

Full Length Research Paper

# Ethnomedicinal and ethnoecological evaluation of *Salvadora persica* L.: A threatened medicinal plant in Arabian Peninsula

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Accepted 26 May, 2010

An ethno-medicinal survey was conducted in various parts of desert and semi desert ecosystem in Saudi Arabia with the aim to document ethnecological and medicinal value of *Salvadora persica*. It has been used by Muslim communities since centuries in traditional system of medicine. It remained a source of income and it is believed to be a type of religious toothbrush plant. The folklore uses, indigenous knowledge of local people, and traditional healers regarding *S. persica* were collected by using standard protocol. Based on the results obtained, it was concluded that *S. persica* is a multipurpose plant. It is one of the commonly used plants for medicinal purposes as well as due to its ethno-ecological importance. Various parts of *S. persica* are used as: food, fruits, fodder, a source of lipids, gum and resins. In addition, it is also used as a honey bee rearing plant. Its root is regularly used as tooth brush throughout the country. During the current study, it was also noticed that *S. persica* is a service provider plant which is grown to provide shelter-belts and windbreaker for agriculture crops. It helps in reclamation of sand dune habitat and saline soil in arid ecosystem of Saudi Arabia. *S. Persica* is distributed throughout the arid and semi arid ecosystem of Saudi Arabia. However, its population suffers from serious environmental problems such as deforestation, soil degradation, loss of biodiversity and unsustainable livelihoods. The study concluded that *S. persica* has high medicinal, economic and ecological values in arid and semiarid ecosystem of Saudi Arabia. Nevertheless, its conservation status is highly threatened and detailed ecological study of *S. persica* is suggested to conserve its remaining population in Saudi Arabia.

**Key words:** *S. persica*, medicinal uses, products, threats and conservation importance.

## INTRODUCTION

*Salvadora persica* L. (Salvadoraceae), commonly called Miswak or Toothbrush tree is one of the most popular medicinal plants in the Muslim world including Saudi Arabia (Sofrata et al., 2007; Hattab 1997; Ezmirly et al., 1979). Saudi Arabia is about 1,969,000 square kilometers and covers two thirds of the Arabian subcontinent. The country is known to have different natural sites with great biological diversity and productivity and such sites are fundamental in the synergistic framework of associated ecosystems (Abuzinada et al., 2005). *S. persica* showed some variations in its distributional behaviour in different

countries, which may be attributed to changes in water resources, climatic factors, edaphic variables and anthropogenic pressures along the elevation gradient (Hegazy et al., 2007).

The vegetation composition of Saudi Arabia reflects the geographical position of the Arabian Peninsula between Africa, Asia and Europe. Consequently, the flora has many elements of two of the eight global terrestrial realms; namely the Palearctic (Europe and Asia) and the Afro-tropical (Africa south of the Sahara) as well as a smaller complement of elements from the Indo-Malayan terrestrial realm. It is thus an area of ecological and academic significance (Ghazanfar, 2007). The general scope of ethno-ecology, an area of human ecology, was well defined earlier as the interface between people and their

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plant resources, and offers clues needed for rural development based on sustainable yields of forest products (Ali et al. 2002).

The climate of Saudi Arabia can be characterized as arid (Hegazy et al., 2007; FAO, 1996; Abulfatih, 1992). Ecologically, such zones are fragile and difficult to develop and use. Except in limited areas, the vegetation of arid areas is sparse and usually highly specialized both morphologically as well as physiologically. Hence, this region has been regarded as a natural reservoir for the collection of a variety of wild medicinal and aromatic plants (Thomas 2007; El-Demerdash et al., 1995). Unfortunately, many such plant species are collected by local communities without any reference to conservation needs in Saudi Arabia; rather they collect and sell plants both in local as well as international market, just to earn some money to support their lives in mountainous and arid environment.

