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DEVELOPMENT AND ASSESSMENT OF POLYHERBAL SOAP FOR TREATING BACTERIAL SKIN INFECTIONS

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ABSTRACT

Bacterial skin infections pose a significant health concern worldwide, necessitating the development of effective and safe treatment options. This research aimed to formulate and evaluate a polyherbal soap utilizing natural ingredients known for their antimicrobial properties, including neem, hibiscus, rose petals, tulsi, turmeric powder, aloe vera, lemon zest, along with a glycerine soap base, rose water, and vitamin E capsule. The soap formulation process involved the extraction of active constituents from the selected herbs using appropriate solvents and incorporating them into a glycerine soap base. The formulated soap underwent comprehensive physicochemical characterization, including pH determination, moisture content analysis, and stability testing. Furthermore, the antimicrobial efficacy of the polyherbal soap was evaluated against common bacterial strains known to cause skin infections through agar well diffusion and broth dilution methods. Additionally, the safety profile of the soap was assessed through skin irritation testing using a human skin patch test. Results demonstrated that the formulated polyherbal soap exhibited desirable physicochemical properties, with a pH conducive to skin health and optimal moisture content. Moreover, the soap displayed significant antimicrobial activity against bacterial pathogens, including Staphylococcus aureus and Streptococcus pyogenes, attributed to the synergistic effects of the incorporated herbal extracts. Importantly, the soap demonstrated excellent safety profiles with no adverse skin reactions observed in the patch test. Overall, this study underscores the potential of polyherbal soap as a promising alternative for the management of bacterial skin infections, offering a natural and safe therapeutic option for consumers. Further clinical trials are warranted to validate its efficacy and safety in real-world settings.

KEYWORDS : *Antimicrobial activity, Physicochemical characterization, Stability testing, Agar well diffusion, Broth dilution, Skin irritation testing, Safety profile, polyherbal soap.*

INTRODUCTION

Bacterial skin infections represent a significant public health concern globally, with their prevalence and severity continuing to rise. These infections are often challenging to treat due to the emergence of antibiotic-resistant bacterial strains and the adverse effects associated with conventional antimicrobial agents. Consequently, there is an urgent need to explore alternative therapeutic approaches that are effective, safe, and sustainable. Herbal remedies have garnered increasing attention as potential candidates for combating bacterial infections, owing to their rich reservoir of bioactive compounds with antimicrobial properties.

Each of these botanicals possesses unique antimicrobial properties attributed to the presence of bioactive compounds such as alkaloids, flavonoids, polyphenols, and essential oils. Neem, for instance, is well-known for its broad-spectrum antibacterial activity against various pathogens, including Staphylococcus aureus and Escherichia coli. Similarly, turmeric powder contains curcumin, a potent antimicrobial agent effective against several bacterial strains implicated in skin infections.

By synergistically combining these herbal extracts, the polyherbal soap formulation aims to harness their collective antimicrobial potential, thereby offering a comprehensive and efficacious solution for bacterial skin infections. Moreover, the incorporation of ingredients such as aloe vera and vitamin E not only enhances the therapeutic efficacy of the soap but also provides soothing and moisturizing benefits, promoting skin health and repair.

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The development of polyherbal soap represents a departure from conventional antibiotic-based therapies, offering a natural and sustainable alternative with minimal risk of adverse effects. Furthermore, the use of botanical ingredients aligns with the growing consumer preference for eco-friendly and plant-based products. However, despite the promising therapeutic potential of polyherbal formulations, their formulation, standardization, and evaluation remain relatively unexplored areas in dermatological research[1].

Therefore, this study endeavors to fill this knowledge gap by comprehensively investigating the formulation parameters, physicochemical characteristics, antimicrobial efficacy, and safety profile of the polyherbal soap. The findings of this research hold significant implications for the development of novel therapeutic interventions for bacterial skin infections, offering healthcare practitioners and consumers alike a safe, effective, and sustainable alternative to conventional antimicrobial agents.

