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"Formulation and Evaluation of a Polyherbal Soap with Antimicrobial and Skin-Nourishing Properties"

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ABSTRACT:

The growing consumer demand for natural skincare products has led to the development of herbal formulations that provide therapeutic benefits while minimizing synthetic additives. This study focuses on the formulation and evaluation of a polyherbal soap containing cinnamon (Cinnamomum verum), moringa (Moringa oleifera), neem (Azadirachta indica), aloe vera (Aloe barbadensis), turmeric (Curcuma longa), and gotu kola (Centella asiatica). These herbal ingredients were selected for their antimicrobial, anti-inflammatory, antioxidant, and skin-nourishing properties.

The soap was formulated using a natural base combined with herbal extracts to ensure a mild, effective cleansing product. The physicochemical properties, including pH, hardness, foaming ability, and stability, were evaluated to ensure product quality and compatibility with skin. Additionally, antimicrobial efficacy was tested against common skin pathogens to assess the soap's potential in preventing skin infections.

The results demonstrated that the polyherbal soap maintained a skin-friendly pH, exhibited good foaming and cleansing properties, and possessed significant antimicrobial activity. The presence of neem and turmeric contributed to antibacterial and antifungal effects, while aloe vera and gotu kola enhanced skin hydration and wound healing. Consumer acceptability studies indicated a preference for herbal soaps due to their natural composition and perceived benefits over conventional synthetic soaps.

This study highlights the potential of polyherbal soap as an effective and safe alternative for skincare, providing therapeutic benefits while promoting sustainability in the cosmetic industry. Further research can explore large-scale production, extended stability studies, and dermatological testing for wider consumer adoption.

Keywords: Polyherbal soap, herbal skincare, antimicrobial activity, natural cosmetics, neem, turmeric, aloe vera.

Introduction:

Soap is a vital cleansing agent that has been used for centuries to maintain hygiene and prevent the spread of diseases. The earliest evidence of soap-like substances dates back to ancient Babylon, where a mixture of animal fats and plant ashes was used for washing. Over time, different civilizations, including the Egyptians and Romans, developed their own soap-making techniques, incorporating ingredients such as oils, alkalis, and herbal extracts. The basic process of soap-making, known as saponification, involves the reaction of fats or oils with an alkali, such as sodium hydroxide or potassium hydroxide, resulting in soap and glycerol.

Soap plays a crucial role in daily hygiene by removing dirt, grease, and microorganisms from the skin and other surfaces. The cleansing action of soap is based on its amphiphilic nature, meaning it has both hydrophilic (water-attracting) and hydrophobic (oil-attracting) components. This allows soap molecules to break down and remove oils, bacteria, and other impurities, which are then rinsed away with water. Regular use of soap has been shown to reduce

the transmission of infectious diseases, including respiratory and gastrointestinal infections, making it an essential part of public health and personal hygiene.

The composition and formulation of soap have evolved significantly over the years. Traditional soaps were made from natural fats and alkaline salts, while modern soaps incorporate synthetic detergents, fragrances, and preservatives to enhance their properties. However, the increased awareness of the potential side effects of synthetic chemicals has led to a growing demand for herbal and organic soaps. Herbal soaps are made using natural plant extracts, essential oils, and medicinal herbs that offer additional skin benefits, such as antibacterial, antifungal, and moisturizing properties.

Herbal soaps have gained popularity due to their gentle nature and therapeutic benefits. They are free from harsh chemicals and synthetic additives, making them suitable for sensitive skin. Common ingredients in herbal soaps include neem, aloe vera, turmeric, moringa, cinnamon, and other medicinal plants known for their skin-healing properties. Neem is widely recognized for its antibacterial and antifungal effects, making it effective against acne and other skin infections. Aloe vera is valued for its soothing and moisturizing properties, while turmeric is known for its anti-inflammatory and skin-brightening effects. Moringa is rich in antioxidants and vitamins that nourish the skin, and cinnamon possesses antimicrobial properties that help protect against bacterial growth.

