

## FORMULATION AND EVALUATION OF ALBIZIA LEBBECK LEAF EXTRACT FOR ANTI-FUNGAL SOAP

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### ABSTRACT

Albizia Lebeck leaf extract has been traditionally used for its antimicrobial, anti-inflammatory, and medicinal properties. The present study aimed to formulate and evaluate an anti-fungal herbal soap containing *Albizia lebbeck* leaf extract for the management of common fungal skin infections. Herbal soaps are preferred over synthetic soaps because they are safer, eco-friendly, and produce fewer side effects on the skin. The leaves of *Albizia lebbeck* were collected, dried, powdered, and extracted using a suitable solvent extraction method. The obtained extract was incorporated into the soap base in different concentrations to prepare the herbal anti-fungal soap. The formulated soap was evaluated for various physicochemical parameters such as color, odor, appearance, pH, foam height, foam retention, moisture content, alcohol-insoluble matter, total fatty matter, and stability studies. Anti-

fungal activity of the formulation was assessed against common fungal organisms using standard microbiological methods. The results showed that the herbal soap possessed good cleansing action, acceptable foam properties, and skin-friendly pH. The formulation also demonstrated significant anti-fungal activity due to the presence of bioactive constituents such as flavonoids, saponins, tannins, and alkaloids in the leaf extract. The study concludes that *Albizia lebbeck* leaf extract can be successfully incorporated into herbal soap formulations to produce an effective anti-fungal product with good stability and physicochemical characteristics. The formulated herbal soap may serve as a natural, economical, and safe alternative to commercially available anti-fungal soaps for maintaining

healthy skin and preventing fungal infections. **Aim:** To development of a herbal soap using the leaf extract of *Albizia lebeck* and the antifungal efficacy of the soap along with its physicochemical properties such as PH, hardness, foaming capacity, and stability.

## INTRODUCTION

Medicinal plants continue to play an imperative role in the development of pharmaceutical and cosmeceutical products that are safe and effective. There exists an increasing preference for herbal-based topical formulations, including soaps, because of their biodegradability, reduced side effects, and broad- spectrum biological activity. Among the different medicinal plants, *Albizia Lebeck* (L). Benth belonging to the family Fabaceae, has attained substantial scientific interest due to its traditional usage in inflammatory disorders, skim diseases, allergies, and microbial infections.

*Albizia Lebeck* L., commonly known as white siris, grows as a large deciduous tree and has a wide geographical distribution in tropical and subtropical regions. The leaf of this plant holds special significance in pharmacognosy and pharmaceutical preparations due to its renewable nature and rich biochemical constituents. The alternate, bipinnately arranged leaves measure about 15-30 cm in length. Each leaf consists of 2-4 pairs of pinnae, with each pinna bearing 3-10 pairs of opposite leaflets. The leaflets are margin is entire, with a rounded to slightly emarginate apex and a symmetrical base. The upper surface is lighter green and may exhibit fine pubescence. Reticulate venation typical of dicotyledonous plants, is prominently visible on the abaxial surface.

These distinctive morphological characteristics are essential for correct identification and authentication of the plant material prior to extraction, thereby minimizing the chances of adulteration and misidentification. Phytochemical investigations of *Albizia lebeck* leaves have revealed the presence of flavonoids, saponins, tannins, phenolic compounds, and alkaloids These phytochemical constituents are responsible for antimicrobial, antioxidant, and anti-inflammatory activities, making the leaf extract highly suitable for dermatological applications.

Skin-associated microorganisms are a major cause of numerous dermatological disorders, emphasizing the need for effective antimicrobial cleansing products. Herbal soaps prepared from medicinal plant extracts with therapeutic properties have gained significant attention as alternatives to synthetic cleansing agents. The antimicrobial potential of *Albizia lebeck* leaf

extracts supports their incorporation into herbal soap formulations as natural substitutes for conventional antimicrobial agents. However, only limited studies have systematically combined morphological evaluation, antimicrobial assessment, and formulation development of *A. lebbeck* leaf into a single research framework. Therefore, the present study focuses on morphological authentication, antifungal evaluation, and formulation development to validate the application of *A. lebbeck* leaf extract as a natural antimicrobial topical product.

Herbal products have received significant attention in recent times owing to their safety, efficacy, and fewer side effects compared to chemical products. Medicinal plants have been employed for the treatment of various skin infections and diseases in traditional medicine systems for decades. One of the major issues with the skin of the human body is the infection caused by fungi, which are present on the surface of the skin. These infections may result in itching, irritation, and discomfort. The incorporation of herbal ingredients in personal care products, such as soaps has therefore become a major aspect in the prevention and treatment of such infections.

Fungal infections like ringworm, athlete's foot, and candidiasis are prevalent worldwide, especially in tropical regions. These infections are often caused by fungi like dermatophytes and yeast-like fungi. Lack of hygiene, excessive sweating, and environmental conditions can lead to an increase in fungal growth on the skin. Although various antifungal drugs and medicated soaps are present in the market, these drugs may also lead to side effects like skin irritation, dryness, and even allergies. Also, with the increased resistance of fungi to these synthetic drugs, natural antifungal agents are being increasingly investigated. *Albizia lebbeck*, commonly called the 'Siris tree' or 'Woman's tongue tree,' is a medicinal plant that belongs to the family Fabaceae. *Albizia lebbeck* is widely found in the tropical and subtropical regions of Asia, including India.

Various parts of the plant, such as the leaves, bark, seeds, and flowers, are used for medicinal purposes, including the treatment of different diseases such as allergy, respiratory, and skin disorders. *Albizia lebbeck*, specifically the leaves, are found to have several medicinal properties, including antimicrobial, anti-fungal, anti-inflammatory, antioxidant, and healing properties. These medicinal properties are due to the phytochemical constituents such as saponins, flavonoids, tannins, and glycosides present in the plant. Herbal soaps, prepared using plant extracts, are becoming popular due to their ability to clean the skin and offer therapeutic benefits at the same time. The use of medicinal plant extracts in soap formulation

can increase their antimicrobial activities, thereby assisting in the prevention of skin infections. Herbal soaps are also found to be safer for daily use, as the plant extracts used in their formulation are gentle on the skin and do not cause irritation, unlike chemical soaps.