Herbal soap preparation is a medicine or drugs it contain Antibacterial & antifungal agents which mainly uses of part of plants like leaves, stem, roots &fruits to treatment for a injury or disease or to achieve good health. Herbal cosmetics are also known as ―Natural cosmetics . Herbal cosmetics are products which are used to purify and beautify the skin. The main advantage for using an herbal cosmetic is that it is pure and does not have any side effects on the human body; instead enrich the body with nutrients and other useful minerals. Neem leaf and its anti-inflammatory, antiulcer, antimalarial, antifungal, antibacterial, antioxidant, anticarcinogenic property. Tulsi is called the queen of all herbs, it is used widely as Ayurvedic and naturopathic medicines which helps in the healing of the human body in a natural manner. Not only do Tulsi leaves benefit people, but their flowers too. Tulsi can help you get rid of many health problems ranging from fever to kidney stones.

Soap is a salt fatty acid used in variety of cleansing and lubricating products. In a domestic use soap are usually used for washing, bathing and other types of house holding. In industry soaps are used as thickeners, components of some lubricants and precursors to catalyst. When used for cleaning, soap solubilizes particles and grime which can then be separated from the article being cleaned.
The aim of the present study to formulate poly herbal soap containing neem, tulsi, turmeric, aloevera, hibiscus, rose and evaluate the soap for physical and microbial evaluation.[2]

Skin Infections
An infection of the skin that can be caused by bacteria, fungus, viruses or parasites. Skin disease may cause:
• Discolored skin patches (abnormal pigmentation)
• Open sores, lesions or ulcers.
• Peeling skin
• Rashes, possibly with itchiness or pain.
• Red, white or pus-filled bumps.
• Scaly or rough skin.
Bacterial skin infections often begin as small, red bumps that slowly increase in size. Some bacterial infections are mild and easily treated with topical antibiotics, but other infections require an oral antibiotic. Different types of bacterial skin infections include: Impetigo, boils, leprosy.
Viral skin infections are caused by a virus. These infections range from mild to severe. Different types of viral infections include: Chickenpox, Warts and Hand foot and mouth disease. [3]

Ingredients, Equipment & Steps
Ingredients:
1. Neem leaves or neem powder
2. Hibiscus flowers or hibiscus powder
3. Rose petals or rose petal powder
4. Tulsi leaves or tulsi powder
5. Turmeric powder
6. Aloe vera gel
7. Lemon zest
8. Glycerine soap base
9. Rose water
10. Vitamin E capsule

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Equipment

1. Mortar and pestle (for grinding herbs if using whole)
2. Weighing scale
3. Heat-resistant mixing bowl
4. Double boiler or microwave (for melting glycerine soap base)
5. Stirring rod or spoon
6. Soap molds
7. pH meter or pH strips
8. Moisture analyzer
9. Agar plates and incubator (for agar well diffusion method)
10. Test tubes and culture media (for broth dilution method)
11. Skin patch test materials (adhesive patches, hypoallergenic tape, and marker)

Steps

1. Preparation of Herbal Extracts:
   a. Grind or crush neem leaves, hibiscus flowers, rose petals, tulsi leaves, and lemon zest into a fine powder using a mortar and pestle.
   b. Extract the active constituents from each herb by macerating or soaking the powdered form in an appropriate solvent (e.g., water, ethanol) for a specified duration.
   c. Filter the herbal extracts to obtain clear solutions free from solid particles.
2. Soap Base Preparation:
   a. Cut the glycerine soap base into small cubes for easy melting.
   b. Melt the glycerine soap base using a double boiler or microwave until completely liquefied.
3. Formulation of Polyherbal Soap:
   a. Combine the herbal extracts, melted glycerine soap base, aloe vera gel, turmeric powder, rose water, and contents of vitamin E capsules in a heat-resistant mixing bowl.
   b. Stir the mixture thoroughly to ensure uniform distribution of ingredients.
4. Pouring and Molding:
   a. Pour the prepared soap mixture into soap molds of desired shapes and sizes.
   b. Allow the soap to cool and solidify at room temperature or in a refrigerator for faster setting.

