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Formulation and Evaluation of Herbal Soap from Wood Apple

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Abstract
During the past two decades, invasive fungal infections have emerged as a major hazard to immunocompromised hosts. Patients with neoplastic disorders are at considerable risk for such infections as a result of their underlying illness and its therapy. In addition to being an important source of medicine, plants are essential to achieving WHO's objectives for the well-being of everyone. The Rutaceae family's Limonia acidissima L. (wood apple, elephant apple, and monkey fruit) has become one of the most prized plants as more people become conscious of natural products because of its many therapeutic uses. Certain sections of Limonia Acidissima L. exhibit distinct qualities. For example, essesial oil extracted from the plant's leaves exhibits antibacterial activity due to the presence of carvacrol and cyclodecandine compounds. Because of psoralene, shell exhibits antifungal action against both gram-positive and gram-negative bacteria. The greater moisture content of Limonia Acidissima L pulp makes it beneficial for skin. Saponins, flavonoids, amino acids, beta carotene, tannins, carbohydrates, vitamin B, and triterpene are among Limonia Acidissima L's other primary ingredients. Limonia Acidissima L. can be utilized in cosmetic goods since it contains elements that give them certain cosmetic qualities. This paper includes the information of formulation and evaluation of herbal soap which is based on anti-fungal properties. The soap is made from absolute herb i.e wood apple without any chemical constituents .

Keywords: fungal infection, wood apple, herbal soap, formulation and evaluation

Introduction

Mycoses, often known as fungal infections, are a broad category of illnesses brought on by harmful fungi that can affect both deep tissues like the bloodstream and internal organs as well as superficial tissues like the skin and mucosa. A subset of fungi, which are eukaryotic organisms that are widely distributed in the environment, have the potential to cause disease in specific situations, even if the majority of their species are safe commensals. Generally speaking, mycoses are divided into superficial, cutaneous, subcutaneous, and systemic (deep) infections according to the site of infection [1]. Mycoses, or fungal infections, can be broadly categorized according to the mechanism of entrance and the extent of tissue involvement. Among the primary categories are:

Types of fungal infection: - 1) superficial, 2) cutaneous, 3) subcutaneous, 4) systemic (deep) infection

Superficial fungal infection: Mycoses that are superficial These infections don't cause an immunological reaction because they just affect the skin's and hair's outermost layers. Typical instances consist of: Malassezia species are the cause of tinea versicolor. White piedra and black Piedra (hair shaft infections) These are frequently asymptomatic and usually benign.

Cutaneous fungal infection: - Mycoses of the Skin An immunological response is triggered by these illnesses, which affect the skin, hair, and nails. Dermatophytes, including species of Trichophyton, Microsporum, and Epidermophyton, are the main culprits. Some examples are as follows: Tinea corporis, often known as body ringworm Ankle pedis, or tinea pedis Tinea unguium (nail infection or onychomycosis).

Subcutaneous fungal infection: - Mycoses under the skin These infections affect the deeper dermis, subcutaneous tissue, or bone and arise when fungus is traumatized into the skin. Typical infections consist of: (induced by Sporothrix schenckii) Sporotrichosis Chromoblastomycosis Mycetoma.

systemic (deep) infection: - Deep (Systemic) Mycoses These are frequently fatal and can impact internal organs, particularly in people with weakened immune systems. Both opportunistic fungi and primary infections can cause systemic mycoses [2].

Common Symptoms of Fungal Infections (Skin, Nails, Mouth, or Genitals):[3]

- Itchy skin
- Red rash (often in a ring shape or with a clear center)
- Dry, flaky, or peeling skin
- Swelling, weight loss, blister
- Cracked or sore skin (especially in moist areas like between toes)
- Discolored or thick nails
- White patches in the mouth (oral thrush)
- Vaginal itching or thick, white discharge (vaginal yeast infection)

Natural Anti-Fungal Herb: - WOOD APPLE

Synonyms: - bel, elephant apple, monkey fruit, stone apple.