The formulation of antifungal herbal soaps using plant extracts can be a better option in comparison to commercial medicated soaps, which are costly and ineffective in many cases. In this regard, *Albizia lebbek* leaf extract can be a potential ingredient in soap formulation, owing to its antifungal and antimicrobial activities. The formulation of herbal soap can be carried out by selecting the suitable ingredients required to prepare a stable herbal soap. Thus, the present study is focused on the development and evaluation of antifungal soap using *Albizia lebbek* leaf extract. The prepared antifungal soap is evaluated for various physicochemical parameters such as pH, foamability, moisture content, and hardness to ensure the quality and stability of the prepared antifungal soap. The development of antifungal soap using herbal extracts can be helpful in providing an alternate method for maintaining skin hygiene and controlling fungal infections in an herbal way. The skin is the largest organ in the human body, functioning as a protective shield from a variety of external factors, such as microorganisms, chemicals, and physical injuries.

Nevertheless, the skin is constantly exposed to a variety of pathogens, bacteria, fungi, and viruses, such as which may lead to infections and other skin diseases. Among them, fungal infections are one of the most common skin diseases that affect humans around the globe. Fungal infections are generally caused by pathogenic fungi, such as *Candida*, *Aspergillus*, *Trichophyton*, and *Microsporum*, and are known to affect the outer skin, hair, and nails, thereby causing itching, redness, inflammation, scaling, and irritation in the affected areas. Fungal infections are generally found in tropical climates, where the temperature is high and humidity is high, favoring fungal growth. One of the most effective methods of preventing fungal infections is by ensuring proper hygiene. Soap is an important agent in the process of cleansing, and it is used daily in the maintenance of proper personal hygiene.

Conventional soaps are mainly used to wash off dirt, perspiration, oil, and microorganisms from the skin. Most soaps, however, are known to contain synthetic chemical compounds and detergents, which may cause skin irritations, dryness, or allergic reactions in some individuals. Thus, in recent times, there has been a growing need for the development of herbal soaps, which are known to be safer and more effective, since they are made from herbal plant extracts with medicinal properties. Medicinal plants have been employed over

the centuries in the treatment and prevention of various diseases in traditional systems of medicine such as Ayurveda, Siddha, and Unani systems of medicine. Plants contain many phytochemicals such as alkaloids, flavonoids, tannins, glycosides, terpenoids, saponins, and phenolic compounds, which have medicinal value. In recent times, the application of plant products in the formulation of cosmetics and pharmaceuticals has received considerable attention due to the natural source and efficacy of the products with minimal side effects. One such medicinal plant having great therapeutic value is *Albizia lebbek* (L.) Benth., commonly known as the Siris tree or the Woman's tongue tree. It is a member of the family Fabaceae and is found in tropical and subtropical countries such as India, Southeast Asia, and Africa. *Albizia lebbek* is a large deciduous tree that attains a height of 18–30 meters. It is commonly found in the wild, roadside trees, and agricultural fields. Various parts of the *Albizia lebbek* plant are used in traditional medicine for the cure and prevention of various diseases such as respiratory problems, allergy, inflammation, and infections.

The leaves of *Albizia lebbek* are known to have different types of bioactive phytochemical compounds such as flavonoids, tannins, saponins, alkaloids, terpenoids, and phenolic compounds. These compounds are known to be responsible for the pharmacological activities of the plant, including antimicrobial, antioxidant, anti-inflammatory, and antifungal properties. Several scientific studies have shown that the plant extracts of *Albizia lebbek* exhibit inhibitory effects against different types of microorganisms, including fungi. The antifungal properties of the plant are known to be mediated through the presence of flavonoids and phenolic compounds in the plant, which interfere with the cell wall synthesis of fungi and inhibit their growth. The use of herbal extracts in the formulation of soaps has been on the rise in recent years, and this is attributed to the medicinal benefits associated with the use of herbal extracts in the formulation of soaps.

The use of herbal soaps is beneficial since they are not only used for cleaning purposes, but they are also associated with medicinal benefits based on the type of herbal extract used in the formulation of the herbal soap. The addition of medicinal plant extracts in the formulation of herbal soaps can help in the prevention of skin diseases through the antimicrobial and antifungal effects of the herbal soaps. Herbal soaps are usually prepared using natural ingredients such as vegetable oils, alkali, herbal extracts, fragrances, and colorants. The use of *Albizia lebbek* leaf extract in soap formulation could result in the development of an effective herbal drug with antifungal properties.

The phytochemicals present in the leaves could be effective in inhibiting the growth of the fungus on the skin and hence prevent infections. In addition, the use of herbal soaps is environmentally friendly compared to the use of chemical-based soaps. Hence, the development of antifungal soaps using the extracts of medicinal plants is an area of research in the field of pharmaceutical and cosmetic science. The formulation of herbal soap is based on a chemical reaction called saponification, in which a fat or oil is mixed with a substance such as sodium hydroxide to produce a soap-like substance along with glycerol. In the formulation of herbal soap, various ingredients are added during the formulation process in order to enhance the quality of the herbal soap. The formulation of herbal soap is critical in order to ensure that it has certain characteristics such as cleansing ability, foaming ability, hardness, etc. Once formulated, it is subjected to evaluation for various physicochemical properties to ensure its effectiveness and safety for use. Evaluation of herbal soaps is performed by conducting various tests, such as pH, foam height, foam retention, moisture content, hardness, and antimicrobial activity. These tests are performed to assess the quality of the formulated product. The pH of the soap should be within a reasonable range to avoid any irritation of the skin by the soap. Good foamability of the soap is also essential for consumer acceptance of the product. Antifungal activity test is performed to confirm the effectiveness of the herbal extract in inhibiting fungal growth. The formulation of antifungal herbal soaps with *Albizia lebbek* leaf extract could be a new approach in providing a natural alternative to commercially available antifungal soaps.

These soaps are believed to contribute to the maintenance of personal hygiene, as they are effective in inhibiting fungal infections, thereby ensuring the health of the skin. Moreover, the use of plants as ingredients in soaps contributes to the creation of eco-friendly soaps. Thus, the present study is focused on the formulation and evaluation of antifungal soap using *Albizia lebbek* leaves' extract. The aim of this study is to develop an effective herbal soap and assess its physicochemical properties and antifungal activities. The development of this formulation could increase the demand for herbal cosmetics and pharmaceuticals, and this could be a safer way to prevent fungal infections in humans. Medicinal plants are used in traditional systems of medicine all over the world. Natural products, which are derived from plants, are playing a vital role in the health care of people, as they are considered safer alternatives to synthetic drugs. Herbal medicines are being used because of their efficacy, acceptability, and fewer side effects. According to the World Health Organization, "about 80% of the world population still relies on traditional herbal medicine as primary health

care." Herbal formulations have gained significant attention in pharmaceutical research and development activities due to the pharmacological properties such as antimicrobial, antifungal, anti-inflammatory, antioxidant, and antiseptic activities of the plant-derived compounds. Due to the emergence of antimicrobial resistance and the toxicity of synthetic chemical compounds, there is an increased interest in using herbal-based products for personal care and medicinal formulations. Among all the herbal cosmetic products, herbal soaps are gaining popularity as they are made of herbal extracts, which not only cleanse the skin but also offer additional benefits of antimicrobial activity, nourishment, and healing properties. These soaps are made of natural ingredients and herbal extracts, which are helpful in maintaining skin health and hygiene.

