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Review Paper

Sandalwood (*Santalum Album.L.*): Exploring Its Phytochemical and Formulation Potential, Particularly in Nourishing Creams.

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ABSTRACT

The oldest and most valuable natural fragrance sources, with significant commercial and medicinal importance. *S. album* has been grown in India for the last 250 years and is well-known worldwide for its fragrant oil, which is tasty, persistent, and useful in medicine. Sandalwood and the essential powder derived from it are used in many traditional medicinal disciplines, such as Ayurveda. Siddhan and Uanai medicine are used to cure and prevent a variety of illnesses. Sandalwood's many medicinal and therapeutic uses are linked to its rich supply of phytochemicals, especially sesquiterpenes. The heartwood of the tree is valued for its fragrance. Sandalwood oil is used in perfumes, cosmetics, aromatherapy, and pharmaceuticals. Sandalwood, an evergreen tree indigenous to India, is used in many industrial products, such as mouthwash, sweets, incense, deodorants, room fresheners, soaps, lotions, and creams. Additionally, skin care items, cosmetics, and medicinal treatments use sandal oil and paste.

INTRODUCTION

The commercially and culturally important plant species known as sandalwood powder are found in the genus *Santalum*, which is part of the *Santalaceae* family. Sandalwood, which is made from the heartwood, has been used for ages for cultural, religious, medicinal, and aroma purposes.

The wood and its powder are used for a variety of uses, especially in the Arab and Asian civilizations. All sandalwood species are considered necessary wood hemi-parasites, which means they consume particular nutrients. About eighteen distinct species of sandalwood are found in the genus *Santalum*, including *S. peniculatum* & *pyrularium*, *S. involutum*, *S. accumulation*, *S.*

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freycinetianum, *S. haleakalae*, & *ellipticum*, *S. boninese*, *S. insulare*, *S. austrocaledonicum*, & *yasi*, five *macgregorii*, *S. Murray tobacco obtusifolium*, *S. lanterne*, and *S. fernandezianum*. The second most costly wood in the world is sandalwood.[1]

Biological source :

The heartwood of the little, evergreen tree *Santalum album* Linn's stems and roots. [1]

Geographical Sources:

The plant is grown in Southern India under government control and is widely distributed throughout the country.

Category:

Trees, parasites, and hemiparasites with sucking roots are included in this category.

Colour:

Dark brown, reddish, and dark grey are the colors.

Fruiting:

October to December is fruiting.

Collection and storage:

Sandal for Gathering and Storing Seeds in December, fresh fruits are picked from the trees, soaked in water, and the mushy pulp removed. After that, they are dried. The seeds keep well in storage.

Chemical Components:

Santenone, Beta-Santalol, and Alpha-Santalol. Two to five percent of sandalwood's volatile oil is made up of 90 to 97 percent santalols, which are sesquiterpene alcohols. 95% of sandalwood oil is

made up of two isomers. Santalol, santanene, and santenone are aldehydes. [1,2]

Family: Santalaceae

Kingdom: Plantae

These trees' wood has a distinctively fragrant scent. Although this genus contains several tree species, the most notable ones are the Australian sandalwood (*S. spicatum*) and Indian sandalwood (*Santalum album*). Indian sandalwood is a tiny evergreen tree that can reach a height of 30 feet. Its wood has a pleasant scent. A valuable gift from the plant kingdom that is ingrained in Indian culture and tradition is sandalwood. It is among the most valuable trees in the world. From Indonesia in the east to the Juan Fernandez Islands in the west, and from the Hawaiian Archipelago in the north to New Zealand in the south, sandalwood's native range spans 30°N to 40°S2.



Figure No:1 Sandalwood Tree

This hemiparasitic tree, which ranges in size from tiny to medium, is found throughout India. The southern region, particularly Karnataka, Tamil Nadu, and Kerala, has a higher population density. India has historically led the world in the production of sandalwood oil for use in medicines and perfumes for over 5000 years³. The wood is

advised for worshipping the god Shiva, according to the Vamana Purana.[5].