Biological source: - it is a fruit of **Limonia acidissima L**. native to the subcontinent and southeast Asia belonging to family- ***Rutaceae***

Geographical source: - India, southeast Asia, Shrilanka, Pakistan

therapeutic and cosmetic qualities are attributed to different sections of Limonia Acidissima L. The fruit of Limonia Acidissima L. is used to treat diarrhea and dysentery in place of bael [4] In India, fruit is widely used as a liver and heart tonic, as well as an effective cure for conditions including excessive cough, sore throat, and gum disease when it is not ripe. Research has examined the anti-tumor and antibacterial properties of wood apple leaves and stem bark, whereas pulp contains anti-inflammatory and antipyretic properties [5] The fruit includes saponins, which cause foaming, flavonoids, which provide antioxidant properties, and antifungal properties. The fruits of Limonia have also yielded glycosides, tannins, some coumarins, and tyramine derivatives. Antifungal substances like psoralene, xanthotoxin, 2, 6-dimethoxybenzoquinone, and osthenol are found in the fruit shells of Limonia Acidissima [6]

1.1Botanical Description of Limonia Acidissima L. [7]

Kingdom	Plantae
Sub-Kingdom	Tracheobionta
Superdivision	Spramatophyta
Division	Magnoliophyta
Class	Magnoliospida
Sub-class	Rosidae
Order	Sapindales
Family	Rutaceae
Genus	Limonia L.
Species	L. acidissima
Synonyms	bael, elephant apple, monkey fruit, stone apple.

1.2 Different Names of Limonia Acidissima L. [7]

State	**Names**
Marathi	Kauth, kavat, kovit, kaveet, sit-ranlimbi
Hindi	Beli, barnahi billan, barnasi.
English	Wood apple, elephant apple
Urdu	Kaitha
Tamil	Vilaa, vilanga
Telugu	Purupuvelaga
Sansikrit	Akshasasya, kapitthah
Kannada	Aruna mullu
Malayalam	Cherrukatnarragam
Arbic	Kabit
Tibetan	Kapita
Persian	Kabit

1.3 Description of different parts of wood Apple: -

1. Limonia Acidissima L. has alternating, dark-green, leathery, deciduous leaves that range in length from three to five inches. Usually born in tiny, loose, terminal, or lateral panicles, they are dull-red or greenish, minutely serrated, blunt, or notched.
2. The fruit has a woody, remarkably hard exterior that can be challenging to split, and it is round to oval, 5–12.5 cm wide. The fruit has a scurfy peel that is roughly 6 mm thick and is greyish-white in color.
3. The fruit has a woody, remarkably hard exterior that can be challenging to split, and it is round to oval, 5–12.5 cm wide. The fruit has a scurfy peel that is roughly 6 mm thick and is greyish-white in color. Large, sweet fruits characterize one of the two varieties, while little, acidic fruits do the same. The plant Limonia Acidissima L. has an aroma.
4. The rind has a greyish-white color and measures 6 mm in thickness. Its rind is a woody, incredibly hard outer shell that is quite challenging to break apart. A hammer is used to break through the wood-apple fruit's tough rind.[8]

1.4 Chemical Constituents of Different parts of Limonia Acidissima L: - [9,10,11]

Plant part	Chemical Constituents
pulp	Furocumarins, citric acid, minerals, alkaloids, fatty acids, sterols, xanthotoxol, xanthotoxin, marmin
Fruit	Polyphenols, saponins, vitamins, tannins, amino acids
Leaves	Alkaloids, gum and mucilage, essential oils
Seed	Carbohydrates, amino acid, proteins
Bark	Feronone
Shell	Psoralene, Xanthoxin
Unripe fruit	Stigmasterol

1.5 Pharmacological Activities of Limonia Acidissima L:-

Antifungal Activity: Using petroleum ether, chloroform, methanol, and water as extraction solvents, the pulp of the Feronia limonia Linn fruit exhibited antifungal activity against a variety of pathogenic fungi. An analysis of eight distinct fungi revealed that the plant's essential oil was effective against all of them [12].

