The most important medicinal plants in Wadi Araba desert in South West Jordan: A review article

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ABSTRACT

This paper reviews the relevant information from journal articles and other resources on the most important medicinal plants present in the desert of Wadi Araba in South-West Jordan including the pharmaceutical and indigenous knowledge research. Many of Wadi Araba plants are common in the deserts of other Arab countries such as Arab gulf countries, Morocco, Tunisia, Egypt, Palestine and Sudan and beyond to India and Pakistan. The flora of Wadi Araba was investigated by many botanist and plant ecologist but the analysis of the medicinal and economical value of those plants is still lacking. From the medicinal plants that present in Wadi Araba and still used by the local inhabitants are: Artemisia judaica, Calligonum comosum, Moringa peregrina, Salvadora persica and Ziziphus spina-christi. However, the traditional and indigenous knowledge of the medical utilization of these and other plants is poorly recorded and is suffering from dramatic erosion. Consequently, further investigations regarding the value of native medicinal plants and the documentation of its traditional and ethnopharmacological knowledge is an indispensible priority in Wadi Araba in particular and in Jordan in general. The aim of this review article is to provide the reader with information concerning the pharmaceutical research and indigenous knowledge of the most important medicinal plants that present in Wadi Araba fragile desert ecosystem in order to: (1) Emphasize the importance of documenting the indigenous knowledge as a part of the cultural heritage, (2) Draw attention of the share holders in the pharmaceutical industry in Jordan and beyond about the important medical values of those plants and (3) Draw attention of the governmental and nongovernmental authorization to preserve those plants from genetic erosion.

Key words: Wadi Araba, medicinal plants, genetic erosion, indigenous knowledge, ethnopharmacology.

Introduction

Jordan as any country in the world has its own valuable traditional medical uses of wild plants. However, most of them are listed in the medicinal plants checklist as names and there is still a need for a comprehensive documentation of their traditional knowledge and the commercial potential in the pharmaceutical industry at the national level. Oran and Al-Eisawi, [46] listed about 363 species of vascular medicinal plants belonging to 263 generas and 86 families which comprise about 20% of the total flora of Jordan. From the few documentations of the indigenous knowledge of medical plants in Jordan is the work of Al-Qura’n, [9] who documented some of the folk medicinal potentiality of wild dicot aquatic plants in Jordan. Furthermore, Hudaib et al., [27] investigated the ethnopharmacology of medicinal plants in Mujib Nature Reserve and surrounding area near Dead Sea area and calculated the informant consensus factor ($F_i$) in relation to medicinal plant use. The highest use value was recorded for digestive problems and anthropologically, women were the primary gatherers.
while healers were reported to be both females, predominantly, and males; yet, herbalists are deficient in this local community. Similar study in the Ajloun Mediterranean highland in Jordan showed that kidney problems scored the highest informant consensus factor while Crocus hyemalis (Zafran) was the plant of highest use value [1].

The desert of Wadi Araba in South-West Jordan harbors many valuable plant genetic resources that can be used for many purposes such as food, feed, energy, aesthetic, fibers and medical treatment. It extends along 170 km from the southern Dead Sea shore (-400 m b.s.l) to the Gulf of Aqaba on the Red Sea (130 m a.s.l). From chorological aspects, the vegetation in this desert is considered as Saharo-Arabian territories with Sudanian penetration. Another feature of Wadi Araba desert is the heterogeneity of habitats (e.g. saline marshes including Dead Sea and Sabkhas, different sand dune types, rocky desert (Hammad), cliffs and water runoff areas). Many of the plants grown in Wadi Araba are also common in the deserts of Arabian Peninsula, Sudan, Egypt, Palestine, and others are common in India and Pakistan. However, little research is done on evaluating their industrial and commercial potentials and their local knowledge in Jordan particularly in Wadi Araba compared to the other neighboring countries like Gulf countries and Egypt.

Medicinal plants signify a crucial health and economic part of biodiversity. The importance of documentation and protection of the medicinal plants indigenous knowledge is as important as protecting them from genetic erosion. These local forgotten treasures are totally ignored and are threatened by being lost despite the sustainable socio-economic and environmental impact they could impose when preserved and utilized by the local community.

Therefore, this article review aims to provide the reader with the relevant information concerning the indigenous knowledge and possible medical uses of the most important medicinal plants that present in Wadi Araba desert in order to; (1) Emphasize the importance of documenting the ethnopharmacological knowledge as a part of the cultural heritage (2) Draw attention of the share holders in the pharmaceutical industry in Jordan and beyond about the important medical values of those plants, and (3) Draw attention of the governmental and nongovernmental authorization to preserve the biological diversity from genetic erosion. Some information about the most important medicinal plants that are present in Wadi Araba is reviewed below.