Sandalwood Morphology:

Santalum album is a little evergreen tree that grows to a height of 4 meters in Australia, while in India it can grow to a height of 20 meters and a diameter of up to 2.4 meters with thin branchlets. The bark of old trees is tight, dark brown, reddish, dark grey, or almost black, and it has big vertical cracks. The leaves are thin, usually opposite, oblong or ovate elliptic, 3-8 x 3-5 cm, glabrous and dazzling green above, glaucous and slightly paler below, and the stalks are grooved, 5-15 cm long. Straw-colored, tiny, purplish-brown, scarlet, green, or violet flowers that are 4-6 mm long, odourless in terminal or axillary panicle cymes, and up to 6 in small terminal or axillary clusters.[8].



Figure No. 2 Sandalwood Flower.

Chemical Constituents of Sandalwood:

Seed and fruit:

- (1) Santalum or ximenynic acid
- (2) stearolic acid
- (3) acetylenic glycerides that make up the majority of the polyunsaturated fatty oil
- (4) palmitic acid

Bark and leaves:

Major tannins (14%) and fatty acids are found in sandalwood bark, along with trace levels of betasitosterol, a triterpene ester (Shankaranarayana et al. 1980a, b). According to Shankaranarayana et al. (1979), urs-12-en-3-beta-yl-palmitate (~0.3%) is a triterpene ester that has both chemosterilant and insect growth inhibitory properties. Several flavonoids were extracted and identified from *Santalum album* leaves, including vitexin (7), isovitexin (8), orientin (9), isoorientin (10), chrysin-8-C- β -D-glucopyranoside, chrysin-6-C- β -D-glucopyranoside, and isorhamnetin (Yan et al.

Root and stem:

The main source of the pricey wood and oil is the heartwood of the *Santalum album*. Its heartwood (stem) and roots are where the majority of the oil is stored. A mature tree can produce up to 6% oil, depending on its age.

Microscopical Character:

Microscopy:

A cross-section of heartwood shows lone veins interwoven with tylosis, which makes up the majority of the wood and contains large lumen fibers with thick walls and brownish condensation; the vessels are arranged in scattered pores, typically vesicentric parenchyma, and nearly parallel medullary rays, except when they slant slightly toward neighboring vessels. [13].

Powder Microscopy:

The distinct diagnostic characteristics that can be seen under a microscope are tylosis, fibers, pitted vessels with tails, uni and biseriate medullary rays, brownish content, and oil globules.[12].

General Features of Sandalwood Album:

The album is widely available and highly popular in places like Southeast Asia and India. A sandalwood tree's typical height is between 12 and 15 meters. It is more likely to thrive in areas with a restricted amount of sunlight during its early stages of development. It may be susceptible to environmental factors like fire and grazing. The bark of sandalwood comes in a variety of hues, such as dark brown, reddish, dark gray, and occasionally almost black. With thin, smooth margins, the leaves are often symmetrical, oval, or elliptical in shape. Observe the blossoms' bluish-purple coloring. In addition to its usage in treating bronchitis, gonorrhea, scabies, hemorrhoids, gastric issues, eye infections, dandruff and hair issues, muscle spasms, skin disorders, ulcers, migraines, and hiccups, these also contain sedative, diuretic, expectorant, and anitietic qualities. Furthermore, the tree is used to make wooden ornaments; the plant's oil and flower are used in the cosmetics and fragrance industries; the seed is used to make oil paints; and the plant's root, bark, and leaves are used to treat liver conditions. According to statistics from the literature, sandalwood (*S. album*) is a significant tree species from an ecological and nomadic standpoint.

Applications for Sandalwood

Sandalwood may be used to treat:

1. Psoriasis
2. Wrinkles, Scars, and Skin Darkening
3. Injuries
4. Eczema
5. Acne
6. Brain
7. Cancer
8. Ulcers
9. Heart
10. Fever
11. Diabetes

Sandalwood herbal soap:

Herbal soaps, often known as natural soaps, are made from plant-based ingredients and botanical extracts. They offer several benefits to the skin because they contain natural ingredients.



Figure No.5 Sandalwood Herbal Soap

Some Potential Benefits of Using Herbal Soap Include The Following:

Mild & Gentle: In general, herbal soaps don't irritate skin too much. They don't contain harsh chemicals, artificial perfumes, or artificial substances that can cause skin irritation or dryness.