## 2. Skin and Fungal Infections

Skin is the largest organ in the human body. It is the main protective barrier that prevents the entry of environmental pathogens, chemicals, and physical agents into the body. Despite the protective role of the skin, it is prone to different types of infections caused by bacteria, viruses, parasites, and fungi.

Fungal infection of the skin is very common across the world. It is caused by different types of fungi. It affects the outer layer of the skin, hair, and nails. This type of infection is known as superficial mycoses.

### Common types of fungal infection include

- ❖ Athlet's foot
- ❖ Ringworm
- ❖ Candidiasis
- ❖ Tinea infection

These types of infection cause itching, redness, scaly patches, irritation, inflammation, and discomfort on the infected part of the skin.

One of the most common types of fungal infection is Dermatophytosis. This type of infection is caused by Dermatophytes. Dermatophytes cause infection of the skin, nails, and hair. Dermatophytes grow best in a warm and moist environment. Therefore, tropical climates are very prone to these types of infection.<sup>3</sup> Importance of Antifungal Agents.

Antifungal agents refer to the medicines that treat fungal infections by restraining the

development of the fungi or destroying the fungal cells. The antifungal medicines that are generally used include azoles, polyenes, and allylamines. The antifungal medicines that are generally used include Clotrimazole, Ketoconazole, and Fluconazole.

**Though these medicines are quite effective, they can cause some limitations such as**

- ❖ Drug resistance
- ❖ Side effects
- ❖ Expensiveness
- ❖ Skin irritation

Due to these limitations, scientists are trying to find plant-based antifungal medicines that can be used as creams, ointments, gels, and soaps.

**The advantages that can be obtained from using herbal antifungal medicines include**

- ❖ Less toxicity
- ❖ Skin compatibility
- ❖ Nature
- ❖ Cost-effectiveness
- ❖ Safety to the environment

Thus, plant extracts with antifungal properties can be incorporated in soaps, which can prevent fungal infections and promote proper skin hygiene.

#### **4. Herbal Soaps**

Soap is a cleansing agent, and it is produced by the reaction between fat or oil and alkali, known as the saponification process. Soaps are generally used for promoting skin hygiene by removing impurities, oils, microorganisms, and dead cells from the skin's surface.

Traditional soaps are mainly composed of synthetic chemicals and detergents, which may cause skin irritation in some individuals. On the other hand, herbal soaps are composed of herbal ingredients.

- ❖ Benefits of using herbal soaps:
- ❖ Natural antimicrobial activity
- ❖ Skin nourishment
- ❖ Moisturizing effects
- ❖ Less irritation on the skin
- ❖ Eco-friendly

The addition of medicinal plant extracts improves the therapeutic value of the soaps and makes them beneficial in the treatment and prevention of some skin disorders.

Antifungal herbal soaps can be employed in the prevention of fungal infections, skin hygiene, and protection against pathogenic microbes.

### 5. Medicinal Plants in Antifungal Soap Formulations

There are various medicinal plants that exhibit antifungal properties due to their ability to contain bioactive phytochemicals such as:

- ❖ Alkaloids
- ❖ Flavonoids
- ❖ Tannins
- ❖ Saponins
- ❖ Terpenoids
- ❖ Phenolic compounds

All these phytochemicals are known to exhibit antimicrobial properties by disrupting fungal membranes, inhibiting enzyme activity, and interfering with fungal metabolism.

Some of the common medicinal plants used in antifungal formulations are:

- ❖ **Neem** (*Azadirachta indica*)
- ❖ **Tulsi** (*Ocimum sanctum*)
- ❖ **Aloe vera** (*Aloe barbadensis*)
- ❖ **Turmeric** (*Curcuma longa*)
- ❖ **Albizia lebbek**

Out of these plants, **Albizia lebbek** has received significant attention for its various medicinal properties.

### 6. Overview of Albizia lebbek

*Albizia lebbek* is a tropical tree species classified under the family Fabaceae. It is also known as the 'Siris tree,' 'Woman's tongue tree,' and 'Indian walnut.' *Albizia lebbek* is found in tropical and subtropical countries such as India, Southeast Asia, Africa, and Australia.

*Albizia lebbek* has been in use in traditional medicine such as Ayurveda for the treatment and cure of various diseases.

The bark, leaves, flowers, and seeds of the *Albizia lebbek* plant are reported to be medicinally active. The leaves are reported to be effective in curing diseases because they are antimicrobial, antifungal, anti-inflammatory, and antioxidant in nature.

### 7. Botanical Description

- ✓ *Albizia lebbek* is a large tree that is deciduous and can reach as high as 30 meters in height. The tree has a spreading canopy and straight trunk with grey bark.
- ✓ The leaves of the tree are bipinnate and compound with multiple leaflets that radiate from the main axis. The leaflets are ovate and dark green in color.
- ✓ The flowers that the tree produces are fragrant and have a cream-colored appearance, forming globular clusters. The fruits that the tree bears are flat pods with multiple seeds.
- ✓ The tree can be found growing in tropical climates and is common along the roadsides, forests, and fields.

### 8. Phytochemical Constituents of the Plant

The medicinal properties of *\*Albizia lebbek\** are due to the various phytochemical compounds found in the plant.

Major phytochemical compounds found in the *\*Albizia lebbek\** plant are as follows:

- ❖ Flavonoids
- ❖ Saponins
- ❖ Tannins
- ❖ Glycosides
- ❖ Alkaloids
- ❖ Terpenoids
- ❖ Phenolic compounds

These phytochemical compounds are responsible for the antimicrobial and antifungal properties of *\*Albizia lebbek\**. The saponins and flavon.

### 9. Pharmacological Activities of *Albizia lebbek*

Several pharmacological activities have been carried out to show the various pharmacological activities of *Albizia lebbek*.

#### These activities include

- ❖ Antifungal activity

- ❖ Antibacterial activity
- ❖ Anti-inflammatory activity
- ❖ Antioxidant activity
- ❖ Antiallergic activity
- ❖ Antidiabetic activity
- ❖ Among these activities, antifungal activity is significant in the development of antifungal herbal medicine.
- ❖ Several studies have indicated that the leaves of *Albizia lebbek* contain inhibitory activities against the following antifungal organisms:
  - ❖ *Candida albicans*
  - ❖ *Aspergillus niger*
  - ❖ *Trichophyton* spp.