2. Some of the Wadi Araba desert medicinal plants

Aerva javonica (Burm. fil) Schultes, (Family: Amaranthaceae, Arabic name: Ra’a).

It is known as the desert cotton; this tropical chamaephyte (semi shrub) is native to Northern Africa to South Western regions of Asia and is being introduced as alien plant to Australia. It is used by local people in the WANA region to fill pillows due to the presence of soft fiber in the seed heads of the plant and it has veterinary medical uses in as a purge and emetic, and given internally for snake-bite. A. javonica is used in diarrhea and dysentery; and seeds are used in cases of diarrhea and haematuria in cattle [32]. It is also recorded to be as a remedy for toothache, headache and protect rheumatic pains [50,49], in treating kidney stones [68,19] and it is also has as an aphrodisiac effect. Moreover, Reddy, [53] detected an anti-hyperglycemic activity of ethanol extract of A. javonica leaves in Alloxan-induced diabetic mice. In Wadi Araba, it appears mostly in highly alkaline Lisan Marl soil and in sandy runnels, Wadis e.g. Wadi Khnazeera in northern of the Araba. It is mainly is threatened by the establishment of mining industry at the expense of natural habitats.

Artemisia judaica L. (Family: Compositae, Arabic name: Baa’ithran):

A Saharo-Arabian fragrant chamaephyte that grows in extreme deserts that is common by local Bedwins to have anti-diabetic effects and it is sold in local markets for this purpose.

Extracts of A. judaica showed pronounced molluscicidal properties on the terrestrial snail Eobania vermiculata [1]. Artemisia species have been used worldwide as a rich source of plant derived pesticides as well as tonic, stomachic, stimulant beverage and as antiseptic oils or tinctures for the relief of rheumatic pains. Mixture of the dry leaves of A. judaica, A. oncospelma and A.herba alba are very common anthelmintic drugs in most of North African and Middle East countries [5]. The single and multiple doses of both water and alcoholic extracts significantly reduced the blood glucose level in experimentally diabetic rats while no significant effect was shown on normal rats [44]. Significantly higher antioxidant activity and flavonoid contents were observed in the tissues of mature greenhouse-grown plants [35]. A protocol for Plant regeneration from mesophyll protoplasts of A. judaica was developed by Pan et al., [47], Liu et al., [35].

A. judaica is endemic in Jordan to Wadi Araba and associated to Hammada salicornica, grows in rocky calcium carbonate rich soils and mountain escarpments, it is considered from the highly threatened rare species in Wadi Araba. The conservation of the plant is very crucial and argent task that must be done.

Balantites aegyptiaca (L.) Del. (Family: Balaniteceae, Arabic name: Heglig, Zaqqum):
It is known in English as Desert date, Soapberry Tree and Jericho Balsam. The tree is distributed in tropical Africa and rift valley, Arabian Peninsula and was introduced to the Latin America and India. The fleshy pulp of both unripe and ripe fruits is edible and eaten dried or fresh. The fresh and dried leaves, fruits and sprouts are eaten by livestock. Traditionally, the fruits have been used in the treatment of liver and spleen diseases and known to kill the snails which carry schistosomiasis and bilharzia flukes [66]. Whereas; roots are used for abdominal pains and as a purgative and when mixed with maize meal the Gum from the wood is used to treat chest complaints.

Some studies analyzed the metabolite profiling of saponins in B. aegyptiaca plant tissues [58,18]. High performance liquid chromatographic (HPLC) analysis of a dichloromethane extract of the stem-barks of B. aegyptiaca has yielded two known alkaloids, N-trans-feruloyltyramine (1) and N-cis-feruloyltyramine (2), and three common metabolites, vanillic acid, syringic acid and 3-hydroxy-1-(4-hydroxy-3-methoxyphenyl)-1-propanone [58]. Moreover, Kamel [31] isolated a new furostanol saponin from the mesocarp of this tree fruits (balanitesin) and was identified by different spectroscopic techniques. Rakotomirina et al., [52] concluded that the decoction of Balanites aegyptiaca possesses sedative and anticonvulsant properties that might explain its use as a traditional medicine for epilepsy in Africa. On the toxicity of Balanites aegyptiaca, a study consumption of the crude oil of Balanites aegyptiaca may be of no serious safety concern, especially on liver and kidney injury [45] As natural insecticides for mosquito control particularly root and bark extracts, all parts of the B. aegyptiaca contain larvicidal properties that could be developed and used [17]. Siddique and Anis, [63] and Ndoye et al., [43] produced successful protocol on in vitro direct plant regeneration of B. aegyptiaca.

