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REVIEW ARTICLE

A Review on Phytochemical Analysis and Ethnobotanical Uses of *Haloxylon stocksii*

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ABSTRACT

Haloxylon stocksii (family: Chenopodiaceae) is a succulent halophyte shrub tolerant to environmental stresses making it suitable for cultivation in saline land of arid and semi-arid regions because it is tolerant to abiotic stresses such as drought and high temperature. It has useful applications that contain fruiting tops and stem as animal feed, different plant parts for medicine, and re-establishment of tarnished lands. One major factor hindering its successful development and promotion is the inadequate and scattered knowledge available on these species. The purpose of this article is to highlight the importance of *H. stocksii* by summarizing information on occurrence, ecology, medicinal and other uses, cultivation and ethnobotany to stimulate interest to promote its domestication and commercialization for regional and global markets. Moreover, it also summarized reported phytochemistry and pharmacological activities.

Keywords: Ecology, *Haloxylon stocksii*, occurrence, phytochemistry, pharmacology.

INTRODUCTION

Plants provide a wide range of ecosystem goods and services and form the backbone of Earth's ecosystem. Out of 300,000 higher plants, human beings have used 40,000–100,000 plant species for food, fiber, forage, fuel, crafts, industrial, cultural and medicinal purposes. Ethnobotanic surveys show that present day agriculture depends on only hundreds of the many thousands of the known food plants worldwide [1]. Knowledge about the pharmacological and beneficial properties of plants is found to exist since few thousand years ago. The utilization of plants as medicine by traditional people forms the basis of the evolution of modern medicine. Medicinal plants are playing a significant role in human health care worldwide. The present study highlights that traditional medicine is still playing an important role to fulfill basic healthcare needs of residents all around Pakistan [2]. Deserted and ignored plant species frequently play an essential role in providing food and livestock supply, generation of income and energy needs of rustic population. In spite of their great potential these plant species are being ignored [3].

Haloxylon stocksii (syn. *Haloxylon recurvum*, sensu Bunge in Boiss.) Benth. & Hook. commonly known as khaar i.e. a perennial shrub, belongs to family chenopodiaceae and is reported as xerohalophyte [4]. Traditionally, this specie has been used for making Saji and has many other uses such as plant ash as washing agent, fodder and folk medicine [1].

Nomenclature

Haloxylon stocksii (Boiss.) Benth. et Hook.f., Gen. Pl.; synonyms *Salsola stocksii* Boiss., *Haloxylon recurvum* sensu Bunge in Boiss. Fl. Orient.

Kingdom: Plantae

Phylum: Magnoliophyta

Class: Magnoliopsida

Order: Caryophyllales

Family: Chenopodiaceae

Genus: Haloxylon

Species: *H. stocksii*

Vernacular Names

Punjabi-Kharilana, Khiri-lani.

Hindi-Khar, Saji lana, Kangan Saji, Sibi-Khar, Khara lana.

BOTANICAL DESCRIPTION

Chenopodiaceae family consists of approximately 1,200 species and 100 genera, from which 85 species are cultivated and the genus Haloxylon also belongs to this family [5]. In Pakistan this family is represented by 35 genera. Only five species of Haloxylon are found in Pakistan [6]. *H. stocksii* is densely branched pale diffuse shrub with brownish wings. Its stem is almost glabrous and leafless which secretes thick fluid on cut. Inflorescence is pale greenish with scattered spikes (Figure **1**) [7]. This shrub is mentioned as an important fodder species [8]. *Haloxylon stocksii* (syn*. H. recurvum*) is perennial, glabrous, dwarf, leaf succulent shrub, native to salt deserts mostly found on the saline depressions in western Rajasthan. It stores high amounts of sodium and chloride ions in the leaf vacuoles. Stem is glabrous and leaves are ellipsoid, trigonous, obtuse or acute at the tip, 0.3 to 0.8 cm in length [1]. *Haloxylon stocksii,* a perennial halophyte shrub with flowering time October-December [9].

Figure 1. *Haloxylon stocksii.*

ECOLOGY AND DISTRIBUTION

Haloxylon recurvum Bunge ex Boiss (Chenopodiaceae), is predominantly scattered in the Mediterranean region to Central and South Asia [10]. It is widely distributed in Turkey, Syria, Iraq, Iran, Afghanistan, Kashmir, India, and Central Asia [6]. In Pakistan, it is commonly found in southern Sindh and Balochistan up to the Northern Himalayan mountain valley of Chitral and widely scattered in saline habitats of western Rajasthan, India [1]. In Cholistan desert, Pakistan the species dominant in the marginal lands having low organic carbon (0.17–0.18 %), high E.C. (8.0 dS m-1) and high Na content (9.9 mg/100 g) [11] and shows a broad range of species association [12].

Most of the halophytes are salt includer because they are able to endure high salt concentration. Glycinbeatine plays vital role as osmo-protectant of protein to avoid oxidative stress and in osmo-regulation of cells under salinity stress. The stem and leaf succulent halophytes accumulate salts in their tissues because thay lack the ability to excrete salt [13].