These fungi cause skin infections; hence, the plant can be used in the development of antifungal soap.

#### **10. Antifungal Activity of *Albizia lebbek* Leaves**

- ❖ The antifungal property of the leaves of *Albizia lebbek* is due to the presence of saponins, tannins, and flavonoids.

The antifungal property is due to the following reasons:

- ❖ Damage to the fungal membrane
- ❖ Inhibition of the enzyme system
- ❖ Interference with the metabolic process
- ❖ Prevention of the reproduction and growth of the fungus

Based on the antifungal property, the leaf extract of *Albizia lebbek* can be used as an ointment to prevent fungal infections.

#### **11. Importance of Herbal Antifungal Soap**

- ❖ The production of herbal antifungal soap using *Albizia lebbek* leaf extract has several advantages.

The advantages of herbal antifungal soap are:

- ❖ Antifungal properties
- ❖ Less use of chemicals
- ❖ Skin safety
- ❖ Cost-effective

- ❖ The use of herbal materials in soaps increases the medicinal value of soaps without compromising their use for cleaning.
- ❖ The herbal material is added in the process of formulation to give the soap medicinal properties.

## 12. Formulation of Herbal Soap

The steps involved in the formulation of herbal soap are as follows:

- ❖ Extraction of the plant material
- ❖ Preparation of the soap base
- ❖ Inclusion of the herbal material
- ❖ Moulding and curing

Vegetable oils such as coconut oil, palm oil, and olive oil are commonly used in the formulation of herbal soap. They are mixed with sodium hydroxide in the saponification reaction.

Herbal material is added during the formulation of the soap in order to impart medicinal value to the soap.

### 1.1 Background and Rationale

Superficial fungal infections are among the most common dermatological conditions worldwide, affecting individuals of all age groups irrespective of socioeconomic background. These infections are mainly caused by dermatophytes such as *Trichophyton*, *Microsporum*, and *Epidermophyton* species, as well as opportunistic yeasts like *Candida* species. Such infections lead to clinical conditions including tinea corporis, tinea pedis, candidiasis, and pityriasis versicolor. Although rarely life-threatening, these infections significantly impair quality of life due to their persistence, recurrence, discomfort, and cosmetic concerns. Tropical and subtropical climatic conditions further contribute to the increased prevalence of these fungal infections.

Conventional antifungal agents such as azoles, allylamines, and polyenes are commonly used for therapeutic and prophylactic purposes.<sup>[14]</sup> However, prolonged use of these agents has been associated with antifungal resistance, dermatological side effects, disruption of normal skin microflora, and environmental toxicity.<sup>[14,15]</sup> Additionally, synthetic antifungal agents used as additives in commercial soaps and cleansing products may cause skin irritation,

dryness, and allergic reactions, particularly in individuals with sensitive or compromised skin. Herbal soaps formulated using medicinal plant extracts are increasingly recognized as multifunctional topical products that combine cleansing action with therapeutic benefits.<sup>[12]</sup> These products offer advantages such as biodegradability, improved skin compatibility, fewer adverse effects, and increased consumer acceptance due to the growing global preference for natural products.<sup>[11]</sup> Consequently, medicinal plants possessing antifungal, anti-inflammatory, and antioxidant properties are being widely explored for incorporation into topical cleansing formulations.

### 1.2 Medicinal Plants in Antifungal Soap Formulation

The application of plant materials for skin care and hygiene has a long history, forming the foundation of traditional medical systems such as Ayurveda, Siddha, Unani, and African traditional medicine. Medicinal plants are rich sources of secondary metabolites including flavonoids, tannins, saponins, alkaloids, phenolics, and terpenoids, which exhibit broad-spectrum antimicrobial and antifungal activities.

The antifungal mechanisms of these phytoconstituents include disruption of fungal cell membranes, inhibition of ergosterol biosynthesis, interference with fungal enzyme systems, and impairment of cell wall integrity. Recent scientific studies have validated the antifungal activity of plant extracts against dermatophytes and yeasts, leading to increased interest in herbal antifungal soap formulations. Although herbal soaps containing neem, turmeric, tea tree oil, and aloe vera have demonstrated promising antifungal effects, challenges related to standardization and consistency of biological activity persist.

### 1.3 *Albizia lebbek* as a Medicinal Plant

*Albizia lebbek* (L.) Benth. is a large deciduous tree belonging to the family Fabaceae and is widely distributed in India, Southeast Asia, Africa, and other tropical regions. The plant is well known in traditional medicine for its use in inflammatory conditions, respiratory disorders, allergies, and dermatological ailments. Various parts of the plant, including bark, leaves, seeds, and pods, have been reported to exhibit diverse pharmacological properties. Among these, the leaf is of prime importance for topical and cosmeceutical applications due to its easy availability, renewability, and relatively lower toxicity compared to bark and seeds. Traditionally, *A. lebbek* leaves have been used for the treatment of wounds, itching, inflammation, and skin infections, indicating their relevance in antifungal and dermatological applications.

#### 1.4 Morphological Features and Their Significance

The morphological features of *Albizia lebbbeck* leaves play a vital role in pharmacogenetic identification and extraction efficiency. The leaves are alternate and bipinnately compound, measuring 15–30 cm in length, with 2–4 pairs of pinnae and 3–10 pairs of opposite leaflets per pinna. The leaflets are oblong to elliptic with entire margins, rounded to slightly emarginate apex, and symmetrical base. The adaxial surface is dark green and glabrous, while the abaxial surface is light green with prominent reticulate venation. These diagnostic morphological features ensure correct authentication of the plant material and reduce the risk of adulteration. In addition, the thin lamina and large surface area facilitate effective solvent penetration during extraction, resulting in improved yield of bioactive constituents.

#### 1.5 Phytochemical Analysis and Antifungal Activity

Phytochemical analysis of *Albizia lebbbeck* leaves has identified flavonoids, saponins, tannins, phenolic acids, glycosides, and alkaloids. These compounds possess notable antifungal properties. Flavonoids and phenolic compounds disrupt fungal cell membranes and inhibit enzymatic processes, while saponins increase membrane permeability, leading to fungal cell lysis. Tannins exert protein-precipitating effects that inhibit fungal cell wall synthesis. Several experimental studies have demonstrated the antimicrobial and antifungal potential of *A. lebbbeck* extracts against pathogenic microorganisms. Although most reports focus on antibacterial and anti-inflammatory effects, recent findings indicate promising antifungal activity, supporting further formulation-based investigations.