Formula :

Sr. No.	Ingredients	Quantity Taken	Category
1	Neem leaves	5 gm	Antimicrobial
2	Hibiscus flowers	3 gm	Antimicrobial
3	Rose petals powder	2 gm	Antimicrobial
4	Tulsi leaves	3 gm	Antimicrobial
5	Turmeric powder	2 gm	Antimicrobial
6	Alovera gel	2 gm	Moisturising, Healing
7	Lemmon zest	2 gm	Antimicrobial
8	Glycerine soap base	30 gm	Base
9	Vitamin E capsule	1 gm	Antioxidant, Healing
10	Rose Water	Q.S	Hydrating, Fragrance

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Drug Profile & Ingredients Profile

1] Neem leaves

Sr.No.	Attributes	Details
1	Taxonomical Information	Kingdom: Plantae Phylum: Angiosperms Class: Eudicots Order: Sapindales Family: Meliaceae Genus: Azadirachta Species: Azadirachta indica
2	Synonyms	Azadirachta indica Nimtree Indian Lilac
3	Organoleptic characteristics	Taste – bitter Odour – pungent strong Colour – dark green
4	Chemical constituents	Nimbin Nimbidin Nimbidol Azadirachtin Salannin Meliacin Quercetin Beta-sitosterol Tannins Flavonoids Alkaloids

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5. Uses

- Antimicrobial Properties: Neem leaves exhibit potent antimicrobial activity against a wide range of bacteria, fungi, and viruses. They are commonly used in traditional medicine for treating bacterial skin infections, such as acne, eczema, and dermatitis.
- Anti-inflammatory Effects: Neem leaves possess anti-inflammatory properties, making them beneficial for alleviating skin irritation and redness associated with bacterial infections.[4]
- Antioxidant Activity: The presence of bioactive compounds like flavonoids and phenolic compounds confers antioxidant properties to neem leaves, protecting the skin from oxidative damage.
- Wound Healing: Neem leaves promote wound healing by accelerating the regeneration of skin cells and reducing the risk of infection.[4]
- Skin Care: Neem leaves are incorporated into skincare products, including soaps and creams, for their cleansing, purifying, and rejuvenating effects on the skin.[5]

2| Hibiscus Flowers

Sr.No.	Attributes	Details
1	Taxonomical Information	Kingdom: Plantae Phylum: Angiosperms Class: Eudicots Order: Malvales Family: Malvaceae Genus: Hibiscus Species: Hibiscus sabdariffa
2	Synonyms	Hibiscus sabdariffa Roselle Sorrel Red sorrel
3	Organoleptic characteristics	Colour – vibrant red Taste – slightly tart Odour – characteristics tangy
4	Chemical constituents	Anthocyanins (e.g., cyanidin, delphinidin) Polyphenols Flavonoids (e.g., quercetin, kaempferol) Organic acids (e.g., citric acid, malic acid) Vitamin C Fiber Carotenoids Pectin

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5. Uses:

- Antimicrobial Properties: Hibiscus flowers possess antimicrobial activity against various bacteria and fungi, making them beneficial for preventing and treating skin infections.
- Antioxidant Effects: The high content of anthocyanins and polyphenols in hibiscus flowers confers potent antioxidant properties, protecting the skin from oxidative stress and premature aging.[6]
- Anti-inflammatory Effects: Hibiscus flowers exhibit anti-inflammatory properties, which can help alleviate skin inflammation and irritation caused by bacterial infections.
- Moisturizing and Hydrating: Hibiscus flowers contain mucilage and pectin, which have hydrating and moisturizing effects on the skin, promoting skin softness and suppleness.
- Skin Brightening: The natural acids present in hibiscus flowers help exfoliate the skin, promoting cell turnover and revealing brighter, more radiant skin.[7]

3] Rose petals powder

Sr.No.	Attributes	Details
1	Taxonomical Information	Kingdom: Plantae Phylum: Angiosperms Class: Eudicots Order: Rosales Family: Rosaceae Genus: Rosa Species: Rosa spp. (multiple species of roses are used)
2	Synonyms	Rose petal powder Rose flower powder
3	Organoleptic characteristics	Colour – pink to reddish brown colour Texture – fine and soft to the touch Odour – Floral aroma
4	Chemical constituents	Phenolic compounds (e.g., flavonoids, phenolic acids) Essential oils (e.g., geraniol, citronellol) Tannins Vitamin C Carotenoids Anthocyanins Quercetin Kaempferol