Haloxylon stocksii is more abundant in saline patches, moderately found in interdunal flats and rarely present along cholistan boarder [14]. *Haloxylon stocksii* shows best germination response in CaCl2 and the order of germination response of *H. stocksii* is given as $CaCl_2$ > Na_2SO_4 > NaCl > $MgCl_2$ > KCl. Germination is inhibited in KCl because potassium causes ion toxicity, cannot be transported across membranes, and results in disordered metabolic functions [15].

ETHNOBOTANICAL USES

Main use of this specie is the production of Saji. Burning of air-dried plant materials of *Haloxylon stocksii* yield Saji also known as barilla (soda ash). Saji obtained from *H. stocksii* is considered best quality. The best Saji called ‘‘Lota Saji’’ is made from Kangan Khar (*H. stocksii*) in Montogomery district of Pakistan. The Saji is an important constituent in papad making. The quality of Saji, khar varies from one geographical area to another [1]. The production of impure sodium carbonate from Barilla (Salsola soda) is used for production of soap and glass [16].

In India, major cultivation areas of *H. stocksii* (syn. *H. recurvum*) include Vijaynagar, Anupgarh, and

Suratgarh Tehsils and sriganganagar district of Rajasthan. Some farmers cultivate it for production of Saji. Semidried plants are burnt in a Bhatti (furnace, a circular pit made in ground) to obtain Saji and Choa. The black solid material collected from circular pit is Saji and the whitish material collected from rectangular pit is Choa [1]. The poultice of young branches is useful for broken bone of the cattle. Common use include the application of paste of the ash for healing wounds [17].

In many developing countries most of the people profoundly rely on traditional cures, generally prepared from plants. Traditionally this plant species is used externally to treat insect stings. Internal ulcers can be cured by using ash of this plant [1]. *Haloxylon stocksii* is extremely useful for treating burns cuts and internal ulcers. It is found to be effective against urinary system problems, especially for kidney and bladder stones [14,18]. Massage of *Haloxylon stocksii's* decoction is used against arthritis, resettlement of disturb joints and paraplegic limbs. Whole plant is used to prepare this decoction [4].

Vasoconstrictor and cardiac stimulatory effects of the plant extract is similar to those of norepinephrine (stimulation of a-adrenergic receptors in the blood vessels and cardiac b-receptors, respectively) as this plant has sympathomimetic component(s) [19]. The plant's ash is applied externally to cure skin diseases, in India. Intestinal ulcer is known to be cured by mixture of plant's ash in water [20]. A decoction of this plant is used by local physicians to treat viral diseases. Medicinal properties of this plant include its use as a resolvent, diuretic, emmenagogue and abortifacient [21].

Haloxylon stocksii contains a significant amount of high quality edible oil (23.2%) with unsaturation approximately 70-80%, highest amount of ion contents and 20% ash content [22]. Whole plant decoction of *H. stocksii* is used against tooth and stomach aches [23]. Whole plant is used for making ash, mixed with sugar and found to be effective against gastric ulcers and renal stones [24]. *H. stocksii* is used in unhealthy skin, ulcer and wound rupturing by local people. Ash powder is found to be in flatulence, dyspepsia, constipation and hemorrhoids [25].

In arid and semi-arid areas, salt-tolerant fodder halophytes have been used as feed resources and valuable reserve feed for grazing animals mostly in famine. Succulent green foliage produced by *Haloxylon stocksii* (syn. *H. recurvum*) is browsed by camels and goats. In many parts of Punjab and Sind, it is favorite feed for camels. Camels regularly graze on halophytic plants to remain healthy as they need higher salt compared to other animals. *Haloxylon stocksii, Haloxylon salicornicum, S. baryosma,* and *S. fruticosa* are the most desirable fodder plants in Cholistan desert because these species are highly delicious and available in whole year. By mixing 25 % in the feed with other edible bran such as groundnut haulm, it could be fed to goats without any injurious effect to goats [26]. During summer under rainfed arid condition, this species is preferred alternate feed. In order to improve degenerated pastures and to establish new grazing lands in deserts and semi deserts of Uzbekistan, Haloxylon and Salsola are suitable species [1].

Washing and Dying of Clothes

In Pakistan, and India plant ash is used to obtain carbonate of soda that is used as a substitute of soap by washer men [27]. *Haloxylon stocksii* is used as soap and boiled to dye clothes [2].

The sorption capacity *of H.recurvum* stems indicate that it can be used as ecofriendly and low cost biosorbent. It can be used as a substitute to the costly methods of removing methylene blue dye from the textile and leather industries effluents [28].

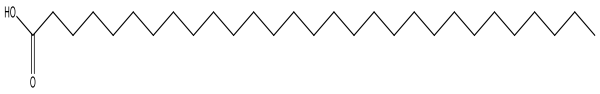
Phytoremediation of Salt Affected Lands

It is a striking opportunity to regain soils affected by salt and in comparison to chemical remediation method, it is found to be more efficient. The ability to grow well under harshly dry or saline conditions and to survive under low moisture and high temperature circumstances make it appropriate candidate for phytoremediation of saline lands in arid and semi-arid zones [29]. Beneficial effects of phytoremediation include creation of macropores in soils, homogeneous and greater depth of retrieval, less initial capital input, development of soil aggregate constancy and economical benefits from plants grown during retrieval.