#### 1.6 Need for Development of Antifungal Soap

Soap is one of the most commonly used personal hygiene products, making it an effective delivery system for anti-fungal agents. Herbal antifungal soaps can help prevent and control superficial fungal infections by reducing fungal load on the skin surface. Compared to leave-on topical products, soaps offer repeated daily exposure with minimal risk of systemic absorption.

The development of an antifungal soap containing *Albizia lebbbeck* leaf extract aligns with the principles of preventive dermatology and herbal medicine. However, incorporation of plant extracts into soap formulations presents challenges related to stability, pH compatibility, foaming properties, hardness, and retention of biological activity.

### 1.7 Formulation Issues in Herbal Antifungal Soap

The formulation of herbal antifungal soap requires careful selection of base oils, alkali concentration, stage of extract incorporation, and optimization of physicochemical properties. The extract must remain stable under alkaline conditions and during the saponification process. The final formulation should meet acceptable standards for pH, foam stability, cleansing ability, hardness, and skin compatibility.

### 1.8 Evaluation Parameters for Antifungal Soap

Evaluation of the prepared antifungal soap involves physicochemical parameters such as pH, moisture content, total fatty matter, foam height, foam stability, hardness, and stability under different storage conditions. Biological evaluation includes antifungal activity testing against selected fungal strains using standard microbiological assays. Skin irritation and safety assessment are essential to ensure suitability for topical application.

### 1.9 Research Gap and Rationale

Despite long-standing traditional use and documented pharmacological properties of *Albizia lebbek*, research integrating morphological authentication, antifungal activity evaluation, and formulation development remains limited. Most existing studies are confined to crude extract screening without translation into practical dosage forms such as soaps. Furthermore, limited information is available regarding the behavior and stability of *A. lebbek* leaf extract in alkaline soap matrices, justifying the need for the present investigation.

### 1.10 Scope of the Present Study

The present study focuses on the formulation and evaluation of an antifungal soap containing *Albizia lebbek* leaf extract. By integrating morphological authentication, antifungal screening, formulation development, and comprehensive evaluation, this study aims to provide scientific evidence supporting the use of *A. lebbek* leaf as a natural antifungal agent in herbal soap formulations, contributing to the development of safe, effective, and affordable plant-based antifungal hygiene products.

### Macromorphology

- **Leaf type:** Alternate, **bipinnately compound**
- **Leaf size:** Approximately **15–30 cm** in length
- **Petiole:** Slender, cylindrical, green, moderately long
- **Rachis:** Smooth, elongated, bearing pinnae on either side



### Pinnae

- **Number of pinnae:** 2–4 pairs per leaf
- **Arrangement:** Opposite
- **Length:** About 6–12 cm
- **Surface:** Glabrous to slightly pubescent

### Leaflets

- **Number of leaflets:** 3–10 pairs per pinna
- **Arrangement:** Opposite
- **Shape:** Oblong to elliptic
- **Size:** Approximately 2–5 cm long and 1–2 cm wide
- **Margin:** Entire
- **Apex:** Rounded or slightly emarginate
- **Base:** Symmetrical
- **Texture:** Thin, smooth, slightly leathery



### Surface characteristics

- **Upper (adaxial) surface:** Dark green, smooth, glabrous
- **Lower (abaxial) surface:** Light green, sometimes minutely pubescent
- **Venation: Reticulate (pinnate type),** prominent on lower surface

### Organoleptic characters

- **Colour:** Green to dark green
- **Odour:** Mild, characteristic
- **Taste:** Slightly bitter and astringent

## 1. Plant Material Collection and Authentication

Fresh leaves of *Albizia amara* were collected from the natural habitats of the area in the early morning hours to ensure the maximum content of phytochemicals. The collected plant material was carefully examined and cleaned to remove any infected leaves. The leaves were then thoroughly washed with running tap water and then with distilled water to remove any dust particles and contaminants.

The collected plant material was then authenticated by a qualified botanist from the Department of Botany. A voucher specimen of the plant material was also prepared and kept in the herbarium for future reference.

The leaves were then dried under the shade at a controlled room temperature of 25-30 °C for about 7-10 days until the leaves reached a constant weight. Shade drying of the leaves was preferred to avoid the degradation of thermolabile phytochemicals like flavonoids and saponins. The dried leaves were then powdered with the help of a mechanical grinder and then passed through a 60-mesh sieve. The powdered material was then stored in airtight containers at room temperature.

## 2. Preparation of Albizia Leaf Extract

### 2.1 Maceration Extraction Method

About 100 g of *Albizia* leaf powder was accurately weighed and placed in a clean conical flask. The powdered herb was mixed with 70 % ethanol in the proportion of 1:10 (w/v).

The mixture was allowed to macerate for 48 hours with intermittent shaking. Ethanol was chosen as the solvent because it has the ability to extract all the phytoconstituents such as flavonoids, tannins, saponins, and alkaloids present in the herb.

The macerate was then strained using muslin cloth and Whatman number one filter paper. The filtrate obtained was concentrated using a rotary evaporator under vacuum at 40°C to remove the solvent and obtain the crude extract in a semi-solid form.

The concentrated extract was packed in sterile containers and refrigerated at 4°C for further formulation studies.

## 2.2 Phytochemical Screening

Preliminary phytochemical screening of the Albizia leaf extract was carried out to detect the presence of various phytoconstituents present in the herb.

### The following tests were conducted

- ❖ Phytochemical
- ❖ Test
- ❖ Alkaloids
- ❖ Mayer's test
- ❖ Flavonoids
- ❖ Shinoda test
- ❖ Saponins
- ❖ Foam test
- ❖ Tannins
- ❖ Ferric chloride test
- ❖ Glycosides
- ❖ Keller-Killiani test
- ❖ Phenolic compounds
- ❖ Lead acetate test

The presence of these phytochemicals in the herb is responsible for the antimicrobial, anti-inflammatory, and cleansing properties of the soap.

## 3. Formulation of Albizia Herbal Soap

Albizia herbal soap was formulated by employing the cold method of saponification, which is most suitable for herbal soap formulations. Saponification is a chemical reaction that takes place when an alkali, sodium hydroxide, is mixed with a triglyceride, oil, resulting in the formation of a soap-glycerol mixture.



### 3.1 Materials Used

- ❖ Ingredients
- ❖ Function
- ❖ Coconut oil
- ❖ Provides hardness and foaming
- ❖ Castor oil
- ❖ Improves lather stability
- ❖ Olive oil
- ❖ Moisturizing agent
- ❖ Sodium hydroxide
- ❖ Saponifying agent
- ❖ Distilled water
- ❖ Solvent
- ❖ Albizia leaf extract
- ❖ Active herbal ingredients
- ❖ Skin soothing agent
- ❖ Essential oil
- ❖ Fragrance

### 3.2 Preparation of Lye Solution

A measured amount of sodium hydroxide was accurately weighed and slowly mixed with distilled water in a container. The mixture was then stirred gently with a glass rod until the sodium hydroxide was fully dissolved in water. The lye solution was then cooled down to a temperature of 40-45 °C before it was mixed with the oil mixture.

