



To Explore The Cosmetic Potential Of Bermuda Grass (*Cynodon dactylon*) Through Herbal Soap

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ABSTRACT:

The current research is focused on developing and assessing an anti-microbial herbal soap with an ethanolic extract of *Cynodon dactylon*, a herb recognized for its ancient medicinal value and wide-spectrum antimicrobial potential. With the aim to increase an awareness about the adverse effects of synthetic chemicals used in personal care products, this study responds to the pressing demand for efficient, safe and environmentally friendly substitutes. The soap formulation used a blend of natural oils and humectants like coconut oil, glycerin, stearic acid and ethanol to impart maximum lathering, transparency and skin moisturization, whereas the *Cynodon dactylon* extract was employed as the active antimicrobial ingredient. Phytochemical analysis of the extract proved the availability of major bioactive compounds viz. flavonoids, alkaloids, tannins, glycosides, phenols and terpenoids which are known for their antimicrobial, anti-inflammatory and antioxidant activities. The anti-microbial activity of the extract was confirmed using agar well diffusion technique, exhibiting remarkable inhibition zones of against *E. coli* and against *S. aureus*, reflecting efficient antibacterial activity. Testing of the formulated soap for major parameter like pH, foam stability, saponification value, total fatty matter content, free alkali content, and alcohol insoluble matter absence proved its physicochemical stability and skin friendliness. The current research not only identifies the potential of *Cynodon dactylon* as a natural antimicrobial agent but also helps in the formulation of sustainable herbal products in the cosmetics and pharmaceutical sectors.

Keywords: Anti-microbial, bermuda grass, *cynodon dactylon*, herbal soap, soap.

Introduction

Skin is the largest organ of the body and measures approximately 1.5-2 m² in surface area in adults. It acts as a barrier against invasion by microorganisms, chemicals, physical agents and dehydration¹. It is the most exposed part of the body to sunlight, environmental pollution and pathogens, which can lead to some of the most common skin conditions including eczema, warts, acne, psoriasis, allergies and rashes. Maintaining proper hygiene is essential for protecting the skin from harmful microorganisms and preventing the transmission of infectious diseases².

In natural medicine, plants have played a significant role as part of traditional medicine for thousands of years. The extracts from different parts of medicinal plants such as stems, roots and leaves have been used in natural therapy to treat numerous diseases and health issues. In contrast with chemical treatments, herbal treatments are not only inexpensive and readily available but also involve fewer risks of adverse effects³. Herbal skincare products are normally applied directly to the skin and come in various forms such as creams, lotions, gels, soaps and ointments, with herbal soap being the most popular and commonly used for the treatment of skin disease⁴.

This study aimed to formulate, develop and evaluate anti-microbial herbal soap using the plant extract of *Cynodon dactylon* against causative bacteria. *Cynodon dactylon* also known as bermuda grass, devil's grass, durva grass belongs to the family Poaceae. It contains various phytochemicals like proteins, carbohydrates, terpenoids, flavonoids, alkaloids, saponins, glycosides, steroids, tannins and resins. These phytochemicals are responsible for exhibiting anti-microbial activity in herbal soap. The herbal soap industry holds great promise in the country, with minimal technological barriers to entry, but achieving market success requires effective promotional efforts and competitive pricing⁵.

Aim And Objectives:

- Develop a natural and eco-friendly herbal soap using Bermuda grass extract.
- To explore the potential of Bermuda grass in cosmetic formulations, specifically in herbal soaps.
- Enhance the formulation with ingredients that offer both antimicrobial and skin-nourishing benefits.
- Assess the antimicrobial activity of the soap against common environmental pathogens.
- Ensure the soap is effective in preventing skin infections while being gentle and beneficial for skin health.

Literature review:

Herbal soaps that include herbal extracts should have considerable anti-bacterial, anti-microbial, anti-aging, anti-oxidant, and antiseptic action, promote skin conditioning, have a great foam, have a pleasant aroma, and be soft on the skin. Herbs as from the beauty of nature have been used to treat a wide range of skin problems, from the very moderate to the serious. The use of various herbal medicines for the treatment of skin infections has been investigated by many traditional medical systems. Eighty per cent of the world's population relies on traditional medicine for their primary care, as verified by the World Health Organization⁶. Herbal soap was formulated and developed using the extract of Neem and Tulsi for anti-microbial activity. Soap base containing stearic acid, sodium hydroxide, water, ethanol, propylene glycol and glycerine. The developed herbal soap was evaluated for organoleptic properties, foam retention, foam height, moisture content, cleansing ability and skin irritation. The obtained results were compared with standard soap. The obtained results passed the evaluation parameters compared to standard soap⁵.