Such practices in turn might lead to cause irreversible damages in the fragile ecosystems in different zones of the country (Sher et al, 2004). In addition, conversion of natural habitats into agricultural land has greatly decreased the population size of many economically important medicinal plants including *S. persica* and other forest resources in Saudi Arabia and else-where. As a result, many plant species become rare and sparse in many parts of Saudi Arabia (Thomas 2007; Ghazanfar, 2007).

The traditional medicinal use of *S. persica* as anti-microbial toothbrush stick for oral hygiene, and to treat gum inflammation, is a centuries old practice and a part of Greeco-Arab System of Medicine (Al-Otaibi et al. 2004, Zakaria et al. 1998). *S. persica* is harvested as wild rather than cultivated and about 80% world population use it as natural remedy for the treatment of different diseases (Noumi et al. 2010; Sofrata et al. 2007; Monforte et al. 2002; Ahmad and Ghazanfer 1991). *S. persica* is known to contain several biologically active chemical constituents such as volatile oils, flavonoids, alkaloids, steroids, terpenoids, saponins, and carbohydrates (Abdillahi et al. 2010; Garboui et al. 2009; Al-Ali and Al-Lafi 2003; Kamil et al. 1999). Roots of *S. persica* were found to contain Salvadourea, a urea derivative (Al-Quran 2008).

Besides medicinal claims, various parts of this plant serve as food, fodder, and it is also used as windbreaker and a source of sand dune reclamation as well as reclaiming saline soils (Ghazanfar 2007; Abuzinada et al. 2005; Sher et al, 2004; Al-Yemeni 2000, Hines and Eckman 1993; Alfaran et al. 1992).

The unregulated collection of *S. persica* for routine domestic use or its market sale have long been an important economic activity in the Arabian Peninsula, which is known to cause habitat loss of plant species survival, their genetic depletion and in an often-rapid downward trend of their populations. Therefore, the present endeavour was initiated with the aim to prepare an ethnoecological inventory of *S. persica* along with its

current traditional uses, ecological abundance and availability. In addition, current investigation included to determine snap shot of the, hitherto unmonitored aspects of *S. persica* ecology and their socio-economic influences on low-income group families.

## MATERIALS AND METHODS

### Plant selection and plant characteristics

*Salvadora persica* L. (Salvadoraceae) is known with a number of common names such as: miswak, arak, toothbrush tree, mustard tree. The rationale behind the selection of *S. persica* for current study (conducted March and April 2010), was the danger of its over collection due to the high demand.

*S. persica* is a well known and established medicinal plant. However, the plant material was collected from different places and its morphological and organoleptic characteristics (appearance, colour, odour, taste) were observed following Applequist protocol for the identification of medicinal plants (Applequist, 2006). The botanical features as defined earlier, were as follows:

*S. persica* is an evergreen perennial halophyte capable of growing under extreme conditions, from very dry environments to highly saline soils (Maggio et al., 2000). It is shrub or small tree up to 7 m in height; main trunk erect or trailing with profusely branched, wide crown, straggling and drooping branches; Leaves oblong-elliptic to almost circular, 3 x 7 cm, light to dark green, rather fleshy, apex broadly tapering to rounded, sharp-tipped; base broadly tapering; margin entire; petiole up to 10 mm long; leaves in opposite pairs. Flowers greenish to yellowish, very small, in loose, slender-branched axillary or terminal panicles, up to 10 cm long. Fruit spherical, fleshy, 5-10 mm in diameter, pink to scarlet when mature, single seeded; seeds turn from pink to purple-red and are semi-transparent when mature and dispersed by animals and man after they eat the fruit (Figure 1). Finally, identification was confirmed by direct comparison with the authenticated plant material available in the Plant Taxonomy Unit, College of Science, King Saud University, Riyadh, Saudi Arabia where voucher specimens were kept on record.

### Plant distribution

The distribution of *S. persica* was a part of the current study. It was found to be a widespread plant: It mostly occurred in thorn shrubs, desert floodplains, and stream bank vegetation, and grassy savannahs of the Kingdom of Saudi Arabia. Its distribution pattern was investigated.