Antimicrobial Action: Ethanolic extract from Limonia acidissima L. leaves has been shown to be effective against both Gram-positive and Gram-negative bacteria, which are responsible for the majority of bacterial infections.

The antibacterial activity was evaluated using the agar well diffusion technique against both Gram-positive and Gram-negative pathogens. The antibacterial activity of methanol extract was robust with significant inhibitory zones, whereas that of chloroform extract was weak to moderate, while hexane extract was less active [13].

Herbal Soaps: - Herbal soaps are free of artificial colors, fragrances, fluoride, and other ingredients that are included in commercial goods [14]. The plants selected for this study are known to have antibacterial qualities that help them fight off skin problems. Herbs are the natural products most commonly used to treat almost all diseases and skin issues because of their high therapeutic value, affordability, accessibility, and compatibility [15]. It can therefore be used in soap bases. Among the soap's benefits are its ability to be gentle on the skin, create a thick lather, prevent rashes, eczema, and scabies, treat infections like ringworm, and preserve the smoothness and evenness of the skin [16].

Uses :-[17]

1] In India, Limonia Acidissima L. is frequently used as a tonic for the liver and heart.
2] The pulp is applied as a poultice to deadly bug bites and stings.
3] It is used as a good treatment for hiccups, sore throats, gum disease, and diarrhea and dysentery.
4] Traditionally, Limonia acidissima stem bark ingredients (in paste form) are combined with water and applied primarily to the face. Regular use on the skin is thought to maintain a cool, smooth, fair, and well-textured complexion. Because it blocks UV radiation, it is also known to protect against skin cancer.

5. Materials and Methods: -

The Pulp: - The pulp of wood apples (Limonia acidissima) has been investigated as a useful natural ingredient in soap formulations because of its distinct phytochemical qualities and functional traits. Flavonoids, tannins, and phenolic acids are among the many bioactive substances found in pulp that give

the soap its antibacterial and antioxidant qualities. These qualities help prolong the soap's shelf life and support skin health by guarding against oxidative stress and microbiological infections [18].

Coconut Oil: - Coconut oil's distinct fatty acid structure and advantageous skin qualities make it an essential ingredient in the creation of herbal soap. The lathering and cleansing qualities of the soap are greatly enhanced by the presence of coconut oil, which is rich in lauric, myristic, and capric acids. Even in hard water, the hard bar of soap made from coconut oil during saponification generates a thick, foamy lather. It is also good for cleaning and protecting the skin because it has natural antibacterial and antifungal qualities. In herbal soap formulas targeted at dry or sensitive skin, coconut oil is particularly helpful because of its exceptional hydrating properties, which assist to avoid dryness and irritation [19].

Olive Oil:- Olive oil's excellent skin-nourishing qualities and gentle washing action make it a widely prized ingredient in the creation of herbal soap. Olive oil, which is abundant in monounsaturated fatty acids, especially oleic acid, and antioxidants like vitamin E and polyphenols, helps make a mild, hydrating soap that is perfect for dry, sensitive skin. Olive oil is used in soap formulation to create a softer bar with a creamy, low-lather profile that cleanses without removing the natural oils from the skin. It helps soothe irritated or damaged skin because of its emollient and anti-inflammatory qualities, which is in line with the objectives of herbal and therapeutic soap formulations [20].

Palm Oil: - The balanced composition of palm oil's saturated and unsaturated fatty acids, which give the soap its hardness, persistent lather, and moisturizing qualities, makes it an important ingredient in the creation of herbal soap. Palm oil is a perfect foundation oil for herbal soap formulations because it is high in palmitic and oleic acids, which create a firm bar of soap with good cleaning properties and a creamy foam. Additionally, it has natural antioxidants like vitamin E (tocopherols and tocotrienols), which help shield the skin and prolong the soap's shelf life. Because it can give soap a strong structure, palm oil is especially prized for balancing out softer oils like castor or olive oil, which are frequently used in herbal soaps [21].

