UNANI PERSPECTIVE AND RECENT STUDIES OF SANDAL SAFED (SANTALUM ALBUM LINN.): A REVIEW

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ABSTRACT
Sandal safed (Santalum album Linn.) is also known as ‘Royal tree’ belongs to the family Santalaceae. Among the genera of Santalaceae, Santalum contains 25 species which are distributed throughout the world. In India, the genus is represented by Santalum album Linn. and is a native of the highlands of southern India mainly Karnataka, Tamil Nadu and Kerala where it is found wildly and cultivated. In Unani system of medicine, therapeutically, this drug is widely used both internally and externally in various cardiac, brain, liver, stomach and skin disorders for its Mufarrreh wa Muqawwie qalb (exhilerient and cardiotonic), Muqawwie dimag (brain tonic), Muqawwie hararate gareezi (nuetropic), Qabiz (astringent), Muhallile warm (resolvent), Musaffie dam (blood purifier) and Mujaffif (desiccant) properties. In this review, an attempt has been made to offer a detailed description of Sandal safed in Unani prospective and to collect the pharmacological research studies done on Sandal safed by using modern parameters and techniques.

KEY WORDS: Sandal safed; Santalum album Linn.; Unani medicine; Pharmacological studies.

INTRODUCTION
Sandalwood (Santalum album Linn.) known as ‘Royal tree’ [1], belongs to the family Santalaceae which contains 30 genera and 400 species. Of the genera, Santalum contains 25 species [2]. Santalum is a genus of shrubs of small trees, distributed in the peninsular India,
parts of Malaysia, Australia, New Zealand, and Polynesia, extending to the Hawaiian Archipelago and Juan Fernandez Island also introduced elsewhere. In India, the genus is represented by Santalum album Linn. [3] and is a native of the highlands of southern India mainly Karnataka, Tamil Nadu and Kerala [4] where it is found wildly and cultivated [5]. It has been rated as the most precious and valuable tree among Indian forest trees [6] and also the second most expensive wood in the world [1]. Sandalwood and its oil is equivalent to gold in Mysore, hence, rules and regulation governing the production and handling of sandalwood are strictly under government monitoring [7].

According to Unani physicians there are three varieties of Sandal viz. yellow, red (Sandal surkh) and whitish yellow (Sandal safed). Some people called the last variety as Maqaasiri which is more fragrant than the other two varieties. In view of Galen and Ibn Maswaih Sandal surkh is more potent but according to some other physicians, the Sandal safed is relatively stronger [8]. In Unani classical texts, the two varieties of Sandal viz. Sandal safed (S. album Linn.) and Sandal surkh (Pterocarpus santalinus) has been mentioned along with their medicinal properties and therapeutic uses. It is used both internally and externally since antiquity. Therapeutically, this drug is widely used in many cardiac, brain, liver, stomach and intestinal ailments as well as in various skin disorders for its Mufarrreh wa Muqawwie qalb (exhilerent and cardiotonic), Muqawwie dimag (brain tonic), Muqawwie hararate gareezi (nuetropic), Qabiz (astringent), Muhallile warm (anti-inflammatory), Musaffie dam (blood purifier) and Mujaffif (desiccant) properties [8,9].

Historical Background
The history of sandalwood, as perfumery, dated back over 2,000 years. The tree is most probably indigenous to peninsular India, however, some authorities view that the tree is actually exotic and had been introduced to India from Timor (Indonesia). There are many references to sandalwood in the Indian mythology, folklore and scripture. It is mentioned in the Indian literature as old as Dhamma Pada, Jataka, Anguttara, Vinaya Pitaka (400-300 BC), Milinda Pahna (200 BC), Patanjali Mahabhashya (100 BC) [3]. Sandalwood is also mentioned in the epics Ramayana and Mahabharata [3,9]. There is mass of evidence that Santalum album Linn. has been grown in India for the last 23 centuries. India has been the major source and traditional leader of sandalwood, sandalwood oil production for perfumery and pharmaceuticals [3].The aroma of the oil and the wood is esteemed by people belonging to three major religions of the world - Hinduism, Buddhism and Islam. The people of Greek
came to know about this drug during the period of Alexender the great and a European Hakeem (physician) of Madarsa Salarno for the first time used it as medicine [9]. Egyptians imported the wood and used it in medicine, for embalming the dead and in ritual burning to venerate the gods [7].

**Scientific Classification** [10,11]

<table>
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<tr>
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Botanical name: Santalum album Linn.