H. stocksii (syn. *H. recurvum*) accumulates large amount of salt because it is an extremely salt tolerant stem succulent plant. The chemical investigation of soil samples from north western Rajasthan shows that *H. stocksii* enhances the organic carbon and reduces pH and electrical conductivity [1].

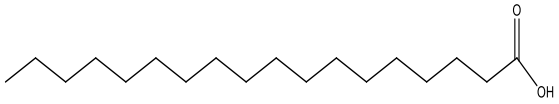
PHYTOCONSTITUENTS AND REPORTED ACTIVITIES

The constituents isolated and characterized from column chromatography of chloroform soluble fraction of *Haloxylon stocksii* are, triacontanoic acid (Figure **2**), β- sitosterol (Figure **2**), ursolic acid (Figure **2**), β-sitosterol 3-O-β-D-glucopyranosid (Figure **2**), 1-triacontanol (Figure **2**) and octadecanoic acid (Figure **2**). These chemical constituents were screened for phytotoxicity and none of them was found phytotoxic [3]. Potent antifungal activity exhibited by the ethyl acetate soluble fraction of this species is due to the presence of steroidal glucosides, Recurvoside A (Figure **2**) and recurvoside B (Figure **2**) [30]. Dillenic acid (Figure **2**) is one of the important active constituent isolated from *Haloxylon stocksii* [14].

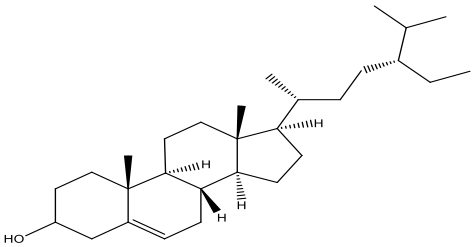


Triacontanoic acid

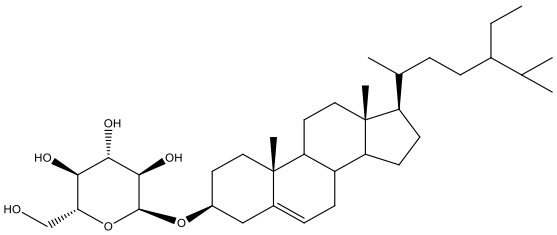
1-triacontanol



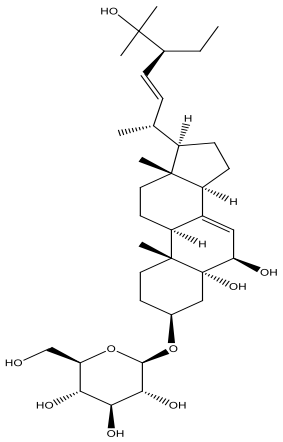
Octadecanoic acid



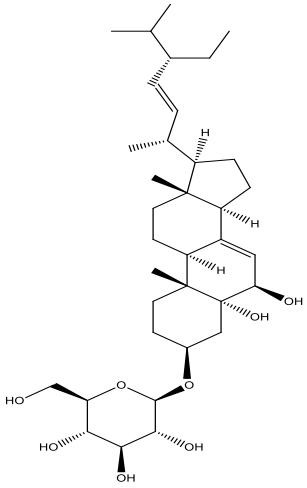
β- sitosterol Ursolic acid



β- sitosterol 3-O-β-D-glucopyranosid



Recurvoside A



Recurvoside B

Figure 2. Chemical constituents of *Haloxylon stocksii*.

In brine shrimp lethality test, the methanolic extract of *H. stocksii* showed significant cytotoxicity. Its chloroform-soluble fraction showed significant chymotrypsin inhibitory potential due to these isolated constituents, haloxylase (Figure **2**) the triglyceride, unsaturated fatty acid, saturated fatty acid [31]. The significance of enzyme inhibitors as drugs relies on the fact that they have been used as remedy of many diseases. The major toxicity was notified in the chloroform soluble fraction upon fractionation. Strong chymotrypsin inhibitory activity was observed by further pharmacological screening of chloroform soluble fraction that led to the isolation and structural elucidation of two new sterols, halosterols A and B[6]. Chloroform soluble fraction of *H. stocksii* (syn. *H. recurvum*), is non-competitive inhibitors of both acetylcholinesterase and butyrylcholinesterase

enzymes due to newly isolated C-24 alkylated sterols given as haloxysterols A, B, C, D (Figure **2**) [1, 32].

CONCLUSION

Haloxylon stocksii is an essential source of food, bioactive phyto-constituents having pharmaceutical importance and has potential for phyto-remediation of salt affected lands. It can withstand extreme environmental stresses and can be grown on marginal lands of arid and semi-arid regions. Its remarkable tolerance to abiotic stresses (drought, high temperature and salinity), makes it a potential crop adapted to a wide range of climate. Keeping in view all aspects and features, *H. stocksii* can be considered a prime candidate for further domestication and commercialization as a new multipurpose shrub species for arid regions.

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