### Ethno-ecological Survey

An ethno ecological evaluation of *S. persica* was conducted during March and April 2010. A semi-structured questionnaire was devised to document the traditional knowledge of local people regarding *S. persica* (Al-Ashban et al., 2004). Generally, in Saudi culture, elder persons with practical knowledge are respected by others and such tribe men are more confident to respond. In addition, people practicing popular folk medicine were contacted and interviewed for their comments on *S. persica*. Information about the medicinal and other local uses, parts used, and time of collection, processing and recipe preparation were recorded. Regarding information about ecological aspects of *S. persica*, it was obtained from on-line literature search during each visit to a selected area (Sher et al., 2004; Al-Yemeni 2000; Al-Yemeni and Zayed, 1999; Alfaran et al.,



**Figure 1.** Camel grazing of *S. persica* L.

1992; Ahmad and Ghazanfer, 1991).

The relative abundance of *S. persica* in different localities was recorded which was substantiated by direct discussion and interviews with the elderly people. Personal observations were also made in the field to notice any pertinent events, which would help gain better understanding of the presence and abundance based on the ecological characteristics of the specie. Local people were asked several questions, in order to make an observation on their knowledge and information about locations of *S. persica* and its uses.

## RESULTS AND DISCUSSION

*S. persica* was found growing in valleys, on dunes and on termite mounds. The tree was found to tolerate a very dry environment (annual rainfall less than 200 mm). Being highly salt tolerant, it was distributed in coastal regions as well as on inland saline soils. Its elevation range, varied from 0-1800 m; and it was noticed growing in clays, black soils and sandy habitat (Ghazanfar 2007; Abuzinada et al., 2005; Maggio et al., 2000).

The present ethno-ecological evaluation of *S. persica* was conducted during March and April 2010 in the Kingdom of Saudi Arabia. The study compiled various traditional medicinal uses of *S. persica*, its pesticidal

importance, and products development. The study concluded that in many parts of the Saudi Arabia *S. persica* is used as food, fruits, fodder, source of: lipids, gums and resin and it is also used as a honey bee rearing plant. The study also showed that *S. persica* is a service provider plant helping in the reclamation of sand dune habitat and saline soils. Moreover, *S. persica* is used as shelterbelts and as windbreaks to protect farm habitation, gardens and horticultural crops in the entire arid ecosystem of Saudi Arabia. Based on the results obtained during current study and earlier experiences, a detailed ethno-ecological description of *S. persica* in the Kingdom of Saudi Arabia is presented as follows:

### Ethno-ecological uses

Fruits of *S. persica* have a sweet, aromatic and peppery taste and are eaten in raw, cooked, or dried and stored form by the inhabitants of the sites where *S. persica* grow in abundance. The leaf is somewhat bitter and aromatic, with mustard taste. The local folk cook the leaves as a sauce and eat it with couscous or as green vegetables. Tender shoots, seeds and seed oil are also edible and

preferred by children. Edible salts are also obtained from the ashes of *S. persica*. Its flowers were found to be a good source of nectar, therefore, *S. persica* is used as honey bee plant. The local Bedouins were found to have strong belief that the honey of *S. persica* had high medicinal value as compared to honey from other plant regions. The honey bee keepers also claimed that *S. persica* reduced the common diseases of honey bees as well.

Seeds of *S. persica* contained 30-40% of a greenish-yellow, non-edible oil that has over 50% lauric and myristic acids. It had high melting point and disagreeable odour that disappeared on purification. The most important aspect of the oil is the presence of a low percentage of C8 and C10 fatty acids confirming its great economic significance. The oil is an alternative source of oil for soap and local detergent industries. In this context *S. persica* supported different small local industrial products. These findings are in line with the results of Garboui et al. (2009); Al-Ali and Al-Lafi 2003; Makwana et al, 1988). They reported that *S.persica* has the potential to support the formations of different industrial products.