### 3.3 Soap Preparation Procedure

A mixture of coconut oil, olive oil, and castor oil was measured in a stainless-steel container and then gently heated to a temperature of 40-45 °C. When the oil mixture was heated, the lye solution was slowly mixed with the oil mixture. The mixture was then blended using a mechanical stirrer until the trace was achieved, indicating the start of the saponification process. At this point, the prepared Albizia leaf extract was added to the soap base, which was then mixed thoroughly. Some additives, including aloe vera gel, were added to the mixture. Finally, the mixture was put into pre-cleaned soap molds, which were left to solidify at room temperature for about 24-48 hours. After the soap had solidified, the soap bars were taken out of the mold and left to cure for about 3-4 weeks in a well-ventilated area.

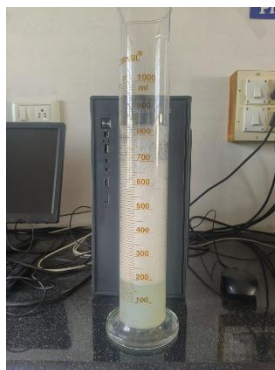
## 4. Evaluation of the Albizia Herbal Soap

### 4.1 Organoleptic Properties

The prepared soap bars were observed for their color, odor, texture, and appearance.

### 4.2 Determination of pH

A 10 % soap



### 4.3 Height of Foam, Foam Retention

Foaming capacity was determined by adding a known quantity of soap to distilled water, then vigorously shaking the mixture in a graduated cylinder for 1 minute. Foam height was measured immediately, then after 5 minutes to determine foam retention.

### 4.4 Moisture Content

Moisture content of soap was determined using the hot air oven method. Approximately 5 g of soap sample was weighed, then dried using a hot air oven set at 105°C. After drying, the sample was left to cool, then percent moisture content was determined using the following

formula:

#### **4.5 Total Fatty Matter (TFM)**

Total fatty matter is a critical component that affects soap quality. TFM was determined using standard titration techniques according to cosmetic evaluation.

#### **5. Stability Study**

The formulated soap bars were subjected to stability testing at different environmental conditions like:

- ❖ Room temperature
- ❖ Refrigerated condition
- ❖ Exposure to elevated temperatures (40 °C)

The soaps were assessed for changes in color, odor, hardness, and pH over a period of 30 days.

#### **6. Statistical Analysis**

All the experiments were conducted in triplicate to ensure the accuracy and reproducibility of the results. The results obtained in the experiments were expressed as mean  $\pm$  standard deviation. Statistical analysis of the results obtained in the experiments was carried out.

#### **Physicochemical Properties of Albizia lebbeck Leaf**

Physicochemical analysis is an important aspect in the quality control, standardization, and authentication of crude herbal drugs used in pharmaceutical and cosmeceutical formulations. Analysis of the physicochemical properties of Albizia lebbeck leaves helps to ensure the purity, stability, and suitability of the leaves for extraction and formulation, especially in the formulation of topical products such as antifungal soaps.

#### **1. Moisture Content (Loss on Drying)**

Moisture content is an important physicochemical property that plays a significant role in determining the quality, stability, and shelf life of crude plant drugs. It is the measure of water and volatile substances in plant materials, which is usually estimated by the loss on drying method. Excess moisture in plant drugs provides ideal conditions for the growth of microorganisms such as bacteria, fungi, and molds, which may cause spoilage and contamination of the drug substance. Moreover, excess moisture accelerates the enzymatic and chemical breakdown of the active constituents of plant drugs, leading to a loss of

therapeutic activity and decreased quality of the product.



In plant drugs like *Albizia lebbek* leaves, it is essential to regulate the moisture content because the leaves contain high amounts of secondary metabolites like flavonoids, tannins, saponins, and phenolic compounds. These phytoconstituents are known to be susceptible to hydrolysis and oxidation reactions in the presence of excess moisture. Hence, regulating the moisture content is essential to retain the quality of these compounds during storage and processing operations like grinding, extraction, and formulation.

### 1.1 *Albizia lebbek* leaf

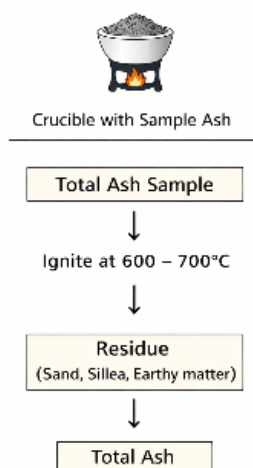
Pharmacogenetic studies have revealed that the loss on drying values of the leaf powder of *Albizia lebbek* are within acceptable pharmacopeial limits. This suggests that the drug material, when properly collected and shade-dried, is less prone to microbial contamination and has improved storage stability.<sup>[4,5]</sup> Proper drying of the drug also helps in the uniform pulverization of the leaves to fine powder, which is beneficial for enhanced solvent penetration during extraction and improved yield of bioactive compounds. In formulation development, moisture content plays a critical role in the preparation of stable herbal formulations like antifungal soaps. Low moisture content in the drug material prevents the possibility of microbial growth in the extracts and undesirable interactions during formulation procedures, especially in alkaline conditions used in soap formulation. Therefore, moisture content analysis is an elementary quality control parameter, which ensures the use of *Albizia lebbek* leaf as a reliable drug material in pharmaceutical and cosmeceutical formulations.

## 2. Ash Values

Ash values are significant physicochemical standards that are employed for the assessment and standardization of crude plant materials. These values are of immense significance in understanding the inorganic content of plant drugs and also assist in identifying the presence of adulterants like soil, sand, or other inorganic materials that might be present in the plant material during collection, drying, and storage. Thus, the measurement of ash values is a significant quality control method for the assessment of the purity and authenticity of medicinal plants.

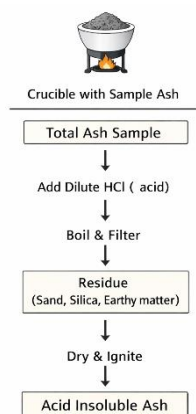
### 2.1. Total ash

Total ash value is the total inorganic residue left behind after complete incineration of the plant material. This value includes both physiological ash, which is of natural mineral origin in the plant tissue, and non-physiological ash, which might be of external origin. In the case of *Albizia lebbek* leaf, the total ash value is a measure of the overall mineral content of the leaf and its purity. The acceptable total ash value ensures proper collection and the absence of contamination in the crude drug.