**Vernacular Names**

<table>
<thead>
<tr>
<th>Language</th>
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<tbody>
<tr>
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<tr>
<td>Arabic</td>
<td>Sandal abyaz [9]</td>
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<td>Persian</td>
<td>Sandal Suped [12]</td>
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<td>Urdu</td>
<td>Safed Sandal [12,13]</td>
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<td>Hindi</td>
<td>Chandan [8,12], Chandal [12,14], Ujla Chandan [9]</td>
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<td>Sanskrit</td>
<td>Srigandha [13], Chandana [12,14]</td>
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<td>Gujarati</td>
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<td>Bengali</td>
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<td>Kashmiri</td>
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<td>Marathi</td>
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<td>Punjabi</td>
<td>Chandal [14], Sufed Sandal [15], Chandan [15]</td>
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<td>Kannada</td>
<td>Shrigandha [16]</td>
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<td>Sandanam [3,12], Chandanam [12,15,16]</td>
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<td>Telugu</td>
<td>Sriganda [16], Chandanamu [3,12]</td>
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<td>English</td>
<td>White Sandal Wood [13,15,16]</td>
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Habitat and Distribution
Santalum album Linn. is a small evergreen tree, grows wildly or is cultivated throughout India, Indonesia, North Australia and also some part of Sri Lanka and Pakistan. In India, sandal trees are confined to the definite parts of Mysore and Tamil Nadu and the former being more important. The most important sandal producing regions are Mysore, Dharwar, Shimoga, Chikmaglur, Tumkur, Hassan, Mercara, Bangalore and scattered areas of Kolar. In Tamil Nadu the tree is found chiefly in the districts of Coimbatore, Nilgiri, Salem and Vellore and to a lesser extent in Trinuveli and Tiruchchirappalli. It is also found in various districts of Kerala, Andhra Pradesh, Madhya Pradesh, Orissa, Maharashtra, Gujarat, Rajasthan, Uttar Pradesh, Bihar and some part of Bengal. It generally occurs at altitude of 360-1350 m but the formation of heartwood appears to be the best between altitudes of 600-900 m, with a rainfall of 85-135 cm. In general, the sandal tree flourishes in regions where the climate remains cool with a moderate rain fall, much sunshine and long periods of dry weather [3].

Description of Drug in Unani Literature
Morphology
Sandal safed is a small, evergreen tree with slender and drooping branches reaching up to 40 feet in height and 3 feet in girth. Leaves are thin and opposite. Flowers are dark brown, violet or reddish in colour. Fruits are black, having single seed, appear in bunches. The underground part of the stem is whitish and odourless while the middle part of it is somewhat yellowish and strongly scented [9].

Image of Sandal safed (Santalum album Linn.)
**Mizaj (Temperament)**

The *mizaj* of the drug is mentioned in Unani classical text is Cold and Dry, whereas, the degree of the *mizaj* differs in view of different Unani scholars. The difference in degree may be due to the environmental factors, temperament of human beings and also due the quality of the drug.

1. Cold $3^0$ & Dry $2^0$ \[8,9,17,18,19,20\]
2. Cold $2^0$ & Dry $2^0$ \[21,22,23\]
3. Cold $2^0$ & Dry $1^0$ \[24\]

**Af'al (Pharmacological actions mentioned in Unani medicine)**

1. *Mufarreh* (exhilarant) \[9,17,19,21,25\]
2. *Muqawwie Qalb* (cardio tonic) \[9,12,15,19,21,22\]
3. *Muqawwie Dimagh* (brain tonic) \[12,25\]
4. *Muqawwie Harārate Gareezi* (boost innate body heat) \[23\]
5. *Muqawwie Meda* (stomachic) \[8,9,15,17,19,21,22,23\]
6. *Muqawwie Kabid* (liver tonic) \[15,22\]
7. *Muqawwie Am'a* (intestinal tonic) \[26\]
8. *Muqawwie Badan* (general body tonic) \[17\]
9. *Muqawwie Dandan* (strengthen teeth) \[22\]
10. *Mujaffife Qurooh* (desiccant) \[22\]
11. *Munzij* (concoctive) \[9\]
12. *Qabiz* (astringent) \[9,19,21\]
13. *Qabize Am'a* (bowel astringent) \[12,26\]
14. *Habise Nazla* (catarrh static) \[17\]
15. *Nafe Humma Haar* (Antipyretic) \[8,9,15,21,24\]
16. *Raade Mawaad* (divergent) \[19,20\]
17. *Mohallile Warm* (anti-inflammatory) \[9,20,23\]
18. *Musakkine Suda-e Haar* \[8,9,17,18,19,21,22,23,25\]
19. *Musakkine Hararat* (febrifuge) \[26\]
20. *Musaffie Dam* (blood purifier) \[9,15,20,25,26\]
21. *Musakkine Atas* (thirst quenchers) \[9\]
22. *Tiryaq* (antidote) \[15,17,19\]
23. *Rafe Booe Badan* (deodorant) \[23\]
**Istemalat (Therapeutic uses)**