It is worth mentioning that the leaves and young shoots of *S. persica* are browsed by all stock, however, not much cattle were found in the driest part where *S. persica* was well distributed, hence, it tends to be valued more as a camel, sheep and goat forage. *S. persica* leaves make good fodder because of the high water content (15-36%). The high salt content of the leaves is thought to affect the taste of milk. However, the leaves were known to increase lactation in cows and improve general body weight of all animals. The wood is sometimes used as firewood with charcoal. It was noticed that, *S. persica* was not used for cooking meat, due to the foul taste of leaves. *S. persica* resin that drips from the tree is used for making varnish. Similar results were also reported by Sofrata et al., (2007) and Al-Oraibi et al. (2004). They revealed that *S.persica* is multipurpose plant and possesses several agro-pharmaceutical applications.

### Ethnomedicinal uses

The study revealed that toothbrushes made from roots and small branches of about 3-5 mm diameter have been used for over thousands of years, and currently the use of *S. persica* is more popular in Islamic populations of the world. These findings are well supported by earlier researchers (Azaizeh et al. 2003), who reported toothbrushes prepared from the roots and small branches of *S. persica*, to be highly useful as maintainer of teeth (Noumi et al., 2010; Al-Khteeb et al., 1991). The tooth stick is also said to relieve toothache and cure inflammatory gum disease. The claimed anti-inflammatory activity of *S. persica* was verified earlier (Zakaria et al., 1998). Roots are also used for cleaning teeth and for

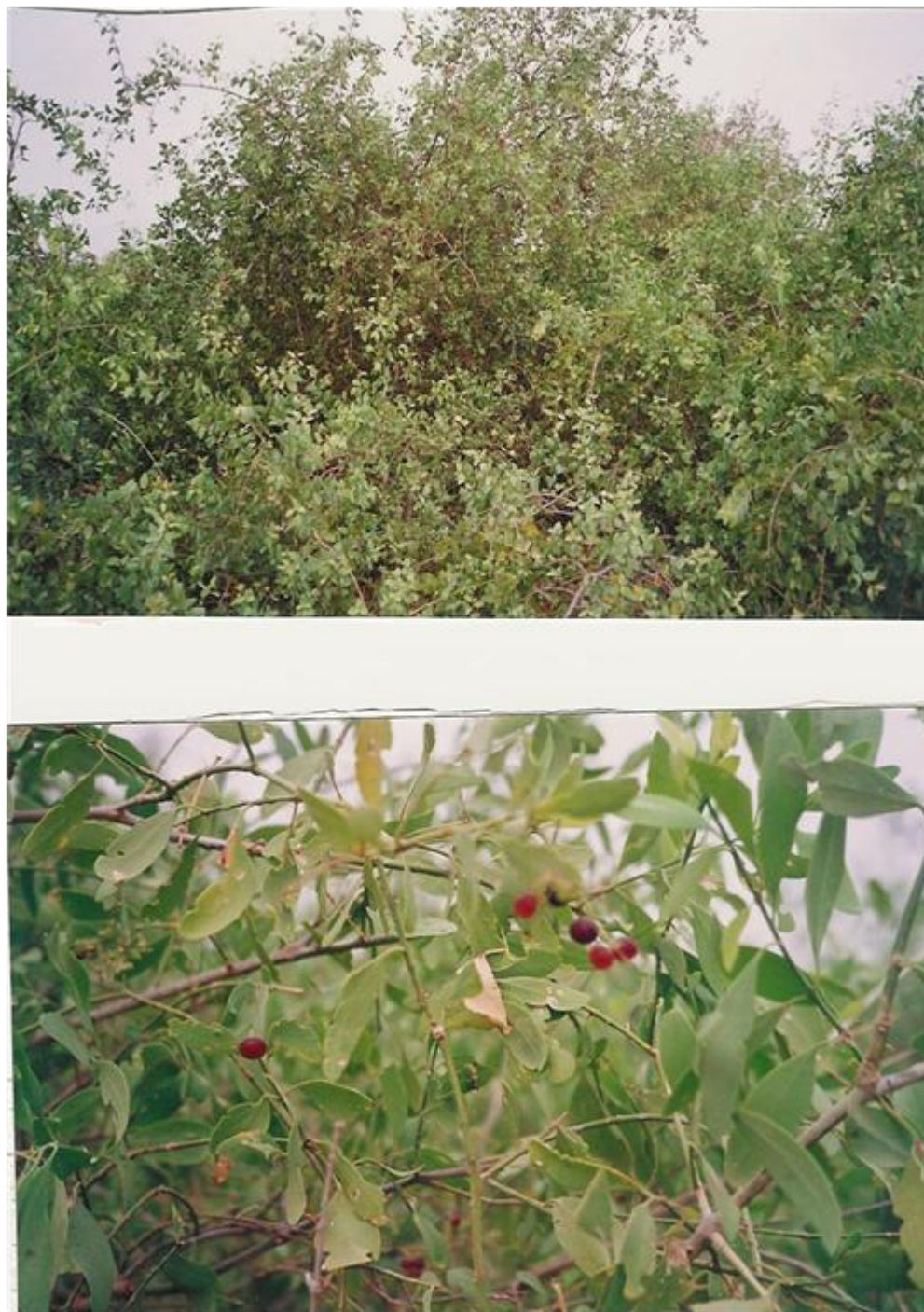
relieving toothache. Our present findings are in agreement with the reports of an earlier study (Akhtar and Ajmal 1981). It is well documented, that several agents occurring in the bark and wood of *S. persica* have been suggested to be used in prevention of dental caries, such as antimicrobial agents that suppress bacterial growth and the formation of plaque (Sofrata et al., 2007; Almas 1999; Al-Bagieh et al., 1994).