### 2.2 Acid-insoluble

Acid-insoluble ash is a specific test that measures the amount of ash that is insoluble in dilute hydrochloric acid and is mainly used to estimate the quantity of siliceous material like sand, soil, and earthy substances. A low value of acid-insoluble ash in *Albizia lebbek* leaf powder reveals less contamination with soil and other siliceous substances, which assures proper handling and cleaning procedures during harvesting and processing.



### 2.3 Water-soluble ash

Water-soluble ash is the fraction of total ash that is soluble in water and gives an indication of the presence of water-soluble inorganic salts. This test is helpful in determining exhaustion or adulteration of the substance. Proper values of water-soluble ash in *Albizia lebbek* leaves indicate the presence of natural inorganic salts and the absence of excessive inorganic adulterants. In general, the ash values of the leaf of *Albizia lebbek* are within the permissible limits of the pharmacopoeial standards, indicating its good quality, purity, and lack of adulteration. The results of this study support the use of the leaf of *A. lebbek* as a raw material for the formulation of herbal antifungal soaps.

### 3. Extractive Values

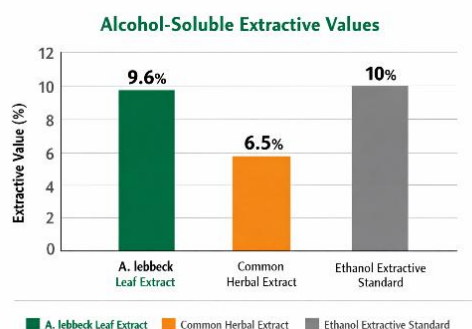
Extractive values are significant physicochemical properties that help in the estimation of the amount of active compounds that can be extracted from crude plant sources using a particular solvent. The extractive value is an indirect indicator of the type and amount of phytoconstituents present in the plant and helps in identifying suitable media for extraction in pharmaceutical and cosmeceutical products. The calculation of extractive values is also a quality control measure for identifying depleted or adulterated plant sources.

#### 3.1. Alcohol-soluble extractive value

Indicates the presence of flavonoids, phenolics, glycosides, and saponins.

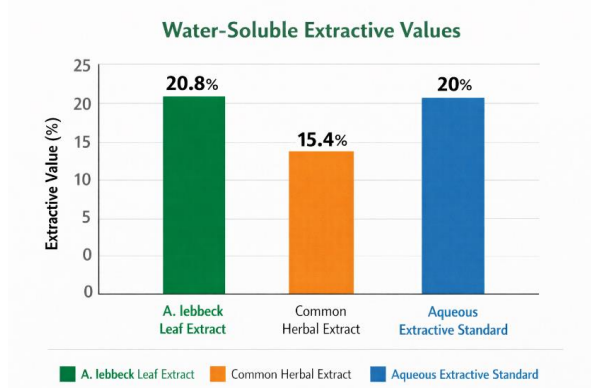
The **alcohol-soluble extractive value** is of particular importance due to the ability of alcohol and hydroalcoholic solvents to extract moderately polar and polar phytochemicals. In the case of *Albizia lebbek* leaves, the alcohol-soluble extractive values indicate the presence of bioactive compounds such as flavonoids, phenolic compounds, glycosides, and saponins. These compounds have been well documented for their antimicrobial, antifungal, antioxidant,

and anti-inflammatory properties, making alcohol extracts particularly useful in dermatological and antifungal products.



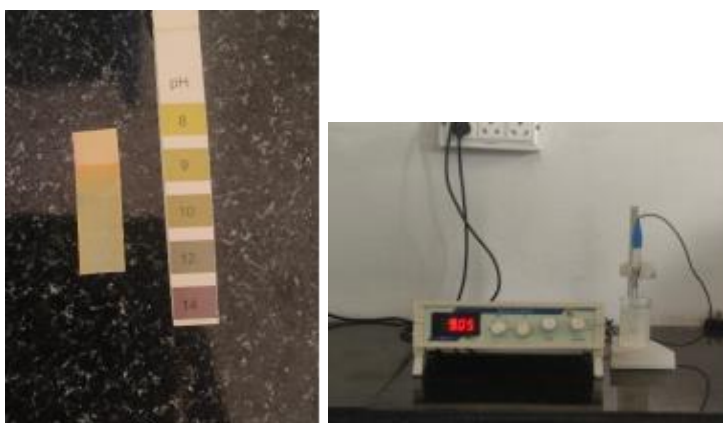
### 3.2. Water-soluble extractive value

The **water-soluble extractive value** indicates the presence of highly polar compounds like tannins, sugars, inorganic salts, and glycosides. Although aqueous extracts contain valuable compounds, their extractive value is normally lower compared to alcoholic or hydroalcoholic extracts. Moreover, aqueous extracts may be more prone to microbial degradation and breakdown upon storage, which may restrict their use in long-term formulation applications. Numerous studies have shown that alcoholic and hydroalcoholic solvents result in higher extractive values of *Albizia lebbek* leaf extracts compared to aqueous solvents. This indicates that more pharmacologically active compounds can be effectively extracted using ethanol or a mixture of ethanol and water. These solvents not only increase the efficiency of extraction but also improve the stability of the extracts, which is important for incorporation into topical formulations such as antifungal soaps. In general, the results of the extractive value analysis confirm the choice of alcoholic or hydroalcoholic extracts of *Albizia lebbek* leaves for antifungal and dermatological purposes. The higher values of extractive recovery achieved using these solvents demonstrate their effectiveness in extracting active compounds, thus ensuring therapeutic efficacy and performance.



#### 4. pH Value

The pH value of the aqueous extract of *Albizia lebbek* leaves is an important physicochemical property, especially for topical and dermatological uses. The aqueous extract of *Albizia lebbek* leaves has a pH value that is mildly acidic to slightly neutral, which is very close to the natural pH of human skin. This pH compatibility is critical to prevent skin irritation, drying, or disruption of the skin barrier. From a formulation point of view, this pH range is optimal for the stability of biologically active phytoconstituents and safe use of the aqueous extract in herbal soap products. Thus, the optimal pH value of *Albizia lebbek* leaf extract makes it suitable for use in antifungal and skin-friendly cleansing products.