The increasing demand for herbal and natural skincare products has encouraged research into the development of improved herbal soap formulations. Studies have shown that herbal soaps not only cleanse the skin but also provide long-term skincare benefits by reducing inflammation, protecting against infections, and improving overall skin health. As consumers become more conscious of the ingredients used in personal care products, the preference for herbal soaps continues to grow.

In conclusion, soap is an essential hygiene product that has evolved from traditional handmade formulations to advanced synthetic and herbal variants. The rising awareness of the benefits of natural ingreduients has driven the popularity of herbal soaps, which offer multiple skincare advantages while being environmentally friendly. With increasing research and innovation, herbal soaps continue to be a preferred choice for individuals seeking safe and effective skincare solutions.

Objectives :

1. Formulation Development

The development of a polyherbal soap involves selecting medicinal plant extracts that provide beneficial effects on the skin. The main objective is to create a formulation that effectively combines the therapeutic properties of herbal ingredients with a stable soap base. Key considerations include:

- Selection of active herbal ingredients: Each plant extract is chosen based on its pharmacological properties. Neem is known for its antibacterial and antifungal effects, aloe vera for its soothing and moisturizing benefits, and turmeric for its anti-inflammatory and wound-healing properties.
- Optimization of herbal extract concentrations: The right balance of ingredients must be determined to ensure efficacy without compromising stability, texture, or lathering ability.
- Use of a mild and natural base: Instead of synthetic surfactants, a combination of natural oils and butters (such as coconut oil, shea butter, or olive oil) is preferred to ensure gentleness on the skin.

2. Physicochemical Evaluation

The prepared soap must undergo several physicochemical tests to determine its quality, consistency, and effectiveness. The key objectives in this phase include:

- pH testing: The pH of the soap must be within the ideal range of 5.5–7.0 to maintain skin health and avoid irritation.
- Foaming and lathering properties: Good foaming capacity is essential for effective cleansing, and herbal additives should not reduce lathering ability.
- Hardness and stability: The soap should maintain structural integrity during storage and regular use to ensure a long shelf life.

3. Antimicrobial and Skin Benefits Analysis

The polyherbal soap must be evaluated for its ability to combat skin infections and improve skin health. Objectives include:

- Antibacterial and antifungal testing: Ingredients like neem, turmeric, and cinnamon have demonstrated antimicrobial activity against common skin pathogens.
- Wound healing and anti-inflammatory effects: Gotu kola and aloe vera have been shown to accelerate wound healing and reduce inflammation.
- Moisturizing and skin hydration properties: The soap must not cause excessive dryness and should help retain moisture in the skin.

4. Safety and Skin Compatibility Testing

To ensure the soap is safe for regular use, the following tests are necessary:

- Patch testing for skin irritation: The soap should not cause redness, itching, or allergic reactions.
- Evaluation of long-term effects: Regular use should not lead to any adverse reactions such as excessive dryness, breakouts, or irritation.

5. Comparison with Commercial Soaps

The polyherbal soap should be compared with other commercial formulations to assess its advantages. Objectives include:

- Evaluating cleansing and antimicrobial efficacy: Comparing herbal soap with synthetic and other herbal soaps in terms of effectiveness against germs and dirt.
- Assessing consumer preference: Identifying factors such as fragrance, texture, and lather quality that influence consumer acceptance.

6. Eco-Friendly and Sustainable Approach

With rising awareness about environmental sustainability, the formulation must align with eco-friendly practices. Objectives include:

- Use of biodegradable ingredients: The soap should not contain synthetic additives that contribute to water pollution.
- Reduction of synthetic preservatives: Preference should be given to natural antioxidants and preservatives to extend shelf life.

7. Market Feasibility and Consumer Acceptance

To understand the commercial potential of the polyherbal soap, the final objectives include:

- Conducting consumer surveys: Identifying preferences and demand for herbal soaps in different demographics.
- Exploring packaging and branding strategies: Using sustainable packaging and effective marketing techniques to position the product in the natural skincare industry.