Two different herbal soaps were prepared using the extract of Embeliaribes Burm and Curcuma longa with the same soap base containing castor oil, coconut oil, tallow, stearic acid, olive oil, sodium hydroxide, distilled water, glycerine, ethanol, sugar and rose water. Both developed soaps were evaluated for organoleptic properties, primary skin irritation, total fatty matter, foam test, alkali content and thumb impression method. The comparative study was conducted between both soaps for their anti-microbial activity and other soap parameters which aligns with standard readings⁷.

Herbal soap was developed for anti-microbial activity, using extract of Azadirachta indica, Ocimum teniflorum with the combination of sodium hydroxide, stearic acid, coconut oil, glycerine, propylene glycol, sodium lauryl sulphate as surfactant, triethanolamine, ethanol and water. Jasmine oil and Amaranth solution are used as fragrance and colouring agents, respectively. Soap evaluation tests like organoleptic properties, foam height and retention, alcohol insoluble matter, high temperature stability and anti-microbial testing were conducted⁸.

Four different crude drugs were used for soap formulation and development, powder of Citrus Sinesi and Sapinbus mukorossi; extract of Moringa oleifera bark and Cinnamomum zeylanicum bark. Herbal soap was prepared using sodium hydroxide, coconut oil, distilled water and glycerine. The developed polyherbal soap was evaluated for organoleptic properties, dirt dispersion, wetting time, foam forming ability and stability, moisture content and skin irritation. The obtained results align with the standard readings of synthetic and herbal soap standards⁹.

Herbal soap has advantages over synthetic soap, Natural elements found in herbal soap, such as plant extracts, essential oils, and herbs, provide several benefits over synthetic soaps.

- **Mild on the skin:** Herbal soaps are often kinder and Milder on the skin than synthetic soap, which makes them appropriate for skin types that are more sensitive.
- **Natural ingredients:** They frequently include skin-nourishing and hydrating natural ingredients including Shea butter, coconut oil, olive oil, and aloe vera.
- **Chemical-Free:** The absence of harsh chemicals, Artificial perfumes, and synthetic colors in herbal soaps lowers the possibility of allergic responses and skin Irritation.
- **Environmentally Friendly:** Compared to synthetic Soaps, the herbal ones are typically biodegradable and environmentally friendly as they are made with natural Ingredients.
- **Aromatherapy advantages:** By combining essential oils with herbal soaps, aromatherapy advantages including Stress alleviation, mood enhancement, and relaxation can Be experienced.
- **Natural antibacterial qualities:** Certain herbal Substances, like neem and tea tree oil, have antibacterial Qualities that assist to cleanse and shield the skin from Infections⁶.

Materials and Methods:

Collection and Authentication of the Plant Material:

Fresh aerial parts of *Cynodon dactylon* (Bermuda grass) were collected from the local market, Thane, on 8 th March 2025. The plant material was identified and authenticated by Harshal Pandit, PHD (botany) on 20th March, 2025.

- **Source/Location of Collection:** Bermuda grass (*Cynodon dactylon*) is sourced from the local market thane.
- **Extraction Method:** (Soxhlet Apparatus)

Sample Preparation:

- Take 6g of finely ground Bermuda grass powder.

Loading the Soxhlet Apparatus:

- Fill the bermuda grass powder into a muslin cloth or a cellulose thimble. Place the thimble into the soxhlet chamber.

Assembling the Apparatus:

- Pour 160 mL of 95% ethanol into a round-bottom flask. Connect the Soxhlet extractor to the flask. Attach a condenser on top of the Soxhlet unit. Ensure all connections are tight and secure to prevent ethanol loss.

Heating and Extraction:

Place the round-bottom flask on a heating mantle. Gently heat the ethanol. It will evaporate, condense in the condenser, and drip into the powder's thimble. As ethanol accumulates in the Soxhlet chamber, it extracts active constituents from the powder. Once the chamber fills, it siphons back into the flask, carrying the extract with it. Repeat this process continuously for 6–8 hours, or until the solvent in the thimble becomes clear.

Post-Extraction:

After extraction, let the apparatus cool down. Disconnect the setup and collect the ethanol extract from the round-bottom flask.

Storage:

Transfer the concentrated ethanolic extract of bermuda grass powder into a clean amber-colored bottle. Label the container and store in a cool, dry place or refrigerate until use in herbal soap formulation.

