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Research Article

Preparation and Evaluation of Natural Antimicrobial Soap

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ABSTRACT

Herbal products have become an item of global importance both medicinally and economically. Although usage of these herbal products has increased, their quality, safety and efficiency are serious concerns in industrialized and developing countries. The present research has been undertaken with the aim to formulate and evaluate the pure herbal formulation. An herbal soap was formulated using the leaf and bark extract of Azadirachta indica, and tulsi. The natural content in the herbs does not have any side effect on the human body. Most herbal supplements are based on several botanical ingredients with long histories of traditional or folk medicine usage. Numerous chemical toxins, microorganism present in the atmosphere may cause chemical infection and damage to skin. Cosmetics alone are not sufficient to take care of skin and body parts. Neem (Azadirachta indica) tree has attracted worldwide prominance owing to its wide range of medicinal properties. neem leaves and its constituents have been demonstrated to exhibit anti– inflammatory, antihyperglycemic, antiulcer, antimalarial, antifungal, antibacterial, antimutagenic and anticarcinogenic properties. This study was conducted to evaluate the effect of aqueous, ethanolic and ethyl acetate extract from neem leaves. The physicochemical parameters of formulations (Physical evaluation, pH, Foaming ability and foam stability) were determined. The results showed that formulation have pH level nearly equal to skin pH, Foaming index is excellent. Saponification is the chemical reaction in which triglycerides are mixed with strong base to form fatty acid metals salts during soap preparation. The herbal extracts were tested for the microbial growth inhibition of Escherichia coli, Staphylococcus aureus and Candida albicans by anti-microbial testing. The herbal extracts formulated and prepared herbal soaps were calculated for hardness, cleansing, conditioning, bubbly, creamy, and INS (Iodine and Saponification Value).

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INTRODUCTION

The outer covering of the body, known as human skin, constitutes the primary line of defense that safeguards the body from a variety of pathogens. Due to its constant exposure to various environmental stimuli, the skin is susceptible to damage as it interacts with the surroundings. Herbal soaps prove effective in addressing diverse skin issues. These soaps incorporate glycerine, a component not commonly found in commercial soaps. Because glycerine is essential for skin moisture retention, these soaps are great for those with dry skin. Medicinal or therapeutic herbal soaps include antimicrobial and antifungal ingredients sourced from various plant components, such as leaves, stems, roots, and fruits. In order to cure injuries, illnesses, or to promote general health, these concoctions use the medicinal characteristics of plants. They come in a variety of forms that may be used topically, including creams, gels, soaps, solvent extracts, and ointments. A bar of natural soap is one that uses only natural components, including plant extracts or essential oils, and does not include any synthetic surfactants. Herbs are used to cure a variety of skin issues and illnesses because they are natural, efficient, inexpensive, widely available, and work effectively for human body.

The concept of using soap for washing and body maintenance was initially introduced by Galen. However, some chemical soaps available today can often lead to dryness and skin irritation. As a consequence, prevalence of herbal-based soaps is on the increase owing to their efficiency in managing cutaneous ailments. Soap was formerly manufactured by combining animal fats with lye, a process that was widely practiced and sourced from nature. On the current day soap is fabricate with fats and an alkali with a most common method cold process also some peoples make soap using historical hot process. Aim of the current research is formulating a polyherbal soap utilizing extracts from Ocimum sanctum, Azadirachta indica (Neem). The study aims to assess various parameters including appearance, pH, physical attributes, foam height, foam retention, and high-temperature stability. This evaluation is essential for the standardization of the polyherbal soap formulation, paving the way for potential commercial Citation use. [1, 2, 3]

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Advantages of Herbal soaps:

- **Natural Ingredients:** One of the most significant advantages of using herbal soap is its composition of natural ingredients, such as essential oils, plant-based oils, herbal extracts, and natural fragrances. These ingredients are carefully selected for their nourishing, soothing, and healing properties, providing the skin with essential nutrients, vitamins, and antioxidants. In contrast, conventional soaps often contain harmful synthetic chemicals and artificial fragrances, which may be harsh on the skin.
- **Gentle on the Skin:** Herbal soap is a skin-friendly alternative, known for its mild and soothing nature. It is particularly beneficial for individuals with sensitive skin, as it gently cleanses without causing irritation. Formulated with natural moisturizing and nourishing ingredients, herbal soap helps maintain the skin's hydration, leaving it soft, smooth, and healthy. Unlike conventional soaps, which often contain harsh chemicals like sulfates, parabens, synthetic additives, and artificial fragrances, that can strip the skin, herbal soap reduces the risk of irritation and allergic reactions due to the presence of its natural oils and will definitely provide a safer and more nourishing cleansing experience. Herbal soaps cleanse the skin with great efficacy by eliminating impurities, excess oil, and dirt, all while preserving its natural oils.
- **No Harmful Chemicals:** Herbal soaps are crafted from all-natural ingredients, free from harmful chemicals, ensuring a gentle and nourishing experience for the skin. Their hypoallergenic nature makes them less likely to trigger allergic reactions, offering a safer alternative to synthetic soaps, which often contain harsh chemicals and artificial fragrances.
- **Eco-Friendly:** Herbal soaps are widely regarded as an environmentally conscious choice compared to synthetic soaps. They are made from natural, biodegradable ingredients that break down easily without leaving harmful residues. Unlike conventional soaps, which often contain harsh chemicals

and synthetic additives that can pollute water sources and harm aquatic life, herbal soaps minimize ecological impact. Their gentle formulation ensures that both the skin and the environment remain unharmed, promoting sustainability and a cleaner, greener planet.

- **Soothing and Calming:** Herbal soaps are enriched with botanical extracts and herbs known for their naturally soothing and calming properties. Ingredients like chamomile, lavender oil, and calendula provide a gentle, aromatic experience that helps reduce stress and promote relaxation. Many herbal soaps also contain nourishing natural oils such as olive oil, coconut oil, shea butter, and cocoa butter, which deeply moisturize and hydrate the skin. These rich emollients form a protective barrier, preventing dryness while leaving the skin soft, supple, and irresistibly smooth.
- **Therapeutic Efficacy:** Herbal soaps harness the power of nature with antibacterial and antifungal ingredients like neem and tea tree, helping to purify the skin, prevent acne, and promote a clearer complexion. Soothing botanicals such as aloe vera alleviate irritation, redness, and inflammation, offering relief for conditions like eczema, psoriasis, and sunburn. Infused with essential oils like lavender, peppermint, and citrus, these soaps create a spa-like experience, uplifting the mood and relaxing the mind during the shower. Rich in antioxidants from green tea, rosemary, and turmeric, they also combat free radicals, reducing signs of aging and enhancing skin vitality.

Disadvantages of Herbal Soap:

- **Variable Quality:** Herbal soaps are available in a wide range of brands and formulations, and the quality may vary. Some herbal soap may contain lower quality ingredients or lack the desired efficacy, which can affect their performance.
- **Limited Lather:** Herbal soaps may not lather as much as synthetic soaps due to their natural ingredients. While lather is not necessarily an indicator of cleaning efficacy, some people may prefer a rich lather during their bathing routine.
- **Shorter Shelf Life:** Herbal soaps may have a shorter shelf life compared to synthetic soaps, as they do not typically contain preservatives. This means that they may spoil or become less effective over time, especially if not used within a certain period.
- **Higher Cost:** Herbal soaps may be more expensive compared to synthetic soaps, as they often contain higher-quality natural ingredients. This can make them less affordable for some consumers, especially those on a tight budget. [4,5,6,7]

Raw materials used for the preparation of Herbal soaps

1) **Neem powder (*Azadirachta indica*)**

Advantages

- Improves Skin & Hair: Applied topically, it helps clear acne, soothes eczema, relieves dandruff, and promotes scalp health.
- Boosts Dental Health: Its antibacterial nature makes it a common ingredient in traditional tooth powders, helping fight plaque and gum disease.
- Eco-Friendly Pest Control: When mixed with water, it acts as a natural, biodegradable pesticide that repels insects without harming beneficial pollinators or soil quality.
- Immunity & Detox: Taken internally, it helps purify the blood and boosts antioxidant levels in the body.