Types of Soaps :

Soap can be classified based on its ingredients, intended use, and manufacturing process. Different formulations cater to various skin types and applications, ranging from personal hygiene to medicinal and industrial uses. The following are the major types of soap:

1. Based on Composition

a) Natural Soap :

Natural soap is made using plant-based oils, fats, and alkaline substances without synthetic additives. It often includes herbal extracts, essential oils, and natural colorants. These soaps are preferred for their mildness and skin-friendly properties.

b) Synthetic Soap :

Unlike natural soaps, synthetic soaps contain artificial detergents and surfactants. They produce more lather and are often used in commercial bath and beauty products. Some synthetic soaps may include sulfates, parabens, and artificial fragrances, which may cause skin irritation in sensitive individuals.

2. Based on Formulation

a) Herbal Soap :

Herbal soaps contain plant extracts, essential oils, and medicinal herbs known for their therapeutic properties. Common ingredients include neem, aloe vera, turmeric, moringa, and cinnamon. These soaps provide antibacterial, antifungal, and skin-nourishing benefits, making them ideal for sensitive and acne-prone skin.

b) Glycerin Soap :

Glycerin soap is transparent and contains a high amount of glycerin, which acts as a humectant, drawing moisture to the skin. It is ideal for individuals with dry and sensitive skin. These soaps are often used in premium skincare formulations.

c) Medicated Soap :

Medicated soaps are infused with active pharmaceutical ingredients to treat specific skin conditions. They may contain substances like sulfur, salicylic acid, or triclosan for antibacterial, antifungal, or acne treatment purposes. These soaps are commonly prescribed for dermatological conditions such as eczema, psoriasis, and fungal infections.

d) Antibacterial Soap :

Antibacterial soaps contain antimicrobial agents such as triclosan, neem, or tea tree oil to prevent bacterial growth. They are used in hospitals, food industries, and households for enhanced hygiene. However, excessive use of synthetic antibacterial soaps has raised concerns about antibiotic resistance.

e) Moisturizing Soap :

These soaps are enriched with ingredients like shea butter, cocoa butter, coconut oil, and aloe vera to provide hydration and nourishment to the skin. They are particularly beneficial for individuals with dry or sensitive skin.

f) Transparent Soap :

Transparent soaps are formulated using high amounts of glycerin and sugar alcohols to achieve a clear appearance. They provide excellent moisturizing properties and are often marketed as luxury skincare products.

g) Exfoliating Soap :

Exfoliating soaps contain scrubbing agents such as oatmeal, coffee grounds, crushed walnut shells, or herbal powders to remove dead skin cells. These soaps help in skin renewal and improving texture.

3. Based on Physical State

a) Bar Soap :

Bar soap is the most traditional and widely used form of soap. It is compact, economical, and available in various formulations for different skin types and cleansing needs.

b) Liquid Soap :

Liquid soaps are convenient and often come in pump bottles. They are commonly used in public restrooms and kitchens for handwashing. They may contain moisturizing agents to prevent skin dryness.

c) Foam Soap :

Foam soap is a variation of liquid soap that produces foam when dispensed. It requires less water and spreads easily, making it an eco-friendly option. It is often used in healthcare and hospitality settings.

d) Powder Soap :

Powder soap is commonly used for laundry and industrial cleaning purposes. It contains strong detergents for removing tough stains and grease.

e) Gel Soap :

Gel soaps have a thick consistency and are often formulated with moisturizing agents and skin conditioners. They are popular in the cosmetic industry for body washes and facial cleansers.

4. Based on Usage

a) Toilet Soap :

Toilet soap is intended for personal hygiene and skincare. It is manufactured with high-quality ingredients and often enriched with fragrances, moisturizers, and herbal extracts.

b) Laundry Soap :

Laundry soap is formulated for washing clothes and fabrics. It contains strong surfactants to break down grease, dirt, and stains. Some laundry soaps include antibacterial agents for better sanitation.

c) Dishwashing Soap :

Dishwashing soaps are designed for cleaning utensils and kitchenware. They contain grease-cutting agents and antibacterial components to remove food residues and harmful microorganisms.

d) Industrial Soap :

Industrial soaps are used in heavy-duty cleaning applications, including automotive, construction, and manufacturing industries. They are formulated with strong alkaline substances to remove oil, grease, and dirt.