Glycerine Base: - Glycerine, sometimes referred to as glycerol, is an essential component in soap production, especially for clear and hydrating soap bases. Its main function is that of a humectant, which draws and holds moisture from the surroundings to keep the skin hydrated and avoid dryness. Because of this, glycerine-based soaps are particularly good for dry or sensitive skin. Glycerine also adds to the soap's smooth texture and mildness, which improves its general skin-friendly qualities. Additionally, it facilitates the solubilization of other ingredients, enabling the soap's active chemicals, essential oils, and herbal extracts to be distributed evenly. Many herbal and natural soaps keep glycerine in order to optimize their moisturizing and therapeutic properties because it is a natural result of the saponification process.[22]

Menthol:- In herbal soap, menthol enhances the user experience with its characteristic minty aroma and cooling effect, making the soap particularly suitable for hot climates or after physical activity. Additionally, menthol exhibits mild antiseptic and antibacterial activity, contributing to the cleansing efficacy of the soap and supporting skin health. It is often combined with other herbal ingredients to amplify therapeutic benefits such as relief from skin discomfort and minor muscle aches[23].

Rosemary Extract:- The use of rosemary extract in herbal soap prolongs the product's shelf life without the need for artificial preservatives by preventing the growth of germs and fungi. Additionally, it promotes circulation, lessens inflammation, and aids in skin cleansing and toning. The soap's sensory appeal is further enhanced by the lovely herbal scent of rosemary, which makes it a popular choice in natural skincare formulations[24].

Sandalwood Oil:- Sandalwood oil's calming, antibacterial, and fragrant qualities make it a crucial component in herbal soap formulation. Sandalwood oil is prized for both its healing properties and its deep, woodsy scent. It is extracted from the heartwood of Santalum album. In herbal soap, it serves as a natural fragrance enhancer, adding a pleasant and soothing aroma that promotes stress reduction and relaxation[25].

Ritha:- ritha act as a Natural Surfactant/Cleansing agent, Ritha contains high levels of saponins, which are natural surfactants. These help in producing lather and effectively remove dirt and oils from the skin. It also act as a Foaming and Emulsifying agent, Helps in stabilizing foam and enhances the texture of the soap, contributing to consumer appeal without the use of synthetic foaming agents[26].

Sr. no.	Name of Herbs	Scientific Name	Use in Soap Formulation
1	Wood Apple pulp powder	Limonia Acidissima L	Anti-fungal agent (main herb)
2	Coconut oil	Cocos nucifera oil	Moisturizing and cleansing agent
3	Olive oil	Olea europaea fruit oil	Skin conditioning
4	Palm oil	Elaeis guineensis	Stabilizer, hardness, leayher creator
5	Menthol	5-methyl-2-(1-methylethyl)cyclohexanol; 2-isopropyl-5-methylcyclohexanol or p-methan-3-ol	Cooling and refreshing agent
6	Glycerine base	Glycerol	Humectants, skin protection, hardness
7	Rosemary	Rosmarinus officinalis L. and Salvia rosmarinus	preservative
8	Sandalwood oil	Santalum album L..	Natural fragrance
9	Ritha	Sapindus mukorossi	Foamimg and cleansing agent

6. Method of preparation: -

Step 1. Extraction of Pulp from the Fruit

- Take one fruit of wood apple ,wash it and cut into two pieces
- Remove the pulp from the fruit with the help of spatula and remove the fibrous material from the pulp by using sieve.

Step 2. Preparation of Powder from the pulp

- Add some pulp on the butter paper and dry it in freeze dryer or in sunlight. Then triturate the dry solid mass in mortar and pestle until the formation of fine powder.

- Sieve this powder by using 85 sieve number.

Step 3. Formulation of Soap

- Cut the glycerine soap base into small pieces, melt the soap base in beaker by using water bath.
- Add prepared wood apple powder to the melted soap base and add essential oils (like coconut oil, palm oil, olive oil), menthol , rosemerry extract and sandalwood oil for fragrance
- Pour the prepared soap mixture into the soap mold. then tap the mold to remove the air bubbles.
- Let the soap set and harden in the mold for 30 min. And remove the soap from the mold after 24 to 48 hours for best result and cut into bars.

