tree possesses multiple medicinal benefits which are discussed in detail in this article. Apart from its medicinal properties the tree could also be utilized for carbon sequestration and storage. As the trees grow slowly it can retain carbon for longer durations with comparatively lesser economic cost and management skills. Over exploitation over the last few decades have threatened the existence of this important multipurpose tree. Its urgent restoration and conservation is severely required. The Central and State machinery should immediately look into the matter and implement timely measures to save the plant. The expertise from Non Government Organizations should also be involved. Tissue Culture Technology should be exploited for mass multiplication of the species.

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