Disadvantages

- Risk of Toxicity: Prolonged or excessive oral consumption can be harmful and may lead to liver damage.
- Unsafe during Pregnancy: It is highly discouraged for pregnant or breastfeeding women, as it can increase the risk of miscarriage and may negatively affect infants.
- Blood Sugar Drops: It can lower blood sugar levels. People with diabetes should use it

cautiously to avoid hypoglycemia, especially if taking other medications.

- Digestive Discomfort: Consuming large amounts can trigger gastrointestinal issues such as nausea, diarrhea, and abdominal cramps. [1, 8, 9]

2) Turmeric powder (Curcuma longa)

Advantages

- Reduces Inflammation: Contains curcumin, which blocks inflammatory pathways and relieves joint pain as effectively as some over-the-counter NSAIDs like ibuprofen.
- Fights Oxidative Stress: Functions as a potent antioxidant that neutralizes free radicals and stimulates the body's own antioxidant defense enzymes.
- Supports Heart Health: Improves the function of blood vessel linings (endothelium) and helps lower LDL ("bad") cholesterol and triglycerides.
- Boosts Brain Function: Increases levels of Brain-Derived Neurotrophic Factor (BDNF), which promotes neuron growth and may protect against age-related mental decline.
- Improves Skin & Mood: Enhances skin radiance when used topically and has been shown to alleviate symptoms of mild depression by boosting serotonin and dopamine.

Disadvantages

- Extremely Low Absorption: The human body naturally metabolizes and eliminates raw turmeric very rapidly, meaning very little curcumin reaches the bloodstream.
- Requires an Activator: To be effective, it must be consumed with black pepper (piperine) to boost absorption or eaten alongside dietary fats.
- Gastrointestinal Distress: Large supplemental doses can cause stomach irritation, acid reflux, nausea, and diarrhea.
- Increases Bleeding Risk: Acts as a natural blood thinner, meaning high doses can dangerously interact with prescription anticoagulants like Warfarin or Aspirin.
- Risk of Kidney Stones: Contains high levels of oxalates, which can bind to calcium in the urinary tract and form painful kidney stones in susceptible individuals.
- Blocks Iron Absorption: Can bind to iron in the digestive system, reducing its absorption and potentially worsening anemia. [1,10,11,12]

3) Aloe juice (Aloe barbadensis miller)

Advantages

- Relieves Constipation: Acts as a natural, highly effective laxative.
- Soothes Acid Reflux: Reduces symptoms of heartburn and GERD.
- Lowers Blood Sugar: Helps improve insulin sensitivity in type 2 diabetics.
- Hydrates Deeply: Packed with water and electrolytes to cure dehydration.
- Clearer Skin: Reduces acne flare-ups by fighting internal inflammation.
- Alkalizes Body: Balances high bodily acidity caused by processed foods.

Disadvantages

- Stomach Cramping: Causes painful intestinal spasms if unpurified.
- Electrolyte Loss: Chronic use depletes potassium, risking heart issues.
- Kidney Damage: Excessive long-term intake can cause renal failure.
- Medication Interactions: Interferes with blood thinners and heart medicines.
- Diarrhea Risk: Excessive aloin content triggers severe watery stools.
- Pregnancy Risk: Stimulates uterine contractions, increasing miscarriage risks. [1, 13]

4) Charcoal (Amorphous Carbon)

Advantages

a. **Clinical Settings:** Utilized by healthcare professionals in specific toxicological protocols.

b. **Industrial Filtration:** Employed to purify drinking water and filter air contaminants.

c. **Personal Care:** Included in various consumer products for its abrasive or deodorizing properties.

d. **Digestive Support:** Sometimes used to address symptoms of intestinal gas.

e. **Drug Interactions:** Can interfere with the absorption of oral medications, including daily prescriptions.

f. **Gastrointestinal Effects**: May cause constipation or changes in stool consistency.

g. **Emergency Protocol**: In the event of suspected poisoning or overdose, it is critical to contact emergency services or a poison control center immediately rather than attempting self-treatment.