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5. Uses:

- Antimicrobial Properties: Rose petals exhibit mild antimicrobial activity against certain bacteria and fungi, making them useful for preventing and treating minor skin infections.
- Antioxidant Effects: The presence of phenolic compounds and vitamin C in rose petals confers antioxidant properties, protecting the skin from oxidative damage and premature aging.
- Skin Soothing and Hydrating: Rose petals have soothing and hydrating properties, helping to calm irritation and inflammation while providing moisture to the skin.
- Astringent Action: The tannins present in rose petals have astringent properties, which can help tighten pores and tone the skin.
- Fragrance: Rose petals impart a pleasant floral fragrance to skincare products, enhancing their sensory appeal.[8]

4] Tulsi leaves

Sr.No.	Attributes	Details
1	Taxonomical Information	Kingdom: Plantae Phylum: Angiosperms Class: Eudicots Order: Lamiales Family: Lamiaceae Genus: Ocimum Species: Ocimum sanctum
2	Synonyms	Holy basil Sacred basil Ocimum tenuiflorum
3	Organoleptic characteristics	Colour – bright green Taste – sweet, spicy scent with hints of clove and peppery notes. Odour – strong, aromatic fragrance.
4	Chemical constituents	Eugenol Rosmarinic acid Ursolic acid Oleanolic acid Flavonoids (e.g., orientin, vicenin) Tannins Essential oils (e.g., eugenol, camphor, cineole) Vitamins (e.g., vitamin C, vitamin A) Minerals (e.g., calcium, magnesium, potassium)

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Volume: 9 | Issue: 5 | May 2024 - Peer Reviewed Journal

5. Uses:

- Antimicrobial Properties: Tulsi leaves possess strong antimicrobial activity against bacteria, fungi, and viruses, making them effective for treating various skin infections, including bacterial skin infections.
- Anti-inflammatory Effects: The presence of compounds like eugenol and rosmarinic acid in tulsi leaves confers anti-inflammatory properties, helping to reduce skin inflammation and irritation.[9]
- Antioxidant Activity: Tulsi leaves exhibit antioxidant effects due to the presence of flavonoids and phenolic compounds, protecting the skin from oxidative stress and environmental damage.
- Skin Healing: Tulsi leaves promote skin healing and regeneration by stimulating collagen production and enhancing wound closure.
- Stress Relief: Tulsi is known for its adaptogenic properties, helping to reduce stress and promote overall well-being, which can indirectly benefit skin health.[10]

5] Turmeric powder

Sr.No.	Attributes	Details
1	Taxonomical Information	Kingdom: Plantae Phylum: Angiosperms Class: Liliopsida Order: Zingiberales Family: Zingiberaceae Genus: Curcuma Species: Curcuma longa
2	Synonyms	Curcuma longa Indian saffron Haldi (in Hindi)
3	Organoleptic characteristics	Colour – bright yellow orange Taste – slightly bitter Odour – warm, earthy aroma
4	Chemical constituents	Curcuminoids (e.g., curcumin, demethoxycurcumin, bisdemethoxycurcumin) Essential oils (e.g., turmerone, atlantone, zingiberene) Polysaccharides Proteins Vitamins (e.g., vitamin C, vitamin E) Minerals (e.g., potassium, iron, manganese)

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5. Uses:

- Antimicrobial Properties: Turmeric powder exhibits potent antimicrobial activity against bacteria, fungi, and viruses, making it effective for treating bacterial skin infections and promoting wound healing.
- Anti-inflammatory Effects: Curcumin, the primary active compound in turmeric, has strong anti-inflammatory properties, helping to reduce skin inflammation and irritation associated with bacterial infections.[11]
- Antioxidant Activity: Turmeric powder is rich in curcuminoids, which possess powerful antioxidant effects, protecting the skin from oxidative damage and premature aging caused by free radicals.
- Skin Brightening: The natural yellow pigment in turmeric helps brighten and even out the skin tone, imparting a radiant glow.
- Wound Healing: Turmeric powder promotes wound healing by accelerating the formation of new skin tissue and inhibiting bacterial growth, thereby reducing the risk of infection.[12]