Methodology for the formation of Bermuda Grass Herbal Soap:**Preparation of Soap Base:**

Solution A (Lye Solution): Take 13.6 ml of distilled water in a beaker. Add 2 g of sodium hydroxide (NaOH) (caustic soda). Stir until the sodium hydroxide dissolves completely. Allow the solution to stand for 5-10 minutes for proper dissolution. **Solution B (Oil Mixture):** In a beaker, add 14 ml of coconut oil and 6 g of stearic acid. Heat the mixture on a gas burner, stirring continuously to ensure uniform melting.

Combining solutions A and B:

Slowly add Solution A into Solution B while stirring continuously. Allow the mixture to heat for 10 minutes over low temperature, ensuring thorough integration of the ingredients.

Addition of other ingredients:

Add 3.4 ml of glycerine and 14 ml of ethanol to the mixture. Stir well and cover the beaker for 5 minutes to allow the mixture to settle. Add 18 ml of propylene glycol and continue mixing for an additional 2 minutes.

Blending and final heating:

Allow the solution to settle for 5 minutes. Heat the blended solution for another 5 minutes to ensure consistency.

Molding :

Pour the hot soap base solution into suitable molds. Allow the soap base to set for 24 hours at room temperature. Once solidified, the soap base is ready for use in preparing the Bermuda grass herbal soap (Shubham Wankhade, et al., 2024).

Preparation of Bermuda Grass Extract:

Take 5 g of Bermuda grass powder (*Cynodon dactylon*). Mix thoroughly for 3 minutes to ensure uniform distribution. Extract the herbal properties using ethanol and filter to obtain 3 ml of ethanolic Bermuda grass extract.

Formation of Bermuda Grass Herbal Soap:**Melting the Soap Base:**

Using the double heating method, melt the glycerine soap base shown in table no.1. Stir continuously to avoid overheating and ensure complete melting.

Incorporation of Ingredients:

Once the soap base is melted, gradually add the prepared bermuda grass ethanolic extract.

Addition of Fragrance:

Once the mixture is uniform and slightly cooled, add 1 ml of perfume for fragrance. Stir gently to ensure even distribution of fragrance.

Molding and Curing:

Pour the final Bermuda grass herbal soap mixture into suitable molds. Allow the soap to solidify at room temperature for 24 hours⁹.

Table no.1: Formulation and development of herbal soap

INGREDIENTS	QUANTITY	ROLE OF INGREDIENTS
Sodium Hydroxide	2 g	Saponifying agent
Coconut Oil	14 mL	Lather formation, moisturization
Stearic Acid	6 g	Hardening agent
Glycerine	3.4 mL	Humectant (retains moisture)
Ethanol	14 mL	Transparency and solvent
Propylene Glycol	18 mL	Humectant and transparency enhancer
Distilled Water	13.6 mL	Solvent (vehicle)
Apple Cinnamon Perfume	1 mL	Fragrance
Cynodon dactylon Extract	3 mL	Active antimicrobial ingredient



Fig 1: Formulated and developed herbal soap

Evaluation parameters:**Organoleptic properties:**

The shape of formulated herbal soap is oval with length, breadth and thickness of 8 cm, 6 cm and 5 cm respectively^{10,11}.

pH determination:

A 10% soap solution was made by dissolving 10 g of soap in distilled water in a 100 ml volumetric flask. For pH determination, pH meter was employed. Electrode was added to the solution and the pH was recorded^{11,12}. The pH of soap was recorded to be 9.16.

Foam retention and foam formability:

To evaluate the quality of soap, foam tests were performed. Weigh 1.0 g of formulated herbal soap and mix in distilled water (around 50 mL) in a measuring cylinder of capacity 100 mL. Then, in the measuring cylinder, the solution is shaken vigorously for approximately 2-3 minutes. The height of foam was recorded for 0, 5, and 10 minutes^{13,15}.

Skin irritation test:

The formulated and prepared herbal soap was used by 3 to 4 volunteers to identify any skin irritation or reactions. The prepared soap didn't cause irritation or any other adverse reaction on the skin of the applicant¹⁴.

Thumb impression method test:

To evaluate the anti-microbial activity of formulated soap, the thumb impression method was performed. Thumb impression of the hand exposed to surroundings was placed on sterile nutrient agar of Sabouraud Dextrose agar. Then, the same hand was washed with formulated soap of Cynodon dactylon and a thumb impression was performed on the same agar plate without overlapping the thumbprints. The pattern of microbial growth on the plate was observed after an incubation period of 24 hours at 37 °C⁷.