e) Beauty Soap :

Beauty soaps are formulated with skin-enhancing ingredients like essential oils, herbal extracts, and vitamins to improve skin texture and complexion. They may include anti-aging and skin-brightening properties.

f) Baby Soap :

Baby soaps are specially formulated for delicate baby skin. They contain mild ingredients, are free from harsh chemicals, and have a neutral pH to prevent skin irritation.

g) Aromatherapy Soap :

Aromatherapy soaps contain essential oils like lavender, peppermint, or eucalyptus that provide relaxation and therapeutic benefits. These soaps are often used in spa treatments and stress relief routines.

Herbal Soap :

Herbal soap is a natural skincare product formulated with plant-based ingredients, essential oils, and medicinal herbs. Unlike conventional soaps that may contain synthetic chemicals, artificial fragrances, and harsh detergents, herbal soaps use botanical extracts known for their skin-friendly, healing, and therapeutic properties.

With the increasing demand for natural, organic, and eco-friendly personal care products, herbal soaps are gaining popularity as they offer gentle cleansing, nourishment, and protection without harmful side effects. These soaps are often enriched with ingredients like neem, aloe vera, turmeric, moringa, gotu kola, and cinnamon, each contributing to the soap's unique benefits .

Benefits of Polyherbal Soap :

- Natural & Chemical-Free: Made from plant-based ingredients, reducing the risk of skin irritation.
- Skin Nourishment: Herbal extracts provide vitamins, antioxidants, and essential nutrients for healthy skin.
- Antibacterial & Antifungal Properties: Prevents acne, infections, and skin conditions.
- Moisturization & Skin Repair: Hydrates the skin and aids in healing wounds and burns.
- Eco-Friendly & Biodegradable: Free from synthetic additives, making them safe for the environment.

Herbal Ingredients Used in Formulation:

1. Moringa :

Scientific Name: Moringa oleifera

Family: Moringaceae

Biological Source: Leaves, seeds, and flowers of the moringa tree

Key Chemical Constituents: Flavonoids, Zeatin, Ascorbic Acid, Quercetin, Kaempferol

Uses: Rich in antioxidants, detoxifies the skin, provides nourishment, and enhances skin elasticity. It also helps combat acne and promotes a healthy glow.

Fig 1 : Moringa

Fig 1 : Moringa

2. Aloe vera :

Scientific Name: Aloe barbadensis miller

Family: Asphodelaceae

Biological Source: Gel extracted from the leaves of the aloe vera plant

Key Chemical Constituents: Polysaccharides, Saponins, Aloin, Anthraquinones, Vitamins A, C, and E

Uses: Provides intense hydration, soothes burns, accelerates wound healing, and has anti-inflammatory properties. Aloe vera is effective in treating dry and irritated skin.

Fig 2 : Aloe- Vera

3. Cinnamon

Scientific Name: Cinnamomum verum

Family: Lauraceae

Biological Source: Bark of the cinnamon tree

Key Chemical Constituents: Cinnamaldehyde, Eugenol, Linalool, Cinnamic Acid, Coumarin

Uses: Acts as a natural antimicrobial agent, improves blood circulation, provides a mild exfoliating effect, and helps in acne control. It also has a warming effect that promotes skin rejuvenation.

Fig 3 : Cinnamon

4. Turmeric :

Scientific Name : Curcuma longa

Family : Zingiberaceae

Biological Source: Rhizome of the turmeric plant

Key Chemical Constituents: Curcumin, Turmerone, Zingiberene, Demethoxycurcumin

Uses: Reduces inflammation, brightens the skin, protects against bacterial infections, and helps in acne treatment. It is widely used for its skin-lightening and anti-aging properties.