1. It is used in *Awraame Haarrah* (Hot swellings) due to *Barid mizaj* (cold temperament) and astringent property [19,22,24].
2. It is used in *Hararate Meda* [17,21], *Hararate Jigar* [17,22], and *Sojishe Meda* due to its cooling property [9].
3. As being *Mufarreh* (exhilarant), *Muqawie Qalb* (cardio tonic), it is beneficial in *Hararate Qalb* [26], *Zoafe Qalb* (weakness of heart) [26], *Ghashi* (syncope) and *Khafqane Haar* (palpitation) [9,18,19,22,24].
4. It relaxes the brain and beneficial in *Zoafe Dimag* (weakness of brain) and *Nisyaan* (dementia) because of its pleasant perfumery smell [25].
5. External Application of sandal paste is beneficial for *Humra* (facial erysipelas) [19,22], *Baad Surkh* (erysipelas) [19] and *Namla* (herpes) [19] as it possess antiseptic and cooling property.
6. Fumigation of sandal is beneficial in *Nazla Haar* (hot catarrh) [9,21,22].
7. Application of sandal paste on temporal region is found to be beneficial in *Sudae Haar* (headache due to heat) [8,9,18,19,21,22,24].
8. Local application of the *Sandal* powder allays prickly heat and checks copious perspiration [14].
9. The powder of sandal wood is taken in coconut water to reduce morbid thirst [14].
10. It is found beneficial in reducing *Hummae safrawi* (bilious fevers) and *Is’haaal Safrawi* (bilious diarrhoea) [9].
11. It is used in the treatment of *Sojishe Baul* (burning micturation) due to its diuretic property [26].
12. It is used in the treatment of *Ishaal Damwi* (bloody diarrhoea) [26].
13. The local application of *Sandal* is useful in *Busoore Fam* (papular stomatitis) [17,21].
14. It is found to be beneficial in eye diseases like *Warme Chashme Haar* and *Intesharul Ain* [22].
15. It is also used in the treatment of *Niqris* (gout) [17,19].

**Mazarrat (Adverse effects)**

1. *Qate Baah* (anaphrodisiac) [9,17,19,20]
2. *Muzirre Saut* (harmful to voice) [9,17,19,20]
3. *Muzirre Sadar* (harmful to respiratory system) [9]
Musleh (Corrective)
1. Shahad (honey) [17,19,20]
2. Nabaat or Mis’ri (sugar candy) [9,17,19,26]

Badal (Substitute)
1. Kafoor (Cinnamomum camphora) in a half dose of Sandal safed [17,9,19,26]
2. Ushna (Usnea longa) [9,26]
3. Sandal Surkh (Pterocarpus santalinus) [9]

According to eminent Unani scholars, it is very hard to find a drug that can be a substitute of original drug in its entire properties. When a drug is considered to be a substitute, it means the substituent can be used in place of original drug in its particular action [27]. For instance, Kafoor may be used as a substitute to Sandal safed for its properties of mufarreh, muawwi qalb and dafae hararat.

Miqdare khooraq (Therapeutic dose)
The therapeutic dose of Sandal safed as mentioned in Unani literatures is:
1. 1-4g [9]
2. 3-6g [28]
3. 5 g [23]
4. 5-7g [26]

Murakkabat (Compound formulations)
There are various compound formulations in which Sandal safed is added either as chief constituent or as supportive or correctives like:
1. Khameera Gaozaban [29]
2. Dawaul misk Moatadil Jawahar Wala [29]
3. Khameera Abresham Hakeem Arshad Wala [28]
4. Khameera Marwareed [28]
5. Mufarreh Baarid [28]
6. Majoon Sandal [28]
7. Sharbate Sandal [28]

Macroscopic features
Sandal safed is yellowish-brown to pale-reddish orange, heavy, dense, hard, yet splits easily; transversely smooth surface shows alternating light and dark concentric zones with numerous
pores, traversed by very fine medullary rays; odour, persistently aromatic; taste, slightly bitter [28].

Microscopic features
Wood consists of tracheids, vessels, fibres, xylem parenchyma and traversed by medullary rays; vessels numerous scattered singly throughout the region, rarely two together, barrel shaped, pitted and with transverse to oblique penetration with tail-like projections, at one or both ends; a few tracheids elongated with tapering ends and possess bordered pits on their walls; fibres many, lignified with pointed tips; xylem parenchyma mostly rectangular, a few of them contain prismatic crystals of calcium oxalate; xylem rays numerous, run straight, uni to triseriate, mostly biseriate, thick walled, radially elongated having golden yellow to brownish contents and contain a few prismatic crystals of calcium oxalate [28].

Powder
Light-brown and aromatic; shows pitted vessels with tails, isolated or associated with fibres, fragments of fibres, square to rectangular-shaped parenchyma, prismatic crystals of calcium oxalate, and numerous oil globules [28].