In Wadi Araba, this valuable plant species is found rarely in water runoff wadis and seriously threatened by human activities such as presence of mining industry and monoculture projects, grazing and wood cutting, thus the restoration of this plant species is very crucial.

Calligonum comosum L’Her. (Family:C. Polygonaceae, Arabic name: Arta, Wargat Al-shamas).

The plant is known in many Arabic deserts and considered as a typical psammophyte shrub that is distributed from the North African deserts, Middle East and India. It is widely used as firewood that gives smokeless fire, as a food colorant and as a feed for animals, it is also used as a medicinal plant by the local Bedwins.

The plant has been found to show anti-inflammatory and anti-ulcer activity when tested on rats [36] and the alcoholic extract of the plant tissues showed cytotoxic and antioxidant activity (Badria et al., 2007). Additionally, water extracts of the dried tissues of C. Comosum and other plant species collected from Saudi Arabia showed a significant lethal effect on the eggs and larva of mosquitoes which makes this species a promising organic pesticide to control mosquitoes without harming the environment [24].

This sandy dune species is highly threatened in Wadi Araba and almost disappeared from Wadi Rum due to frequent cutting for fuel and heavy grazing [42,55]. Vegetation efforts and preservation of this species must be done in order to protect it from the genetic erosion.

Citrullus colocynthis (L.) Schrad (Family: Cucurbitaceae, Arabic name: Handul).

This annual viny plant is known as the Bitter Apple, it tolerates a wide range of environmental conditions [15] and the fruits are described as bitter and Poisonous particularly the seeds [21]. This wild melon species is widely distributed, it grows in the Mediterranean basin, North Africa and South-West Asia in dry and sandy habitats [70].

C. colocynthis is identified as a native medicinal plant in the international trade. In Yemen the pulp of seeds are used traditionally as anti-malarial [10]. In Sudan, the fruits are used as anti-diabetic, purgative and for making tar, which is used as anti-scabie. In Tunisia it used for impetigo, a skin infection due to the Streptococcus bacteria [34]. The crude extracts showed active response against some bacterial strains may be due to carbohydrates, flavonoids, glycosides and tannin [41]. Some studies concluded that oral administration of C. colocynthis might lighten the diabetes-induced disturbances of haematological parameters and can protect the RBC’s from the oxidative stress produced from alloxan administration [20]. Further medical uses of C. colocynthis are nose bleeding, pains of ligament, joint and sciatic nerve, gout, skin diseases, rheumatism, cold, gastro-intestinal problem and scorpion sting [56].

Although the medical benefits of the plant are very famous, caution should be taken when consuming it, as it can result in severe anticholinergic toxicity, atropine poisoning, and hallucination. However, and despite of the fact that the plant toxicity, it was recommended by the famous Arab physician Al-Kindi to rub the fruit with the foot to cure back pain and constipation, this recommendation is followed up by many Bedwins in the Arabian Peninsula. Further investigation should be made to evaluate the toxicity of the direct local usage of the C. colocynthis. It worth mentioning that Meena et al., [40] produced the first direct in vitro
protocol for plantlet regeneration in *C. colocynthis* from shoot tip explants as a useful method for *ex-situ* conservation.

Although the plant is considered from the segtal plants in Wadi Araba and grows in various habitats, the commercial cultivation of *C. colocynthis* is highly recommended. As a member of the family *Cucurbitaceae*, it could be cultivated in a manner similar to water melons, however, it is more drought-resistant and the plant produces numerous fruits every year, ca 40-60 fruits per plant.

*Moringa peregrina* Forssk. (*Family: Moringaceae, Arabic name: Habb Elyasar*):

This valuable deciduous tree is mainly distributed in countries bordering the Red Sea, from Somalia and Yemen to Jordan, Palestine and Syria. It is considered as a very important medicinal and economic tree. The seed oil contains almost all the fatty acids that are also found in olive oil. This oil is used in cooking, cosmetics, and lubricant for small machines. *Moringa* wood is reported to be resistant to termites and is therefore popular as a building material. The young leaves of *M. peregrina* are also eaten as a vegetable and it is used traditionally in folk medicine and sold in local markets in Oman and other Arab Gulf countries as antioxidant and wound healer [39]. In Egypt, it is used locally to treat slumpness, constipation, headache, fever, burns, back and muscle pains [64].