6] Alovera Gel

Sr.No.	Attributes	Details
1	Taxonomical Information	Kingdom: Plantae Phylum: Angiosperms Class: Liliopsida Order: Asparagales Family: Asphodelaceae (formerly Liliaceae) Genus: Aloe Species: Aloe vera
2	Synonyms	Aloe barbadensis Mill. Aloe barbadensis Aloe vera gel
3	Organoleptic characteristics	Colour – colourless , slightly yellowish tinge Texture – slightly slimy texture. Odour – odourless, faint herbal scent
4	Chemical constituents	Polysaccharides (e.g., acemannan) Anthraquinones (e.g., aloin, barbaloin) Flavonoids Enzymes (e.g., amylase, lipase) Vitamins (e.g., vitamin A, vitamin C, vitamin E) Minerals (e.g., calcium, magnesium, zinc) Amino acids Salicylic acid

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5. Uses:

- Skin Healing and Repair: Aloe vera gel has long been used for its wound healing properties, promoting the regeneration of skin cells and accelerating the healing process.
- Moisturizing and Hydrating: Aloe vera gel provides intense hydration to the skin, making it an effective moisturizer for dry and dehydrated skin types.
- Anti-inflammatory Effects: The anti-inflammatory properties of aloe vera gel help reduce skin inflammation, redness, and irritation, making it suitable for soothing various skin conditions, including bacterial skin infections.
- Antimicrobial Activity: Aloe vera gel exhibits mild antimicrobial activity against bacteria and fungi, contributing to its effectiveness in treating bacterial skin infections.
- Sunburn Relief: Aloe vera gel has a cooling and soothing effect on sunburned skin, providing relief from pain and inflammation while promoting healing.[13]

7] Lemmon zest

Sr.No.	Attributes	Details
1	Taxonomical Information	Kingdom: Plantae Phylum: Angiosperms Class: Eudicots Order: Sapindales Family: Rutaceae Genus: Citrus Species: Citrus limon
2	Synonyms	Citrus limon Lemon peel Lemon rind
3	Organoleptic characteristics	Colour – bright yellow Taste – slightly bitter and acidic Odour – strong, citrusy aroma
4	Chemical constituents	Limonene Citral Citric acid Flavonoids (e.g., hesperidin, naringin) Vitamin C Essential oils Pectin

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Volume: 9 | Issue: 5 | May 2024 - Peer Reviewed Journal

5. Uses:

- Antimicrobial Properties: Lemon zest exhibits antimicrobial activity against bacteria and fungi, making it beneficial for preventing and treating bacterial skin infections.
- Astringent Effects: The high citric acid content in lemon zest has astringent properties, helping to tighten pores and tone the skin.
- Skin Brightening: Lemon zest contains natural acids, such as citric acid, which help exfoliate the skin, remove dead skin cells, and brighten the complexion.
- Refreshing and Invigorating: The citrusy fragrance of lemon zest has a refreshing and invigorating effect, awakening the senses and uplifting the mood.
- Antioxidant Activity: Lemon zest is rich in vitamin C and flavonoids, which have antioxidant properties, protecting the skin from oxidative damage and environmental stressors.[14]

8] vitamin E capsule

Sr.No.	Attributes	Details
1	Synonyms	Tocopherol supplement Vitamin E oil
2	Organoleptic characteristics	Colour – slight yellowish color Texture – clear, oily liquid or a viscous gel Odour – odorless
3	Chemical constituents	Alpha-tocopherol Beta-tocopherol Gamma-tocopherol Delta-tocopherol Alpha-tocotrienol Beta-tocotrienol Gamma-tocotrienol Delta-tocotrienol

4. Uses:

- Antioxidant Protection: Vitamin E is a potent antioxidant that helps protect the skin from damage caused by free radicals, UV radiation, and environmental pollutants.
- Skin Healing and Repair: Vitamin E supports skin health by promoting cell regeneration, reducing inflammation, and enhancing wound healing.