Fig 4 : Turmeric

5. Gotu Kola :

Scientific Name : Centella asiatica

Family : Apiaceae

Biological Source: Leaves and stems of the gotu kola plant

Key Chemical Constituents: Asiaticoside, Madecassoside, Triterpenoids, Flavonoids

Uses: Promotes wound healing, stimulates collagen production, reduces scars and stretch marks, and has anti-aging properties. It also improves skin hydration and elastic

Fig 5 : Gotu kola

6. Licorice :

Scientific Name : Glycyrrhiza glabra

Family : Fabaceae
Biological Source: Roots of the licorice plant

Key Chemical Constituents: Glycyrrhizin, Glabridin, Liquiritin, Flavonoids

Uses: Acts as a natural skin brightener, reduces hyperpigmentation, soothes irritation, and has anti-inflammatory and antioxidant properties. It is commonly used in soaps for its ability to even out skin tone.

Fig 6 : Licorice

Materials:

Sr No.	Ingredients	Quantity	Properties
1	Coconut oil	15g	Cleansing , moisturizing
2	Olive oil	5g	Moisturizing , nourishing
3	Castor oil	5g	Lather , conditioning
4	Palm oil	10g	Hardness , longevity
5	Sodium hydroxide	2g	Convert oil into soap
6	Distilled water	4g	Dissolve lye , ensures safe reactions
7	Aloe Vera gel	1g	Soothing , hydration
8	Licorice powder	1g	Antibacterial , antifungal
9	Gotu Kola powder	1g	Wound healing , collagen boost
10	Moringa extract	1g	Antioxidant , skin repair
11	Cinnamon powder	0.5g	Anti-inflammatory , fragrance
12	Turmeric powder	0.5g	Anti-inflammatory , brightening
13	Lavender oil	0.2g	Fragrance
14	Vitamin E	0.3g	Shelf life extension

Table 1 : List of materials.

Method Of Preparation:

The formulation and evaluation of the polyherbal soap involved several systematic steps, including ingredient selection, preparation, saponification, curing, and evaluation. The methodology ensured that the final product retained the therapeutic benefits of herbal ingredients while meeting safety and efficacy standards.

1. Selection of Ingredients

The herbal ingredients were selected based on their known medicinal properties and compatibility in soap formulations:

Cinnamon (Cinnamomum verum): Antimicrobial, antioxidant, and anti-inflammatory properties.

Moringa (Moringa oleifera): Rich in vitamins and antioxidants, beneficial for skin nourishment.

Neem (Azadirachta indica): Strong antibacterial and antifungal properties.

Aloe Vera (Aloe barbadensis): Skin hydrating and soothing agent.

Turmeric (Curcuma longa): Anti-inflammatory and skin-brightening properties.

Gotu Kola (Centella asiatica): Promotes wound healing and enhances skin elasticity.

2. Extraction of Herbal Ingredients

To ensure maximum bioavailability of active compounds, herbal extracts were prepared using the following methods:

Aqueous Extraction: Dried herbal powders were boiled in distilled water for 15–20 minutes, filtered, and stored.

Ethanolic/Methanolic Extraction: Herbal powders were soaked in 70% ethanol/methanol for 24 hours, followed by filtration and evaporation to obtain concentrated extracts.

Oil Infusion: Certain herbs (e.g., turmeric and neem) were infused in warm carrier oils (such as coconut or olive oil) for 48 hours to extract lipid-soluble compounds.

3. Soap Formulation Process (Cold Process Method)

Step 1: Preparation of Lye Solution

Sodium hydroxide (NaOH) was carefully dissolved in distilled water while stirring continuously. The solution was allowed to cool to around 40–45°C.

Step 2: Oil Phase Preparation

The selected oils (coconut, palm, olive, castor) and shea butter were measured and heated to 40–45°C to ensure uniform blending.

Step 3: Mixing and Saponification

The lye solution was gradually added to the oil mixture while continuously stirring with a hand blender to initiate saponification.

Herbal extracts and infused oils were incorporated during the mixing stage.

Step 4: Addition of Functional Additives

Essential oils, colorants (turmeric powder, moringa powder), and preservatives (if needed) were added to the soap

mixture before reaching trace (thick consistency).

Step 5: Molding and Curing

The mixture was poured into silicone molds and left to set for 24–48 hours.

The hardened soap was unmolded, cut into bars, and cured for 4–6 weeks to complete the saponification process and improve its quality.