Tahany et al., [64] separated six important antibacterial constituents from the aerial parts of *Moringa* and those are: lupeol acetate, amyrin, amyrin, sitosterol, sitosterol-3-O-D-glucoside and apignin. Many countries made attempts to produce this tree commercially in order to produce oil for industry.

*M. Peregrina* is listed amongst the rare plants present in Wadi Araba [54] and it is almost disappeared due to the presence of mining factories and farms in the Dead Sea area. The conservation of this species and the documentation of the local knowledge are very crucial and anargent task must be done to prevent it from genetic loss.

*Retama raetam* (Forssk.) Webb, (*Family: Fabaceae, Arabic name: Ratem*):

The White broom shrub is endemic to North Africa and East Mediterranean (Jordan, Lebanon and Palestine) in sandy drought regions. In late winter and early spring, it produces very attractive small white flowers that emit a sweet, honey fragrance and adds an aesthetic value to the harsh desert ecosystem. In Australia, it was introduced as an ornamental shrub.

The plant is documented in an ethnomorphological survey targeting Palestine and Golan Heights as an important plant in treating aching joints, back pain and skin bruises in which a decoction of 200 g is prepared in 1 liter water, boiled for 30 min and added to hot bath, then the patient is immersed in the bath for 15 min [57]. Furthermore, *R. raetam* is listed amongst important anti-diabetic plants in folk’s medicine in India [62].

The methanolic extract of white broom is effective in controlling the elevated blood glucose levels in streptozotocin-induced diabetic rats. This antidiabetic activity is partly due to stimulation of insulin release and inhibition of intestinal glucose absorption [7]. Another study showed that the aqueous extract of *R. raetam* possesses significant hypoglycaemic effect in both normal and streptozotocin-induced diabetic rats [37,38] found that the plant aqueous extract exhibits lipid and body weight lowering activities in both normal and severe hyperglycemic rats after repeated oral administration of the plant aqueous extract at a dose of 20 mg/kg. Moreover, *R. raetam* showed the best activity against Gram positive organism especially against methicillin resistant *Staphylococcus aureus*, however, it showed low antifungal activity [26]. Another study suggested that oral administration of aqueous *R. raetam* extract exhibited antihypertensive and diuretic effects in spontaneously hypertensive rats and diuretic action in normotensive rats [22]. Koriem et al. [33] suggested a beneficial effect of *R. raetam* plants extracts against experimentally-induced hepato- and nephro-toxicity of cadmium and the possible mechanism of the protective effects may be partly due to the antioxidant activity of these plants.

As an organic pesticide, aqueous extracts of *R. raetam* showed a great replant effect and as toxic as Imidacloprid to the sweet potato whitefly *Bemisia tabaci* affecting sweet potato in Jordan [16]. Additionally, due to the antioxidant, antimicrobial and antiviral effect of the *R. raetam* flowers, they could be used as a natural preservative ingredient in the food and/or pharmaceutical industries [22].

Despite the benefits of native plants in medical treatment, the proper procedures and doses recommended should be carefully followed due to the toxicity and other health hazards that those natural products have. For example, Schmid et al., [59] recorded a seven day old baby boy who was lethargic and cyanotic for one hour and showed shallow respiration due to huge over dose of white broom tea to treat the mildly jaundiced that the baby suffered from.

The large to medium seeds of white broom collected from south Jordan showed high germination rate when soaked in highly concentrated pure sulfuric acid for three hours [42], not published). In general, the plant is considered fairly distributed in Wadi Araba due to its low palatability value; however, it
is still facing the hazard of being cut as a source of fuel.

*Salvadora persica* L. (Family: *Salvadoraceae*, Arabic name: *Miswak, Siwak, and Arak*):

An upright evergreen small tree or shrub with small, oval, thick and succulent leaves with a strong smell of cress or mustard. When fresh, they are eaten as salad and are used in traditional medicine for cough, asthma, scurvy, rheumatism, piles and other diseases. The flowers are small and fragrant and are used as a stimulant and are mildly purgative. The berries are small and barely noticeable; they are eaten both fresh and dried [8]. The twigs of this tree are considered as a natural toothbrush that is widely used in Islamic countries and beyond. The local Bedouins in Saudi Arabia have a strong belief that the honey of *S. persica* had high medicinal value when compared to honey from other plant species. Additionally, the honey bee keepers noticed that *S. persica* reduced the common diseases of honey bees as well [61].