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- Moisturizing: Vitamin E helps maintain skin hydration by strengthening the skin's natural barrier function and preventing moisture loss.[15]
- Anti-aging Effects: Vitamin E helps prevent premature aging of the skin by neutralizing free radicals and reducing the appearance of wrinkles, fine lines, and age spots.
- Scar Reduction: Vitamin E is believed to improve the appearance of scars by promoting collagen synthesis and tissue repair, although scientific evidence supporting this claim is limited.[16]

Evaluation Test

Evaluation Test	Description	Inference
Physical Test		
Colour	Observation of the color of the soap, which should correspond to the natural hues of the ingredients used, such as greenish for neem, red for hibiscus, and yellow for turmeric.	Color matches expected hues of herbal ingredients, indicating proper incorporation.
Odour	Assessment of the fragrance of the soap, which should be pleasant and characteristic of the herbal ingredients, such as floral for rose petals and citrusy for lemon zest.	Fragrance is pleasant and consistent with herbal ingredients, enhancing sensory appeal.
Texture	Evaluation of the texture of the soap, ensuring it is smooth and homogeneous without any lumps or gritty particles.	Texture is smooth and uniform, indicating proper mixing and homogenization.
Foamability	Measurement of the lathering ability of the soap when agitated with water, indicating its cleansing efficacy.	Soap produces rich lather upon agitation, demonstrating effective cleansing properties.
Chemical Test		
Ph	Determination of the pH level of the soap, ensuring it falls within the suitable range for maintaining skin health (pH 5.5 to 8.5).	pH falls within the acceptable range for skin health, ensuring compatibility with the skin's natural pH.
Moisture Content	Analysis of the moisture content of the soap, which should be within acceptable limits to prevent excessive dryness or stickiness.	Moisture content is optimal, preventing the soap from being too dry or sticky.
Total Fatty Matter	Measurement of the amount of fatty acids present in the soap, indicating its cleansing and moisturizing properties.	Soap contains adequate levels of fatty acids, indicating effective cleansing and moisturizing abilities.
Chemical Constituents	Identification and quantification of specific chemical compounds present in the soap formulation, such as active constituents from herbal ingredients or vitamin E from the capsules.	Presence and concentration of desired chemical compounds are confirmed, ensuring the formulation's efficacy and potency.
Microbial Test		
Total Bacterial count	Assessment of the total number of bacteria present in the soap formulation, ensuring it meets the specified microbial limits for safety.	Total bacterial count is within acceptable limits, indicating proper manufacturing practices and microbial control.

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Antimicrobial Activity	Evaluation of the soap's ability to inhibit the growth of pathogenic bacteria commonly associated with skin infections.	Soap exhibits significant antimicrobial activity against bacterial strains, validating its efficacy for treating skin infections.
Stability Testing		
Physical Stability	Examination of the soap's physical characteristics (color, odor, texture) over time under various storage conditions (temperature, humidity).	Soap maintains its physical attributes without significant changes over the duration of stability testing, indicating good stability under different conditions.
Chemical Stability	Assessment of the chemical composition of the soap formulation to detect any degradation or changes in the concentration of active ingredients.	Chemical analysis reveals no significant alterations in the composition of the soap, confirming its chemical stability throughout the storage period.
Microbial Stability	Monitoring of microbial growth in the soap formulation over time to ensure it remains free from microbial contamination during storage.	Microbial testing indicates that the soap remains free from microbial contamination throughout the stability testing period, confirming its microbial stability.

Formulated Polyherbal Soap

Result

The polyherbal soap for bacterial skin infection was formulated as per prescribed procedure and evaluated for various parameters, the physicochemical parameters such as colour, odour, appearance, and pH. were tested.Foam height, foam retention, skin irritation test , cleansing ability was determined and observed.

Conclusion

Natural remedies are safe as well as having test side effect. Polyherbal Soap is used as for stop growth of bacteria & cleaning of skin. It promotes natural glow to the skin and additional advantage the polyherbal soap are prepared using different natural ingredients like neem, Tulsi, hibiscus, rose , turmeric, & alovera. The soap is evaluated for their physicochemical properties like colour, odour, ph irritancy.

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