Rich and Emollient: typically composed of organic oils and butters, such as shea, coconut, or cocoa. By supplying moisture, these components help the skin remain moisturized, smooth, and supple.

Cleaning: Use herbal soaps to efficiently remove oil, debris, and other pollutants from your skin without sacrificing its natural oils. They can lessen extreme dryness and preserve the skin's natural pH balance. Plants are the source of natural fragrances. Even though these natural perfumes have a nice scent, some people might find it annoying that no artificial chemicals are employed in their creation.

Soap type:



1. Bar Soap: Lipids and an alkali, like sodium hydroxide, are combined to make traditional bar soap. Despite the fact that it cleans well, using it may make your skin dry. Glycerin soap is more suited for dry or sensitive skin because it contains the natural moisturizer glycerin.

2. Castile Soap: Olive oil and other vegetable oils are used to make castile soap. It is biodegradable and mild.

3. Antibacterial soap: Made with antibacterial substances that help kill germs, such as triclosan or triclocarban. However, due to bacterial resistance and other health risks, their usage has been contested.

4. Exfoliating soap: To aid in the removal of dead skin cells, it may contain pumice, oats, or crushed seeds.

5. Body Soap:

Surfactants are the main cleansing ingredients that aid in removing oil and debris from the skin. Sodium lauryl sulfate (SLS) and sodium lauryl sulfate (SLES) are common surfactants.

6. Moisturizers: To keep skin hydrated, ingredients like glycerin, shea butter, and different oils (almond, coconut, and olive) are utilized.

7. Fragrances: Added to create a pleasing scent, while those with sensitive skin might prefer scent-free products.

8. Colorants: Added to soap to give it a striking hue. Colorants might be synthetic or natural.

9. Preservatives: Used in liquid soaps to stop bacteria from growing.

Advantages of Body Soap Use: One of the numerous advantages of herbal soap is that it efficiently removes debris, pollutants, and extra oil from your skin, leaving it feeling clean.

Sandalwood Powder:

Powdered Sandalwood Face Pack This herbal paste is applied to the face to treat pigments, scars, markings, acne, and pimples. A comparable formulation is Face Pack, which is a smooth powder that is applied to the face as pastes or liquids and let to dry and set to produce a film that tightens the skin. Action on the skin that is both cleaning and strengthening. In order to allow all the water to drain, they are typically kept on the skin for fifteen to thirty minutes. This causes the ensuing films to compress and harden, making them easily removed with water. Applying a face pack has a tightening and scouring effect that revitalizes the skin on the face. Ayurveda describes several types of face packs that are nutritious. Sandalwood Skin Cream for Moisture Around the world, sandalwood is a popular scent that frequently conjures images of gentle breezes, peaceful settings, and serenity. [13] It is utilized as incense, rosary beads, in religious rituals, and as a decorative and purifying paste. [14] There is a wealth of scientific data to support the several medical applications of sandalwood, which are praised in ancient Ayurvedic scriptures and Traditional Chinese Medicine. [15] The skin is a very flexible, self-repairing covering that shields the interior organs, tissues, and cells from stressors and the outside environment. It needs moisture to remain supple and smooth so that it may carry out its physiological role efficiently. Ayurveda describes several types of face packs that are nutritious. Astringent, antibacterial, cleansing, and healing qualities. By lessening wrinkles, pimples, acne, and dark spots, they improve the skin's radiance and smoothness.





Figure No.6 Sandalwood Powder

Benefits Of Powdered Sandalwood Face Pack:

- Nourishes the skin by giving it vital nutrients.
- Aids in minimizing skin scars, marks, acne, and pimples.
- Face packs give the skin a calming and relaxing impact.
- They aid in quickly restoring the skin's lost radiance.
- Using natural face packs on a regular basis improves the complexion, texture, and radiance of the skin.
- The appropriate usage of face packs can successfully counteract the negative effects of pollution and severe weather.
- They aid in halting the skin's premature aging.