The Prophet Mohammad stated that:" the Siwak is an implement for the cleaning of mouth, teeth and pleases God. " The prophet also stated that: "If it were not that it would create hardship for my people, I would have ordered them to use the miswak with every Pray."

The studies on the medical uses of this tree particularly on teeth and mouth health are very rich. It contains an antibiotic and antimycotic which suppresses the growth of bacteria and the formation of plaque in the mouth. It increases saliva volumes without altering the pH of the mouth hence the prevention of dental caries [23]. The chemical composition of the air dried stem bark of *S. persica* is mainly trimethyl amine, salvadoline, chlorides, high amounts of fluoride and silica, sulphur, vitamin C, small amounts of tannins, saponins, flavonoids and sterols [29], that is vitamin C helps in the healing and repair of tissues. Miswak was reported to have anti-inflammatory, hypoglycemic activities beside the astringent and detergent effect (Sadhah et al., 1999). Studies showed also that *S. Persica* extract solution could be a substitute for sodium hypochlorite and chlorhexidine as an irrigating solution for root canal if it is available for use in future [12].

*S. persica* tree is considered also from the rare and highly threatened species in Wadi Araba. It is threatened by the presence of mining industry near the Dead Sea and the agricultural projects that is being established along the desert.

*Ziziphus spina-christi* (L.) Desf. (Family: *Rhamnaceae*, Arabic name: *Sidr, Nabbak*):

A tropical evergreen tree of Sudanian chorotype, it is cultivated mainly as a dry crop for its mucilage nutritious fruits, honey production and landscaping purposes. It is considered as a wild tree can be domesticated. Widely distributed in Asian and African Arab countries and prefers to grow in edges of ponds, river and wadi banks where groundwater is available. It serves the ecosystem by controlling erosion, acting as wind break and it improves soil quality by increasing available Phosphorus. Traditionally, it is used in Arab countries as a medicinal plant, the fruits of some *Zizyphus* species are used for the treatment of fever, pain, dranduff, wounds and ulcers, in inflammatory conditions, asthma and to cure eye diseases, while the seeds are as use as a tonic [60,4].

Extracts from these plants could be useful in the treatment of nosocomial infections, opportunistic infection of the urinary tract, infantile gastroenteritis, traveler’s diarrhea, wound infection, meningitis, and wounds infection which are caused by some of these organisms [4]. Additionally, *Ziziphus spina-christi* fruit extract caused neurotransmitters release which is probably related to presence of ascorbic acid [67] and the leaves may potentially be safe for use as sedative drug [68]. A variable activity of the plant extract against *Staphylococcus aureus* which highly infect various burns [13] and it also inhibited the growth of *Bacillus subtilis* [44] and *Streptococcus pyogenes* [44].

Moreover, the methanol extract of Sidir could be used not only as a safe potential natural functional food ingredient or as therapeutic drug in the treatment of diabetes, but also it is effective in reducing both hyperlipidemia and oxidative stress accompanying diabetes [28,63]. A micropropagation protocol has been developed from shoot tip explants of Sidir [14].

In Jordan including Wadi Araba, it is widely distributed in all valleys and lowlands, and usually is confined to low elevations below a.s.l. 500 m. It easily domesticated and can be grown commercially for the benefit of pharmaceutical industry and re-vegetation purposes.

In addition to the mentioned medicinal plants, there are other valuable medicinal plants present in Wadi Araba, amongst the others are: *Anastatica heirochuntica*, *Conyza incana*, *Haplophyllum tuberculatum*, *Maerua crassifolia*, *Ochradenus baccatus*, *Peganum harmala*, and *Ricinus communis*.

Conclusions and recommendations:

This review referred to some of the studies that investigated the pharmaceutical value and indigenous knowledge of some wild plants that also present in Wadi Araba in Jordan. It showed the various uses of those valuable plants by different folks in treating...
different medical problems such as diarrhea, diabetes, skin and eye diseases, dental health and others. Many of those plants are seriously threatened by genetic erosion due to the different human activities and the indigenous knowledge about their use along the local community generation is poorly documented. Thus, the need of a comprehensive documentation and focused research on the medical plants that present in Wadi Araba in particular and Jordan in general is very important tasks that the decision makers should take seriously into consideration at the national level. The utilization of the medicinal wild plants in the economic and sustainable development should be carried out in synchronization with a firm and wise plan of preserving and sustaining the ecosystems that provide us with such important service.

References