Decoctions of leaves are used as a mouthwash, and masticated leaves for tooth and gum problems. Our current findings are supported by earlier researchers reporting *S. persica* leaves and root extracts to be effective in various teeth problems, gum inflammation, and joint pain (Al-Sadhan, et al. 1999). A decoction of the root is used to treat gonorrhoea, spleen trouble, epilepsy, and skin diseases, general stomach-ache, and stomach ulcers. Our findings are supported by earlier reports where decoction of *S. Persica* was shown to possess significant protective action against ethanol and stress-induced ulcers, and the elements of gastric mucosa reestablished normally in animal models (Sanoqo et al., 1999). Another study proved that *S. persica* stems decoctions reduced cholesterol and LDL plasma levels (Galati et al., 1999).

Furthermore, *S. persica* extract extended sleeping-time and decreased induction-time induced by sodium pentobarbital. These findings are well supported by Sanogo et al. (1999) and Islam et al. (1998). They stated that *S.persica* possessed significant protective action against ethanol, sodium hydroxide, phenylbutazone, indomethacin, thermocautery and stress-induced ulcers. It also showed protection against pentylenetetrazol-induced convulsions by increasing the latency period and diminishing the death rate in animals, thus confirming the folklore claim about its use to cure seizures (Monforte et al. 2002). Roots are also used for chest diseases or pounded and used as a poultice to heal boils. The bark is scratched and the latex used for treating sores.

Seeds are used as a tonic to increase fertility, and seed oil is used as a cure for inflamed skin and rheumatism. The present information and medicinal claims recorded about different parts of *S. persica* are in agreement with the report of Ahmed et al. (2008) who stated that *S. persica* seed oil is useful for the treatment of some skin diseases and joint pain. Mansour et al. (1996) also reported that the plant extract itself has an analgesic effect against heat stimuli but not the chemical stimuli. The study also reported that in Greco-Arab System of Medicine the fermented juice prepared from the fresh fruits is a strong aphrodisiac agent and is used as general body tonic (Ahmed et al., 2008; Darmani et al., 2003).

Another report suggested that crusted leaves *S. persica* placed in cow urine together with leaves of *Pergularia tomentosa* are used to clear hair from tanned hides, allowing the hair to be removed with a knife. *S. persica* is known to be a good source of volatile oil (also called



**Figure 2.** *S.persica* L.

essential oil).