Sandalwood Skin Cream:

for Moisture **Around** the world, sandalwood is a popular scent that frequently conjures images of gentle breezes, peaceful settings, and serenity. It is utilized as incense, rosary beads, in religious rituals, and as a decorative and purifying paste. There is a wealth of scientific data to support the several medical applications of sandalwood, which are praised in ancient Ayurvedic scriptures and Traditional Chinese Medicine [22]. The skin is a very flexible, self-repairing covering that shields the interior organs, tissues, and cells from stressors and the outside environment. It needs moisture to

remain supple and smooth so that it may carry out its physiological role efficiently.[23]



Figure No.7 Sandalwood Cream

Formulation Of Sandalwood Cream:

In a borosilicate glass beaker, heat the liquid paraffin and beeswax to 75 °C and keep it there. (Phase of oil). Borax and methyl paraben should be dissolved in distilled water in a different beaker, which should then be heated to 75 °C to produce a clear solution. (Phase of water). Next, gradually incorporate this watery phase into the heated oily phase. A calculated amount of sandalwood is then added, and everything is rapidly stirred until a creamy cream formed. Then, for aroma, add a few drops of rose oil. To give the cream a smooth texture and ensure that all the components are properly mixed, place the cream on the slab, add a few drops of distilled water if needed, and mix the cream in a geometric pattern.

Sandalwood Essential Oil:

Chemical components of sandalwood essential oil include: Numerous important components found in sandalwood essential oil contribute to its medicinal qualities. Santillo: The main ingredient that gives sandalwood its distinct scent and many of its therapeutic benefits. It adds to the oil's

calming and relaxing qualities and has antibacterial and anti-inflammatory qualities.

Uses:

- 1.Sandalwood essential oil is prized for its numerous medicinal and aesthetic uses.
- 2.Aromatherapy It is used to promote relaxation and lessen tension and anxiety because of its calming and grounding properties.
- 3.Skincare: Frequently found in products that soothe inflamed skin, lessen acne, and enhance skin texture.
- 4.Fragrances and perfumes: One common component of high wound healing is sandalwood oil: Its antibacterial qualities help small cuts and wounds heal.



Figure No.8 Sandalwood Essential Oil.

Sandalwood Oil Extraction:

Using microwave technology, essential oils are extracted from the sandalwood of the *Santalum album*.

- 1) Hydrodistillation in a microwave.
- 2) Air-hydrodistillation in microwaves.

1.Microwave Hydrodistillation:

A 1 L flask of deionized water (400 mL) was filled with 20 grams of sandalwood powder samples. To collect the extracted essential oils, a condenser was

placed on top of the flask, outside the microwave oven cavity. For two hours, the microwave oven was run at 600 W of power. The essential oils in the sample were completely extracted during this time. The essential oil was separated using the separating funnel. To The essential oil was separated using a separating funnel. After extracting the essential oils, the water was removed and the surface was dried. Amber vials holding weighed anhydrous sodium sulfate were kept at 4 C until they were required for analysis.[28]

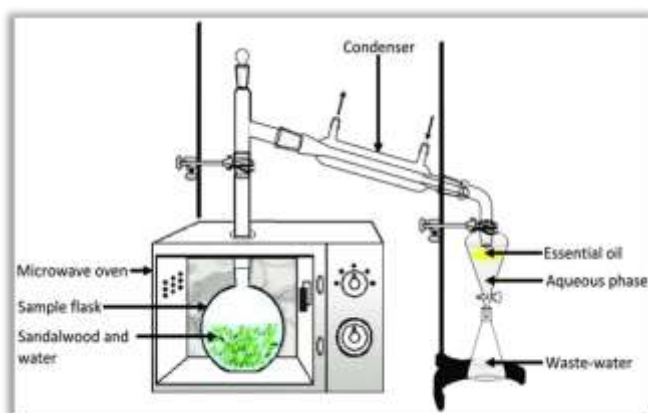


Figure No. 9. Microwave Hydrodistillation Apparatus

2.Microwave Air-Hydrodistillation:

EMM-2007X, Electrolux, 20 L, 800 W; variable in 200 W increments, 2.45 GHz, was modified to function as a microwave hydrodistillation apparatus. The PTFE-coated cavity of the microwave oven is 46.1 cm by 28.0 cm by 37.3 cm. A 1 L flask of deionized water was filled with 20 grams of sandalwood powder samples. An external condenser was set on top of the flask, which was inside the microwave oven cavity. It was modified to function as a device for microwave hydrodistillation. [29]To collect the extracted essential oils, the flask was put inside the microwave oven cavity and an external condenser was set on top of the oven. The compressor was used to fill the distiller with air, deionized water,

and powdered sandalwood. After that, the air flow is modified to meet the needs of operation. The research variables were ascertained using the flow meter. The microwave oven was used at 600 W for two hours. During this period, all of the essential oils were sufficiently extracted from the sample. The essential oil was separated for analysis using a separating funnel. The yield of sandalwood oil was calculated using the following formula. After being extracted, the essential oils

were dried over anhydrous sodium.[29] Sulfate to remove water, weighed, and stored at 4 C in amber vials until analysis is required. The yield of sandalwood oil was calculated using the following formula. Where y is the sandalwood oil yield (percent, weight-for-weight) (g), W is the weight or mass of sandalwood powder, and V is the weight or mass of extracted sandalwood oil (g). shows the microwave air-hydrodistillation system schematically.[30]

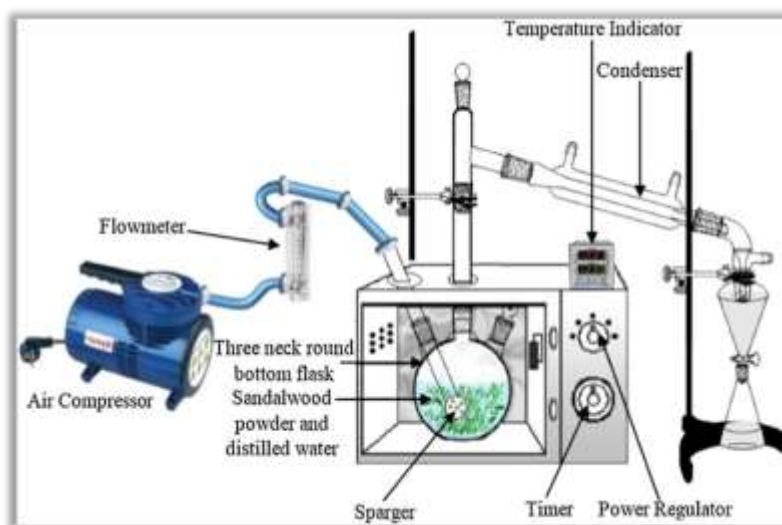


Figure No.10 Microwave Air-Hydrodistillation Apparatus.

SANDALWOOD OIL EVALUATION:

1.Physical Appearance:

Assessment Cold cream's physical characteristics were examined visually against a dark background. Three readings are averaged and recorded.[34]

2.Uniformity the Homogeneity:

The cold cream formulation was evaluated both visually and through touch. Following the application of the predetermined quantity of cream, the amount of residue, slipperiness, and emolliences were assessed. Smear type: Following cream application, the kind of film or smear that

developed on the skin was examined. Elimination By washing the applied area with tap water, the cream's ease of removal was assessed.[35]

3.Test of Sensitivity:

The prepared cream was applied to the hand's skin and left in the sun for four to five minutes.

4. Spread Ability:

Under a specific load, the spread ability was measured in seconds, with two slides slipping off the cream that was positioned between them. The spread ability improves with less time spent separating the two slides. Two sets of standard-sized glass slides were taken. After that, a slide

with the right dimensions was selected, and the cream formulation was put on it. On top of that, another slide was positioned. The cream between the two slides was then uniformly compressed to form a thin layer by placing a weight or specific load on the upper slide. After that, the weight was taken off, and any extra formulation that was sticking to the slides was scraped off. Because of the weight attached to it, the upper slide was able to slide off without any assistance. It was noted how long it took the upper slide to slip off. Spread ability is equal to $m \times l/t$, where m is the standard weight (30g) that is fastened to or placed over the upper slide. L = glass slide length (5 cm) t is the amount of time in seconds.[36]

5.PH:

The sandalwood cold cream's pH was measured with a pH meter. A lab tool known as a probe and meter, or simply a pH meter, is the most precise frequent way to measure pH. A little voltage is applied to a glass electrode that makes up the probe. The voltmeter shows pH units rather than volts and measures the electrical impedance in the glass electrode. To take a measurement, immerse the probe in the semisolid until the meter registers a reading.[34]

Pharmacological Activity

1. Activity of Biology:

Plants have evolved defense systems to shield themselves from a range of outside influences in their natural habitat. Secondary metabolites are produced as a result, and these are crucial to biological functions. The main indicators of a plant's biological activity are the secondary molecules it produces (Mohammed et al., 2020; Mohammed et al., 2023a). We compiled the studies on *S. album*'s biological activities that have been published in the literature for our study.

A range of extracts have been used in these investigations. Hydroalcoholic, diethyl ether, essential oil, petroleum ether, dichloromethane, n-hexane, methanol, aqueous, ethanol, acetone, callus extract, sandalwood oil, chloroform, ethyl acetate, and butanol are among them.[20]

2.Activity of Antioxidants:

Every living thing produces oxidant compounds in different amounts as a result of metabolic activity. When present in larger concentrations, these oxidant chemicals have the ability to seriously harm cells, but at lower concentrations. Reducing or eliminating the effects of oxidant chemicals is the responsibility of the antioxidant defense system. Nevertheless, there are specific situations when oxidant chemical concentrations can be high enough to deplete the antioxidant defense system, leading to the development of oxidative stress conditions. Oxidative stress and DNA and RNA damage are correlated, and this can contribute to the emergence of neurological disorders, diabetes, cancer, and cardiovascular problems.[21]

3. Antimicrobial Action:

An extensive range of chronic illnesses are largely influenced by microorganisms. In order to combat bacteria, antibiotics are now used. However, these antibacterial medications are no longer effective enough. The overuse of antibiotics, which has caused the growth of bacteria resistant to drugs, is thought to be the main cause of this predicament. Because of the possible negative effects associated with the currently available drugs, research has shifted its focus to natural antibacterial resources. As natural sources of antibacterial action, plants are essential. Numerous studies pertaining to *S. album*'s antibacterial qualities were found when the literature was reviewed.[22]



Adulterant:

Castor oil and, on the Continent, oil of cedar, which is made by distilling the leftover chips from the production of lead pencils, are examples of adulterants.[38]

FUTURE SCOPE:

1. Repellent for Mosquitoes Sandalwood:

Sandalwood essential oil is prized for its application in stress relief, meditation, and skin care. It is extracted from the heartwood of Sandalwood trees and has a pleasant, woody scent. It has been demonstrated to boost emotions, calm the body, boost the immune system, and lessen mild depression. Not all insects like its scent, but humans do. It can be applied to repel mosquitoes.[39]

2. Forms: There are many different types of sandalwood mosquito repellent, such as popular incense sticks that last anywhere from three to six hours, sandalwood sprays, and even perfume oils and balms.[41]

3.Origins: Australia and India are two frequent places to find sandalwood. Many societies have been using sandalwood for millennia to keep mosquitoes away by burning the wood, bark, and leaves.[40]

CONCLUSION:

Santalum album is a priceless gift from the plant kingdom that is entwined with Indian heritage and culture. With more than 200 constituents, the essential oil is becoming a more interesting and practical source of phytochemicals. Understanding and outlining the current body of information regarding the biological activity of this sandalwood tree, as well as its cultivation and harvesting, is the aim of this

review. Microscopically *Alta's* sandalwood album. The quality of sandalwood oil produced by microwave hydrodistillation and microwave air-hydrodistillation techniques can be assessed based on its physical and chemical characteristics. Understanding and disseminating current information on this plant's biological activities from a pharmacological perspective for potential clinical uses is the aim of this review. As indicated by the pharmacological studies mentioned above, the therapeutic potentials of this plant and its active chemical ingredients promise future healthcare applications. These include the roles of santalols in preventing cancer, tumors, viral diseases, microbes, oxidants, as well as anti-ulcer, skin-nourishing agents, and dietary factors, supporting its traditional uses.

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