Determination of percentage free alkali:

To determine free alkali content, weigh 5 g of prepared herbal soap and dissolve it in 50 ml of neutralized alcohol in a conical flask. Then boiled under reflux on a water bath for 30 minutes. The solution was cooled and 1 ml of phenolphthalein solution was added as an indicator. Then the solution was titrated with 0.1 M HCl⁷.

Alcohol insoluble matter:

Dissolve 5 g of prepared soap in warm ethanol. Then filter the solution with a tarred filter paper. Then dried the filter paper at 105 °C. Then the weight of the dried paper was taken and calculated as % alcohol insoluble matter. No evidence of residue was observed on the filter paper⁷.

Determination of total fatty matter (TFM):

The total fatty matter test is carried out by reacting the soap with acid in the presence of hot water and measuring the acids. About 10 g of the formulated soap was added to 150 ml of distilled water and heated. The soap was dissolved in 20 ml of 15 % sulphuric acid while heating until a clear solution appeared. By adding 7g of beeswax, the fatty acids on the surface of the resulting solution were solidified and reheated. The cake was formed, removed, dried and weighed to obtain the total fatty matter using a formula: $\%TFM = (A-X)/W \times 100$ Where; A= weight of beeswax, X weight of wax,, W= weight of herbal soap¹¹.

Dirt dispersion test:

To determine the foam quality of formulated herbal soap dirt dispersion method was performed. 1% sample solution was prepared and taken in a measuring cylinder and two drops of ink were added to the sample solution. The measuring cylinder was then shaken ten times while being covered by a hand. The low amount of ink was observed in the formed foam hence, the quality of the soap is better. The remaining dirt particles are then found in the water section¹⁴.

Saponification value determination:

To determine the mean molecular weight of fatty acid, which is present in oil or fat this method was performed. 2 g of the soap sample was taken in a conical flask and 0.5M KOH solution was added to it. This mixture was heated to about 55 °C along with continuous stirring on a hot water bath. Then the temperature was further increased to 100 °C, and boiling was continued for about 1 hour. Titration was performed with phenolphthalein indicator and 0.5M HCl. The endpoint observed is the pink color disappearance. [15,16] The saponification value is calculated by using the formula: $\text{Saponification value} = [\text{Mass of sodium hydroxide} / \text{mass of soap}] \times 1000$ ^{16,17}.

Moisture content:

5g of formulated herbal soap was precisely weighed, moved to a known weight tarred porcelain dish, and then heated to 105°C for 2 hours in a hot air oven. The true weight of the sample and the petri dish were weighed together. To determine the % moisture content, the content's weight was recorded. $\text{Moisture content} = (\text{Difference in weight} / \text{initial weight}) \times 100$ ¹⁷.

Accelerated stability studies:

Stability tests were carried out in accordance with ICH norms for accelerated testing, with the necessary changes. The sample formulation was taken and stored for one month at 30 °C ambient temperature and 4 + 2 °C in the refrigerator. Physical appearance, pH, moisture content, foaming ability, and percent cleaning effect were all assessed on the samples^{18,19}.

Results and discussions:

- pH Determination:***

The pH of a 10% soap solution was measured using a calibrated pH meter and found to be 9.16, indicating mild alkalinity suitable for skin application

- **Organoleptic properties:**

The shape of formulated herbal soap is oval with length, breadth and thickness of 8 cm, 6 cm and 5 cm respectively.

- **Foam Retention & Foam Formability:**

Foaming characteristics are essential indicators of cleansing efficiency. Adequate foam height and stability suggest that the soap forms a rich, stable lather, which is beneficial for dirt and oil removal. Table no.2 explains the results of foam height and retention of herbal soap showing good quality results compared to standards.

Table no.2: Results of foam retention and foam formability:

Foam height (cm)			
After 0 min	After 5 mins	After 10 mins	After 15 mins
4.5 cm	4.4 cm	4.2 cm	4.2 cm

Skin Irritation Test:

This test ensures that the soap is non-toxic and non-irritant to human skin. Absence of irritation confirms the safety and dermatological compatibility of the herbal formulation. Volunteers: 3–4 individuals Observation: No skin irritation or adverse reaction.



Fig 2: Skin irritation test

Thumb Impression Method:

The microbial growth reduction demonstrates the antimicrobial potential of the soap. Effective inhibition of microbial growth supports the functionality of the herbal extract used. The figure 3 showed significant reduction in microbial colonies after washing.