Generally, such essential oils obtained from different plants were found to possess different pharmacological, microbiological, and insect repellent activities. Other finding in Sudan has supported our results and showed that *S. persica* has antiplasmodial activity and used as part of remedies to treat malaria (Ali et.al., 2002).

Currently, the use of synthetic chemicals to control insects and arthropods raises several concerns related to environment and human health. As an alternative environment friendly natural resources were explored and various *Cymbopogon* species, *Ocimum* species, *Eucalyptus* species, *Kunzea ambigua*, and *S. persica* essential oils were found to have insect repellent activity.

Such an activity was often found to depend on the concentration of alpha-pinene, limonene, citronellol, citronellal, thymol and camphor, usually present in essential oils in different concentrations. In some cases addition of vanillin to essential oils having relatively higher concentration of monoterpenes and sesquiterpenes showed increased protection time by potentiating the repellent activity (Nerio et al., 2010; Thomas et al., 2009).

### Pesticidal importance of *S. persica*

The volatile oils of *S. persica* are known to possess significant tick-repellent effects, however, the duration of action was short (Garboui et al., 2009). *S. persica* growing on a bank of stream or river terraces, was found to be a preferred host of *Cistanche tubulosa*, an obligate phanerogamic root parasite. Defoliating larvae of several beetles attack the tree, and leaves were often attacked by the lepidopteran *Colotis ephiae*. The mite *Eriophyes* causes leaf gall. A number of fungi such as *Cercospora udaipurensis*, *Placosoma salvadorae* and *Sephogloeum salvadorae* are known to damage the leaves (Sheikh, 1989). It was confirmed that the leaves extract of *S. persica* is highly effective for the control of root rot diseases and dies back problem in some plants. In addition to its medicinal uses, the *S. persica* is also popular among folk as a pest control plant. Our current findings are full in agreement with the earlier reports where various high plants were observed to possess significant antimicrobial and repellent activities including their role even in pest control (Abdillahi et al., 2010; Garboui et al., 2009; Nakanishi, 2006; Ali et al., 2002).

### Miscellaneous services of *S. persica*

In many parts of the Arabian Peninsula *S. persica* is planted as shelterbelts and windbreaks to protect farm habitation, and horticultural crops. Similarly, *S. persica* plantation help in the reclamation of sand dune habitat and also useful for reclaiming saline soils. Ahmed et al. (2008) study also concluded that *S. persica* can be propagated from wild seeds and by tissue culture.

### ABUNDANCE AND DISTRIBUTION

*S. persica* was found widely distributed from lower altitude (0 m) to the high altitude (1500 m) in the entire arid and semi arid ecosystem of Saudi Arabia. However, their distribution and abundance range was influenced by altitude aspect and slope of the area. While the pattern of distribution and availability of *S. persica* were found to be quite variable according to differences in harvesting intensity, grazing and habitat loss. These factors have adversely affected the natural regeneration and seriously

reduced the availability of *S. persica* in particular sites of Saudi Arabia. The current findings are in accordance with our earlier observations on topographic, edaphic and biotic factors determining the shape, distribution and availability of vegetation structure of *S. persica* in many parts of Saudi Arabia (Al-Yemeni and Zayed 1999)

During present study, it was also observed that *S. persica* mostly grow and occur on relatively open south facing slopes, and prefer moist habitat. The specie was rarely found in highly grazed and disturbed sites. The present study also revealed that the existence and distribution of *S. persica* is the result of interactions of physical and biotic factors within different habitats. It may give valuable indications to the characteristics of the habitats for other associated important species. Other reports support our results regarding plant community association and the structure supports each other population (Sikarwar 1996). However, it is well established fact that both over grazing and trampling damage the plants, young seedlings and influence their habitat and species composition (Figure 2). Based on the results of present study it can safely be concluded that *S. persica* is an important plant which needs to be brought under conservation measure.

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