7. Evaluation parameter of soap: -

Physical appearance: - The prepared herbal antifungal soap was visually inspected by its colour, appearance and shape.

PH:- The small amount of soap was mixed with distilled water and prepare soap solution. dip the PH paper into soap solution and check the colour changes to the PH chart provided. or the PH meter was calibrated and insert the probe into the soap solution and measure the PH reading.

Solubility: - Mix 1.5 gm of soap into 10 ml of distilled water and shake it for 3 min then observe the solubility result . If the soap dissolve quickly then it is soluble.

Foamability: - wet the hand by using water and rubbed the soap between the hand and observe the amount and stability of foam formed.

Foam Height: - Measure the foam height above the aqueous volume by applying 25 strokes after dissolving 0.4 grams of prepared soap in 50 ml of disttiled water in a 100 ml measuring cylinder.

Foam Retention: - 25 ml of the 1% soap solution were prepared and put into a 100 ml measuring cylinder. The cylinder was then shaken ten times, and the volume of foam was measured every minute for 4 to 5 minutes.

Skin Irritation test: - Mark a 2-square-centimeter region on the right dorsal surface. Apply herbal soap to the right side at the designated spot. At that point, no changes were made to the hand irritancy, erythema and edema were monitored for up to 24 hours before being reported.

Weight Variation: - weighed each of the ten soaps that were taken in order to determine the average weight of the herbal soap.

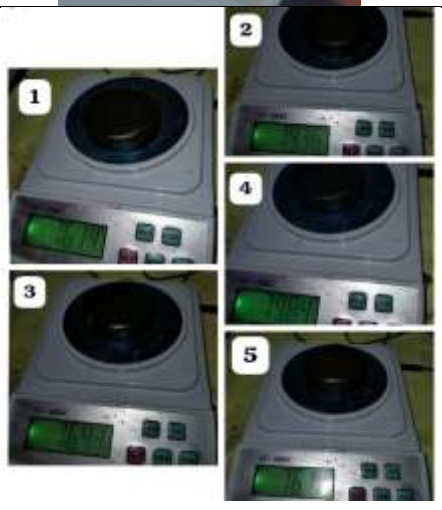
Percentage Yield: - The herbal soap formulation was kept in the empty container, and the container was weighed again with the herbal soap formulation inside. Percentage yield = practical yield / theoretical yield * 100

Stability: - ***1. Visual Inspection:*** Check for differences in appear, texture, or color over time. ***2. pH Testing:*** Maintain watch on pH values over time to ensure that they don't fluctuate. ***3. Temperature Test:*** Put soap in various temperatures (such as 40°C/104°F) for a while and see if anything changes.

4. Humidity Test: Keep soap in a moist environment and watch for any changes.

5. Shelf-Life Testing: Keep soap in a typical storage environment and check for adjustments on a regular basis. Minimal variations in appearance, pH, and performance over time are signs of stability

Sr.No.	Evaluation Test	observation	images
1	Physical appearance	Colour , shape Colour :- reddish brown Shape :- round, oval, square.	
2	PH	Slightly neutral PH= 7.45	
3	Solubility	1.5 gm of soap + 10 ml of distilled water and shake it for 3 min Result = partial soluble	
4	Foamability	wet hand by using water and rubbed the soap between the hand and observe the amount and stability of foam formed . Result = PASS	

5	Foam Height	0.4 gm soap in 50 ml of distilled water in 100 ml measuring cylinder. Result = 9cm.	
6	Foam Retention	25 ml of 1% soap solution put into a 100 ml measuring cylinder. The cylinder was then shaken ten times, and the volume of foam was measured every minute for 4 to 5 minutes. Result= Partial Retention	
7	Skin Irritation test	The soap is applied to hand,no changes were made to the hand irritancy, erythema and edema were monitored for up to 24 hours before being reported.	
8	Weight Variation	weighed each of the ten soaps that were taken in order to determine the average weight of the herbal soap. Weight variation - 1) 76.14 2) 79.36 3) 76.41 4) 79.84 5) 76.19	