Disadvantages

Not effective against all substances, such as alcohols, corrosive agents. [1, 14]

5) Other excipients used:-

a) **Soap base**- A glycerin soap base is a pre-made, "melt and pour" foundation crafted from plant oils, glycerin, and natural solvents. Renowned for its hydrating qualities, it is the safest and easiest way to create customized, skin-friendly soaps at home without handling harsh chemicals like lye. Understanding what makes up a glycerin base will help you choose or formulate the perfect bar.

b) **Vegetable Oils:** Nourishing bases like coconut or palm oil provide the primary lather and cleansing.

c) **Glycerin:** A natural humectant that draws moisture from the air to keep your skin deeply hydrated. It. is arguably the most important pharmaceutical excipient after water. Its standout pharmaceutical key point is its remarkable multifunctionality—it safely acts as a solvent, humectant, sweetener, and lubricant all at once, making it indispensable in modern drug formulation.

d) **Sugar & Solvents:** Ingredients like sucrose and propylene glycol dissolve soap molecules to give the base its signature translucent or transparent look.

e) **Surfactants:** Compounds like sodium stearate and SLES create the rich, bubbly lather you expect from a great bar of soap.

f) **Bees wax-** Beeswax is a natural lipid secreted by worker honeybees to build honeycomb. It is renowned for its moisture-locking, non-toxic, and antimicrobial properties, making it a staple in cosmetics, pharmaceuticals, food preservation, and candle making.

g) **Sodium Lauryl sulfate (SLS) -** also known as sodium dodecyl sulfate (SDS), is a highly effective anionic surfactant and foaming agent. Derived naturally from coconut or palm kernel oil, it is widely used across the cosmetic, pharmaceutical, and cleaning industries to emulsify oils, reduce surface tension, and create lather.

h) **EDTA (Ethylenediaminetetraacetic acid) -** is a powerful, synthetic chelating agent. Its primary function is to bind tightly to di- and trivalent metal ions (such as calcium, magnesium, and iron), making it a staple in medicine, laboratory testing, food preservation, and industrial manufacturing.

i) **Citric Acid Anhydrous -** is a water-free, naturally occurring organic acid used in pharmaceutical and cosmetic soaps to control pH, act as a chelating agent to prevent soap scum and rancidity, and act as a mild exfoliant.

j) **Coconut Oil-** is primarily used as a multi-functional pharmaceutical excipient (inactive ingredient) rather than an active drug. Its unique chemical structure, high stability, and biocompatibility make it a critical component in modern drug delivery systems. [1, 15, 16]

METHOD OF PREPARATION

Table 1: Composition of Soap's

S. NO.	INGREDIENT	F-I (Neem)	F-II (Turmeric)	F-III (Aloe)	F-IV (Charcoal)
1.	HERBAL POWDER	5 gm	5 gm	5 gm	5 gm
2.	SOAP BASE	33.5 gm	33.5 gm	33.5 gm	33.5 gm
3.	BEES WAX	4.5 gm	4.5 gm	4.5 gm	4.5 gm
4.	GLYCERIN	5.3 ml	5.3 ml	5.3 ml	5.3 ml
5.	SLS	1.5 gm	1.5 gm	1.5 gm	1.5 gm
6.	EDTA	0.5 gm	0.5 gm	0.5 gm	0.5 gm
7.	CITRIC ACID	0.5 gm	0.5 gm	0.5 gm	0.5 gm
8.	COCONUT OIL	2.5 ml	2.5 ml	2.5 ml	2.5 ml

Procedure: -

1) Neem soap (F-I)

Measure out neem **powder** into a small bowl. Add coconut oil to the powder and stir to create a smooth, clump-free paste. This ensures the neem powder blends evenly into the hot soap base. Place soap base and beeswax into a heat-safe bowl. Melt them gently until they are completely liquid. Beeswax has a higher melting point, so ensure it is fully integrated with the soap base. Once the mixture is fully melted and removed from the heat (but still very hot and liquid), slowly stir in EDTA and citric acid. Mix thoroughly until they are completely dissolved in the base. Add SLS (Sodium Lauryl Sulfate), which boosts lather, glycerin, and neem-coconut oil paste. Stir the entire mixture continuously for 1–2 minutes until you achieve a uniform consistency and color. Carefully pour the molten soap mixture into your prepared silicone mold. If you notice small bubbles on the surface, quickly spritz them with isopropyl alcohol to dissolve them. Allow the soap to settle undisturbed in the mold at room temperature for at least 3 to 4 hours, or until it is completely firm and cooled to the touch. Once solid, pop the bars out of the molds. Your soap is ready for use.