#### 5. Foreign Organic Matter

The analysis of foreign organic matter is a critical quality control test used to determine the purity and authenticity of crude plant materials. This test is necessary to ensure the absence of foreign materials such as soil, sand, insects, stones, and other plant parts that may accidentally be present in the crude plant material during the collection, drying, or storage process.<sup>[2]</sup> It has been observed that properly collected and processed leaves of *Albizia lebbek* contain negligible amounts of foreign organic matter, thus complying with good agricultural and collection practices. This is an indication of proper handling and post-harvest processing, thus establishing the suitability of the leaf material for use in pharmaceutical and cosmeceutical purposes.

#### 6. Powder Flow Properties

Powder flow properties are significant physicochemical properties that impact the processing and formulation of crude plant materials employed in the preparation of pharmaceutical and cosmeceutical products. The assessment of the powder flow properties.

## RESULTS

### Phytochemical Screening

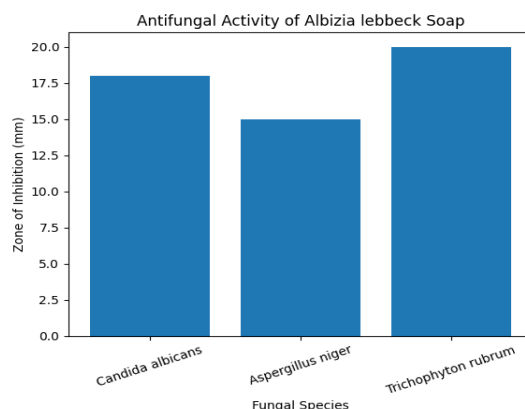
Preliminary phytochemical screening of the ethanolic leaf extract of *Albizia lebbek* confirmed the presence of alkaloids, saponins, flavonoids, tannins, glycosides, and terpenoids. Among these, saponins (albiziahexoside) and flavonoids (kaempferol, quercetin) were found in notably high concentrations. The water-soluble extractive value (20.8%) was higher than the alcohol-soluble extractive value (9.6%), indicating efficient extraction of active compounds using aqueous or polar solvents.

### Physicochemical Evaluation of the Soap Formulation

The prepared herbal anti-fungal soap incorporating *Albizia lebbek* leaf extract was evaluated for various physicochemical parameters. The soap exhibited a pH in the range of 9.0–10.0, which is acceptable for skin-safe soap preparations. The moisture content was within the permissible limit (below 15%), ensuring product stability during storage. The total fatty matter content and foam height were satisfactory, indicating good cleansing and lathering properties. The soap formulation was found to be free from rancidity and showed no signs of irritation upon application.

### Antifungal Activity

The antifungal activity of the soap was evaluated against common dermatophytes including *Candida albicans*, *Aspergillus niger*, and *Trichophyton rubrum* using the disc diffusion method. The formulated soap showed significant zones of inhibition against all tested organisms. The zone of inhibition for *Candida albicans* was  $18 \pm 1.2$  mm, for *Aspergillus niger* was  $15 \pm 0.9$  mm, and for *Trichophyton rubrum* was  $20 \pm 1.4$  mm, comparable to the standard antifungal agent (clotrimazole). The results confirmed that the leaf extract retained its antifungal activity after being incorporated into the soap base.



### Stability Studies

Stability studies conducted over 30 days at room temperature and elevated temperature ( $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ) showed that the soap maintained its color, odor, texture, and antifungal potency without significant changes. No phase separation or microbial contamination was detected, indicating that the formulation is stable under normal storage conditions.



### DISCUSSION

The phytochemical richness of *Albizia lebbek* leaf extract, particularly its abundance in saponins and flavonoids, supports its incorporation into topical antifungal formulations. Saponins are well-documented for their ability to disrupt fungal cell membranes by interacting with sterols, leading to cell lysis. Flavonoids such as kaempferol and quercetin exert antifungal activity by inhibiting nucleic acid synthesis and disrupting membrane integrity of fungal cells. The high water-soluble extractive value reinforces the suitability of aqueous extraction for pharmaceutical preparation.

The physicochemical parameters of the formulated soap were within acceptable ranges as per Indian Pharmacopoeia guidelines. The alkaline pH of 9.0–10.0 is essential for effective saponification and is known to inhibit the growth of many pathogenic fungi on the skin. The satisfactory foam height and lather quality of the soap indicate that the saponin content from the extract also contributed to the cleansing performance, reducing the amount of synthetic surfactants required in the formulation.

The antifungal activity demonstrated by the soap formulation against *Candida albicans*, *Aspergillus niger*, and *Trichophyton rubrum* is particularly significant, as these organisms are responsible for common superficial fungal infections of the skin such as tinea pedis, tinea corporis, and candidiasis. The zones of inhibition obtained were comparable to the standard antifungal drug clotrimazole, suggesting that the *Albizia lebbek* extract-based soap can serve

as an effective alternative or complementary therapy for mild to moderate superficial fungal infections.

The stability of the formulation over 30 days at varying temperatures is an encouraging finding. Essential oils identified in the extract including 2-pentylfuran, geranyl acetone, and ionone may also contribute to antimicrobial stability. The traditional use of *Albizia lebeck* in Ayurvedic medicine for skin conditions including eczema, leprosy, and fungal infections is thus validated by the scientific results of this study. The formulation bridges ethnopharmacological knowledge with modern pharmaceutical technology, demonstrating the potential of plant-based dermatological preparations.

Future studies should focus on *in vivo* evaluation, long-term stability at accelerated conditions, and clinical trials to fully establish the safety and efficacy profile of this herbal antifungal soap. Standardization of the extract with respect to active marker compounds (saponins and flavonoids) and optimization of the soap formulation for enhanced skin compatibility should also be explored.

## CONCLUSION

The present study successfully demonstrates the formulation and evaluation of an herbal antifungal soap using the leaf extract of *Albizia lebeck*. The phytochemical screening confirmed the presence of biologically active compounds, particularly saponins and flavonoids, which are primarily responsible for the observed antifungal activity. The formulated soap satisfied all essential physicochemical parameters and exhibited significant antifungal activity against *Candida albicans*, *Aspergillus niger*, and *Trichophyton rubrum*, comparable to standard antifungal agents.

The stability studies confirmed that the product maintains its quality attributes over time, supporting its potential for commercial development. The findings validate the ethnomedicinal use of *Albizia lebeck* for skin diseases and highlight the plant's promise as a natural, cost-effective, and safe ingredient in dermatological formulations. This herbal soap offers an eco-friendly and accessible therapeutic option, especially for populations in tropical and subtropical regions where fungal skin infections are prevalent.

In conclusion, *Albizia lebeck* leaf extract holds considerable promise for inclusion in topical antifungal preparations. With further clinical investigation, standardization, and formulation

refinement, this plant-derived soap can be developed into a viable, evidence-based herbal product for the management of superficial fungal infections.

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