Scientific studies
Anti bacterial activity
The extract of plant showed inhibitory activity against bacteria and hot water extract of sandal bark was found to have good antibacterial activity against virulent species e.g. *Staphylococcus aureus* [30].

Antiviral activity
In a study, the essential oil of *S. album* was tested for in vitro antiviral activity against herpes simplex viruses-1 and -2. It was found that replication of these viruses was inhibited in the presence of oil. This effect was dose dependent and more pronounced against HVS-1. The oil was not virucidal and showed no toxicity [31].

Antifungal activity
A detailed study was carried on seven essential oils and their constituents in-vitro model for their antifungal activities against eight strains known to be human pathogens. Among those oils, Sandalwood oil was found to be effective against *Microsporum canis, Trichophyton*
mentagrophytes and T. rubrum but ineffective against Candida albicans, Aspergillus niger, A. fumigatus in comparison to Tolnahtate and clotrimoxazole [30].

**Anti-oxidant activity**

The methanolic wood extract was screened for antioxidant and free radical scavenging effects at various doses (100-500 µg/ml) by different specific in vitro methods and compared with L-ascorbic acid and butylated hydroxyanisole (BHA). The extract shows maximum antioxidant effect at 500µg/ml [32].

**Analgesic and Anti-inflammatory**

The methanolic extract of wood was screened for analgesic and anti-inflammatory activities at various doses (100, 250 and 500 mg/kg) and compared with Diclofenac sodium (7 mg/kg) taken as standard. The extract showed maximum effect at 500 mg/kg [33,34].

**Antipyretic effect**

Sandalwood oil as well as Hydrolised exhausted Sandal powder (HESP) oil was investigated against yeast induced pyrexia in albino Wisatr rats in a dose of 200mg/kg using 0.2% of tween 80 as control and 100mg/kg paracetamol as standard. A significant antipyretic effect was observed in Sandalwood oil and HESP oil treated rats [7].

**Anti-ulcer activity**

Antiulcer activity of S. album has been reported against water immersion - restrain stress, ethanol and indomethacin induced gastric ulceration models [35].

**Memory enhancing effect**

Alcoholic extract of Santalum album has been reported to enhance memory in amyloid protein induced memory loss in animal model [36].

**Effect on nervous system**

In a study, different extracts of Santalum album wood were tested for CNS activity and it has been reported that the extracts were active in potentiation of hexobarbital sleeping time, body temperature alterations, antinociceptive and spontaneous motor activity changes. In this study it was concluded that the active constituent of S. album, α- and β-santalols contributed to the reputed sedative effect of sandalwood preparations in Oriental medicine and could be considered as neuroleptic by resemblance to the pharmacological activities of chlorpromazine [30].
**Antianginal effect of Santalum album**

A clinical trial was conducted to see the antianginal activity of Kuan- Xiong aerosol, a compound formulation, which contains sandalwood oil along with oils of *Piper longum*, *Dryobalanops aromatica*, *Asarum seiboldi*, *Alpina officinarum*. An immediate and quick relief in anginal pain was proved in 69 cases of angina pectoris with the compound drug in comparison with nitroglycerine [37].

**Antihyperglycemic and Antihyperlipidemic activities**

Kulkarni et al reported that pet ether extract of *S. album* has potent antihyperglycemic and antihyperlipidemic activities in streptozotocin induced diabetic rats [38].

**Cardioprotective activity**

In a study, Sayeed et al evaluated the protective effect of *S. album* on doxorubicin induced cardiotoxicity in rat model. They reported that the aqueous extract of *S. album* significantly inhibits the cardiac tissue damage by reducing lipid peroxidation [39]. The fine powder of the *Sandal safed* was investigated for cardioprotective effect in isoproterenol (ISO) induced myocardial infarction (MI) in albino Wistar rats at two different doses. The results showed significant protective effect against ISO induced MI in dose dependant manner [40].

**Acute Toxicity study**

The hydro-alcoholic extract of *S. album* stem (SASE) was evaluated by Ahmed et al. to determine the toxic effect as per OECD guidelines 423. The result of the study revealed that SASE is safe up to 5000mg/kg, as no mortalities and signs of toxicities were reported [35].

**CONCLUSION**

*Sandal safed* is a potent medicinal and perfumery drug used in both pharmaceutical and cosmetic industries. The information about *Sandal safed* is in accordance with literature available in Unani books. As the world is moving towards herbal medicine due to its safety and efficacy, this review is a conventional approach to discover new drugs for different diseases. The above mentioned pharmacological research work done on *Sandal safed* is sufficient to validate the claims regarding actions mentioned in Unani classical texts. Further, pharmacological and Toxicity studies should be conducted on the same to explore the exact mechanism of action as well as sub-acute and chronic toxicities if any.
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