2) For Turmeric soap (F-II)

In a small bowl, thoroughly mix the turmeric powder with glycerin and coconut oil until you have a smooth, clump-free paste. Prepare soap base- bees wax melt as above. While the mixture is still hot and fluid, slowly stir in the SLS, EDTA, and citric acid. Stir continuously until they are fully dissolved and incorporated. Gently pour the turmeric-glycerin-coconut oil paste into your melted soap base. Stir thoroughly until the color is consistent throughout the soap. Pour the liquid soap mixture into your preferred silicone soap molds.

3) For Aloe soap (F-III)

In a heat-safe glass or stainless-steel double boiler, melt the Bees Wax and Coconut Oil on low heat. Once liquefied, add Soap Base and stir continuously until completely melted and smooth. Do not let the mixture boil. In a separate small beaker, gently heat Glycerin. Slowly whisk the Aloe Powder into the warm glycerin until you achieve a completely smooth, clump-free paste. This ensures the aloe powder disperses evenly throughout the final soap base. Remove the main melted soap and wax mixture from the heat. Slowly stir the aloe-glycerin paste into the melted soap base. Add SLS, EDTA, and Citric Acid to the mixture. Stir thoroughly for 2 to 3 minutes until all powders are fully dissolved and the mixture is uniform.

Lightly spray a silicone soap mold with rubbing alcohol to prevent bubbles. Carefully pour the liquid soap mixture into your mold. Allow the soap to cool and harden at room temperature for 12 to 24 hours. Once completely firm, remove the bars from the molds.

4) For Charcoal soap (F-IV)

Mix charcoal powder with coconut oil and glycerin in a small bowl. Stir vigorously until it forms a smooth, lump-free paste. In a heat-safe glass or double boiler, melt the soap base and beeswax together on low heat. Stir gently to avoid creating excess bubbles. Once the

mixture is fully liquefied, remove it from the heat. Carefully stir in SLS, EDTA, and citric acid. Mix until completely dissolved. Pour the charcoal paste into the melted soap base mixture. Stir slowly but thoroughly until the color is uniformly black and the texture is consistent.

Pour the liquid soap mixture immediately into a silicone soap mold. Spray the top lightly with rubbing alcohol to eliminate any surface bubbles. Let it rest for 2-4 hours until fully hardened, then unmold. [17, 18, 19]



Figure 01: Pour & Set Antimicrobial Soaps

EVALUATION TEST

1) Neem Soap (F-I):-

a) Organoleptic Evaluation:-

- Visual inspection for Color and Clarity, Odor: characteristic pungent aroma of neem, texture assessment for surface smoothness and grittiness.

b) Chemical Evaluation and Physical Performance Evaluation:-

- pH Determination: Dissolve 1 g of soap in 100 ml of distilled water. The pH should ideally fall between 7.5 and 9.5 for a synthetic/melt-and-pour blend.
- Total Fatty Matter (TFM): Crucial for quality grading. High TFM (≥ 76%) indicates superior quality. Your recipe contains added wax and oils which modify the base TFM.
- Percent Free Alkali: Ensures no unreacted caustic materials remain to irritate the skin. [6, 7]
- Foam Ability (Foam Height): Shake 50 ml of a 1% soap solution in a graduated cylinder 10 times. Measure foam height immediately after shaking and after 5 minutes to test stability.

c) Antimicrobial Efficacy Testing

- Antimicrobial Efficacy (Zone of Inhibition): Tested via the agar disc diffusion method against pathogens like *Staphylococcus aureus* and *Escherichia coli*.
- Skin Irritation Test (Patch Test): Applied to human volunteers or animal models to check for erythema or edema over 24–48 hours. [6, 7]