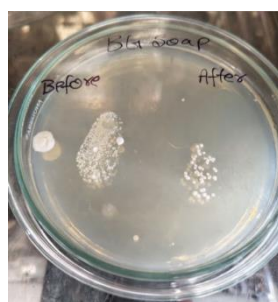


Fig 3: Results of thumb impression method

Free alkali determination:

Free alkali content is an important parameter for skin safety. A controlled level of alkali indicates that the soap is not overly harsh and is safe for regular application. The polyherbal soap showed 8.2% free alkali content expresses safe use of soap. The figure 4 showed final end point of titration.



Fig 4: Results of free alkali determination

Alcohol Insoluble Matter:

This test evaluates formulation purity and homogeneity. The absence of insoluble matter indicates a well-processed soap, free from undissolved particles or contaminants. Figure 5 shows no amount of residue was obtained, showing high level of purity.



Fig 5: Results of alcohol insoluble matter

Total Fatty Matter (TFM):

TFM reflects the quality of the soap in terms of its moisturizing ability and softness. A balanced TFM value signifies that the soap can cleanse effectively without being overly drying to the skin. Formulated soap showed 30.06% content of fatty matter which aligns with standard soap parameters.



Fig 6: Total fatty matter

Dirt Dispersion Test:

This assesses how effectively the soap removes dirt rather than trapping it in foam. Good performance in this test indicates effective dirt removal, contributing to overall cleansing quality. The formulated herbal soap showed low ink presence in foam indicates good quality.



Fig 7: Dirt dispersion method

Saponification Value:

Saponification value provides insight into the type and amount of fatty acids in the soap. It correlates with lathering ability and consistency, with proper values suggesting well-saponified oils in the base. Formulated polyherbal soap showed 116 value indicating high quality of soap parameters.

Moisture Content:

Moisture content influences the shelf life and hardness of the soap. A low percentage ensures microbial resistance and stability during storage. 2.89% indicates less amount of moisture which can contribute to good shelf life of the soap.



Fig 8: Results of moisture content

Accelerated Stability Studies:

These studies simulate long-term storage conditions to assess formulation resilience. Stable organoleptic properties, pH, and functional performance over time confirm the product's durability and shelf stability. The accelerated studies were conducted according to the guidelines of ICH Q1A(R2). Table no. 3 describes the stability of the soap after 1 month of prepared.

Table no.3: Results of accelerated stability studies

Parameters	Initial readings	After one month
Odour	Aromatic	Aromatic
Color	Light yellowish	Light yellowish
pH	9.16	9.13
Foam retention time	15 mins	13 mins
Moisture content	2.89 %	2.89 %
Skin irritation	No irritation	No irritation

A herbal soap base was prepared by using ingredients like sodium hydroxide, coconut oil, stearic acid, glycerine, Ethanol, propylene glycol and distilled water with an optimum concentration of *Cynodon dactylon* for its antimicrobial activity. The formulated herbal soap was evaluated for pH determination. The observed pH of 9.16 aligns with standard soap readings, indicating good foam retention and formation. Foam was formed within a minute of applying soap to the hands and remained for more than 10 minutes, demonstrating the high quality of the soap.

Skin irritation tests were conducted for 5-6 volunteers, showing no signs of irritation or allergic reactions. To ensure the antimicrobial activity of soap, the thumb impression method was performed, showing satisfactory effects with less growth of microorganisms after using formulated herbal soap. To verify the quality of the formulated herbal soap, chemical testing, such as percentage of free alkali, alcohol-insoluble matter, and total fatty matter, was performed. The results obtained were 8.2%, 0%, and 30.09%, respectively, which align with the standard readings of herbal soaps and marketed herbal soaps.

Conclusion:

A herbal soap was formulated and developed using *Cynodon dactylon* extract for its anti-microbial activity. The soap had a pH of 9.16, foam formed quickly and lasted over 10 minutes. Skin irritation tests on volunteers showed no adverse reactions. The thumb impression method confirmed its antimicrobial efficacy.

Chemical quality tests showed free alkali at 8.2%, 0% alcohol-insoluble matter, and 30.09% total fatty matter, aligning with herbal soap standards. Explore the possibility of creating personalized soap formulations based on individual skin needs, thus offering consumers the ability to choose the antimicrobial strength or additional ingredients (for example: added essential oils, customized fragrance or additional herbs) or to create complementary products like antimicrobial body washes, shampoos, or lotions that also feature Bermuda grass as a key ingredient, offering a complete skincare line. The formulated herbal soap elaborates the safe use of *Cynodon dactylon* as an cosmetic product without any adverse reactions on the skin.

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