9	Percentage Yield	percentage yield = Practical yield × 100 Theoretical yield 1. (76.14 / 85) × 100 = **89.57%** 2. (76.44 / 85) × 100 = **89.92%** 3. (79.36 / 85) × 100 = **93.37%** 4. (79.87 / 85) × 100 = **93.96%** 5. (79.84 / 85) × 100 = **93.93%**	
10	Stability	Humidity - this herbal soap is suitable for storage in humid environment. Temperature- the soap get melted at 40°c which shows moderate stability.	

8. Batches Table: -

No.	Ingredients	B1	B2	B3	B4	B5
1	Wood apple pulp powder	3.5 gm	4 gm	5 gm	5.5 gm	6 gm
2	Dry coconut oil	2 drops	2 drops	3 drops	3 drops	4 drops
3	Olive oil	2 drops	2 drops	3 drops	3 drops	4 drops
4	Palm oil	2 drops	2 drops	3 drops	3 drops	4 drops
5	Menthol	0.42 gm	0.85 gm	1 gm	1.5 gm	2 gm
6	Ritha	2 gm	2.5 gm	3 gm	4 gm	5 gm
7	Rosemary	1 gm	2 gm	2.5 gm	3 gm	3.5 gm
8	Sandalwood oil	q.s.	q.s.	q.s.	q.s.	q.s.
9	Glycerine base	85 gm	85 gm	85 gm	85 gm	85 gm

9. OBSERVATION TABLE: -

SR. NO.	**TEST COMPOUND CODE**	**ANTIMICROBIAL SENSITIVITY TEST AGAINST FUNGUS After 24 hrs at 37°C Temp.** ***(Zone of Inhibition in mm)***			
		FUNGUS			
1	**A**	**20 mm**	**17 mm**	**--**	**--**
2	**B**	**16 mm**	**16 mm**	**--**	**--**

3	**C**	**--**	**15 mm**	**--**	**--**
4	**Reference Fluconazole (10 mcg) for fungus**	**18 mm**	**17 mm**	**15 mm**	**18 mm**

10.RESULT&INTERPRETATION: -

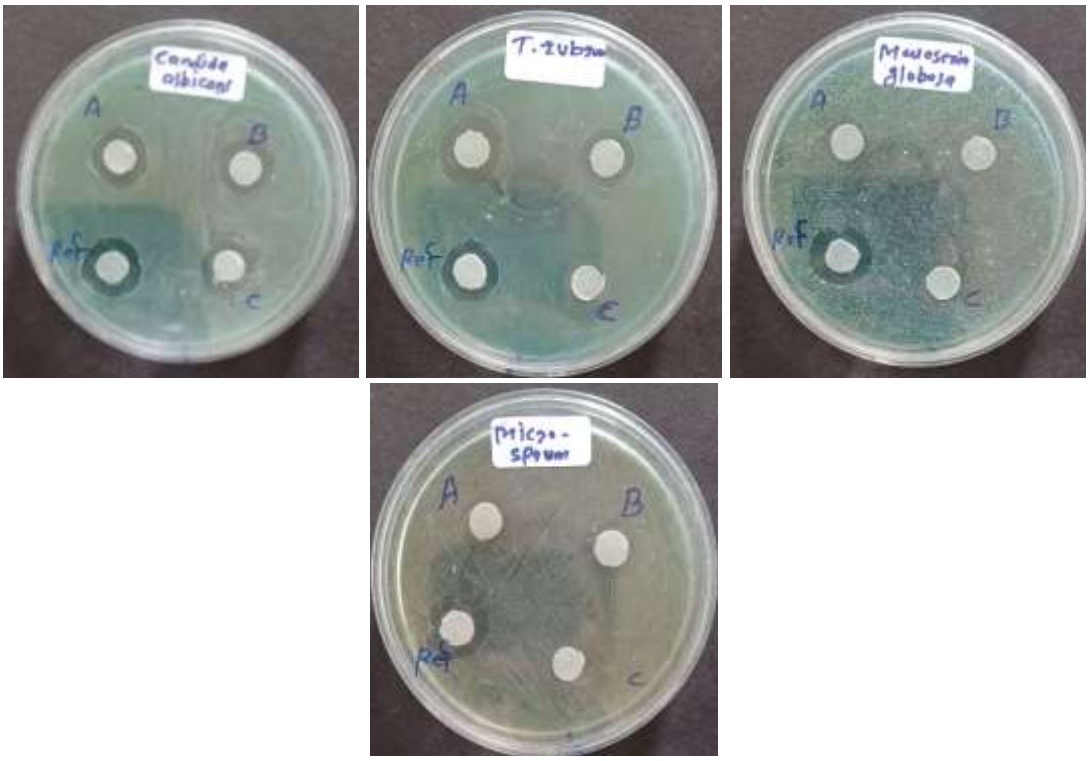
On the basis of antimicrobial testing performed, the zone of inhibition of given test compounds is **very good**, noted as above in the table.