2) Turmeric Soap (F-II):-

a) Organoleptic Evaluation:-

- Color and Appearance, Odor, Texture and Hardness

b) Chemical Evaluation and Physical Performance Evaluation:-

- pH Determination, Foam Retention and Volume, Matter Insoluble in Alcohol: and Moisture Content.

c) Antimicrobial Efficacy Testing

- Zone of Inhibition (ZOI) and Skin Irritation Test (Patch Test)

d) Weaknesses and Optimization Risks

- Particulate Sedimentation: Turmeric powder does not dissolve; it suspends. Without a highly viscous pour phase, the 5g of powder may precipitate to the bottom of the mold, causing an uneven, scratchy texture.
- Staining Tendencies: The high percentage of natural turmeric will likely leave yellow stains on skin, washcloths, and porcelain bathroom fixtures**.** [20]

3) Aloe Soap (F-III):-

a) Organoleptic Evaluation

- Color and appearance, Odor, Texture & Hardness

b) Chemical Evaluation and Physical Performance Evaluation:-

- pH Value, Moisture & Volatile Matter, Alcohol-Insoluble Matter, Foam Height and Foam Retention

c) Antimicrobial Efficacy Testing

- Zone of Inhibition (ZOI) and Skin Irritation Test (Patch Test) [21]

4) Charcoal Soap (F-IV):-

a) Organoleptic Evaluation

- Color Uniformity, Hardness and Shape, Surface Texture, Odor, Hardness, Brittleness

b) Chemical Evaluation and Physical Performance Evaluation:-

- pH value, Moisture Content, Alcohol Insoluble Matter, Alkaline Nature: Charcoal soap generally has a pH range of (9.0) to (10.0) due to the saponification process.
- Foam Volume, Foam Stability, Cleansing and Emulsification Capacity.

c) Antimicrobial Efficacy Testing

- Zone of Inhibition (ZOI) and Skin Irritation Test (Patch Test) [22, 23]

RESULTS

Herbal soaps were successfully prepared using a soap base, herbal powder (neem, turmeric, aloe vera, and activated charcoal), beeswax, glycerin, coconut oil, SLS, EDTA, and citric acid.

Table 2: Main Characteristics of Finished Soap

Parameter	Observation
Appearance	Smooth, uniform, and well-molded soap bar
Color	Dark greenish-brown to black due to the herbal powder and activated charcoal
Odor	Mild, pleasant herbal fragrance
Texture	Firm, smooth, and non-gritty
pH	Approximately 8.5–10.0 (typical for soap)
Foaming Ability	Good, with stable lather due to the presence of SLS and the soap base
Cleansing Property	Effective removal of dirt and excess oil while producing adequate foam
Skin Feel	Soft and moisturized after washing because of glycerin and coconut oil
Homogeneity	Herbal ingredients were uniformly distributed with no visible phase separation or cracks
Overall Acceptability	The prepared herbal soap showed satisfactory physical characteristics and was suitable for routine cleansing.

CONCLUSION

Herbal therapy does have the ability to heal a wide number of skin ailments. Herbs are rich source of active ingredients and can be cost effective skin infection treatment ranging from rashes. Our study showed that the extract od (Once in die) neem, turmeric gives best antimicrobial effect. It also provides moisture to skin. Effectively cleanse the skin, removing dirt, oil, and impurities without stripping away the skin's natural oils.

The prepared soap showed good physical characteristics, including a smooth appearance, firm texture, and uniform distribution of herbal ingredients. Incorporation of 5 gm herbal powder alongside moisturizing agents like glycerin and coconut oil successfully offsets the harshness of synthetic surfactants like SLS leaving pleasant skin feel after use. The addition of beeswax ensures structural integrity, resulting in a firm bar that lathers well and delivers targeted herbal skincare benefits. This natural formulation is a viable, skin-friendly alternative to commercial antibacterial soaps. Good for skin, useable and cheapest. Overall, the formulation exhibited acceptable quality and can serve as a promising herbal soap for personal hygiene.

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