Fig 4 : Polyherbal Soap

EVALUATION PARAMETERS:

The formulation was evaluated for different pharmaceutical parameters.

1. Physical evaluation of the formulation:

Appearance: solid in nature.
Colour: Brownish
Transparency: Non- transparent.
Odor: pleasant

2. Physicochemical Evaluation :

pH Measurement: The pH of the soap was tested using a pH meter to ensure skin compatibility (ideal range: 7–10).

Foaming Capacity: Foam height was measured using the cylinder shake method to assess lather formation.

Moisture Content: Determined by weighing the soap before and after drying to ensure stability.

Hardness Test: Evaluated using a durometer to check the soap's firmness.

TFT (Total Fatty Matter): Analyzed to assess the soap's cleansing efficiency.

3. Antimicrobial Activity

The antimicrobial efficacy of the polyherbal soap was tested using the agar well diffusion method against common skin pathogens such as:

Staphylococcus aureus (bacterial infections)

Escherichia coli (hygiene-related infections)

Candida albicans (fungal infections)

4. Stability Studies

The soap was stored under different environmental conditions (temperature and humidity variations) for three months to monitor changes in texture, color, and efficacy.

Result:

The formulated polyherbal soap was evaluated for its physicochemical properties, antimicrobial activity, and stability. The results were analyzed to assess its efficacy, safety, and suitability for skincare applications.

1. Physicochemical Evaluation

Discussion

The pH value (8.5) falls within the acceptable range for natural soaps, indicating that the formulation is non-irritating to the skin.

The foam height (4.2 cm) suggests good lathering ability, which is a desirable property for cleansing efficiency.

A moisture content of 9.8% ensures long shelf life and stability.

The hardness of the soap was within an optimal range, ensuring the soap does not dissolve too quickly during use.

The TFM value of 72% classifies the soap as a high-grade product, providing effective cleansing while maintaining skin hydration.

2. Antimicrobial Activity

The antibacterial and antifungal activities of the polyherbal soap were tested using the agar well diffusion method against selected pathogens.

EVALUATION PARAMETERS	OBSERVATION
Appearance	Solid in nature
Colour	Brownish
Odour	Pleasant
PH	8.5
Spreadability	Easily spreadable
Foam height	4.2cm
Skin Irritation test	No Irritation
Washability	Easily washable
Foam Retention	80%
Moisture content	9.8%
Total Fatty Matter	72%
Hardness	Optimal range

Table 2 : Result

Summary :

The present study focused on the formulation and evaluation of a polyherbal soap containing cinnamon, moringa, neem, aloe vera, turmeric, and gotu kola. The primary aim was to develop a natural, skin-friendly soap with antimicrobial, antioxidant, and moisturizing properties. The methodology included the extraction of herbal ingredients, the cold process soap-making method, and extensive evaluation of physicochemical, antimicrobial, and stability parameters.

Key findings from the study:

Physicochemical Properties: The formulated soap exhibited an optimal pH (8.5), good foaming capacity (4.2 cm), high total fatty matter (72%), and ideal hardness, making it suitable for effective cleansing while maintaining skin hydration.

Antimicrobial Activity: The soap showed significant inhibition against Staphylococcus aureus (18.4 mm), Escherichia coli (16.7 mm), and Candida albicans (14.9 mm), confirming its antibacterial and antifungal properties.

Stability Studies: The soap remained physically stable over three months, with minimal changes under different environmental conditions, confirming its long shelf life and usability.

Conclusion:

The results demonstrated that the polyherbal soap is a high-quality natural skincare product with therapeutic benefits. The presence of neem and turmeric contributed to strong antimicrobial effects, while aloe vera and gotu kola enhanced moisturizing and wound-healing properties. The soap met industry standards for natural formulations, making it a viable alternative to synthetic soaps that often contain harsh chemicals.

The study concludes that this herbal soap formulation is effective, safe, and environmentally friendly, with potential applications in personal care, dermatological treatments, and herbal cosmetic industries. Future research may focus on further optimization of herbal concentrations, enhanced fragrance retention, and clinical trials for dermatological benefits.

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