10.1 Result: - The primary objective of this work was to develop Antifungal soap from pulp of ***Limonia acidissima L***. the development of such herbal formulation will mark an important advancement in the area of phytopharmaceutical. The current study looks at the creation and assessment of antifungal soap. The herbal antifungal soap were evaluated for various parameter such as physical appearance include colour and shape , PH, solubility, foamability, foam height, foam retention, skin irritation test, weight variation, percentage yeild and stability .

1. The colour of herbal antifungal soap was found to be Dark brown colour and shape of soap is round ,oval, square.
2. The PH of the herbal antifungal soap was found to be 7.42
3. The herbal antifungal soap was partial soluble in the water.
4. The herbal antifungal soap were pass the foamability test.
5. The foam height of herbal antifungal soap was found to be 9 cm .
6. The foam retention of herbal antifungal soap was found to be partial retention .
7. The herbal antifungal soap was pass the weight variation test. Individual weight of soap is 79.36, 76.41, 79.84, 76.14 and 70.19 having total weight is 381.94 and average weight is 76.38
8. The percentage yeild of herbal antifungal soap was found to be

percentage yield = Practical yield × 100
Theoretical yield

1. (76.14 / 85) × 100 = **89.57%**
2. (76.44 / 85) × 100 = **89.92%**
3. (79.36 / 85) × 100 = **93.37%**
4. (79.87 / 85) × 100 = **93.96%**
5. (79.84 / 85) × 100 = **93.93%**



12. Conclusion:

This study successfully demonstrates the formulation and evaluation of an herbal antifungal soap incorporating the pulp of Limonia acidissima L. (wood apple) as the primary active ingredient. The research highlights the therapeutic potential of wood apple, which contains a diverse array of bioactive phytochemicals such as saponins, flavonoids, and psoralenes, known for their antifungal and antimicrobial properties. In the formulation process, complementary natural ingredients including coconut oil, olive oil, palm oil, glycerin, menthol, rosemary extract, sandalwood oil, and ritha were integrated to enhance the soap's moisturizing, cleansing, stabilizing, and preservative functions. Evaluation parameters revealed that the soap maintained an acceptable pH range (6.1–7.3), exhibited satisfactory foamability, and passed physical, solubility, and irritation tests, confirming its safety and usability. Additionally, the formulation showed stability under varying environmental conditions and presented consistent physical and functional attributes, suggesting commercial viability. The average weight of the soap was consistent, and a high percentage yield affirmed the efficiency of the preparation process.In conclusion, the herbal soap developed using Limonia acidissima L. pulp offers a natural and effective alternative for combating superficial fungal infections. It underscores the potential of phytopharmaceutical formulations in promoting sustainable, chemical-free personal care solutions. Further clinical evaluation may validate its broader therapeutic applications and pave the way for its commercial production.

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