



Formulation And Evaluation Of Antimicrobial Facewash From Coconut Leaves

¹ Mr. Ayush Shrenik Upadhye, ² Mr. Sanyam Vardhaman Thole, ³ Ms. Manasi Keshav Tate,

⁴ Ms. Gauri Abasaheb Undare, ⁵ Ms. Poonam Rajendra Bramhane.

¹ Student, ² Student, ³ Student, ⁴ Student, ⁵ Assistant Professor

⁵ Department of Pharmaceutics,

Rasiklal M. Dhariwal Institute of Pharmaceutical Education & Research, Acharya Anand Rushiji Marg, Chinchwad, Pune 411019.

Abstract: The increasing demand for natural and effective skincare products has led to the development of facewashes incorporating antimicrobial agents derived from plant-based sources. This study focuses on the formulation, characterization and evaluation of a facewash enriched with antimicrobial ingredients, including extracts from coconut leaves, known for their potent antimicrobial activity. The facewash formulation combines surfactants with natural extracts such as coconut leaf extract, to enhance skin health and combat microbial growth. The antimicrobial activity was assessed using standard methods against common skin pathogens, including *Escherichia coli*. Results demonstrated significant antimicrobial efficacy, alongside favourable pH balance, viscosity, and skin compatibility. The facewash exhibited strong cleansing performance with minimal irritation, suggesting its potential as an effective, natural alternative for daily skincare routines.

Keywords- Antimicrobial activity, Coconut leaf, Tamarind seeds, Semisynthetic, Skin compatible.

1. INTRODUCTION

- The skin is the largest organ of the body, and facial skin is particularly sensitive and a key reflection of an individual's personality. It performs numerous vital functions, including protection against external physical, chemical, and biological threats. To maintain healthy, clear, and radiant skin, a balanced and nutritious diet is essential ^[1]. Facewash removes the dirt, sebum, oil and dead skin cells ideally without damaging or irritating the skin ^[2].
- Antimicrobial activity is a critical factor in maintaining healthy skin, as it helps prevent the growth of harmful microorganisms that can lead to skin infections, irritation, and other dermatological issues. Skin disorders often occur when the skin's natural barrier is compromised, allowing bacteria, fungi, and viruses to thrive. This can result in various conditions, including inflammation, redness, and the development of pustules or lesions ^[2].
- The skin, being the body's largest and most exposed organ, plays a vital role in protecting against harmful UV rays, producing vitamin D, regulating body temperature, and serving as a barrier against mechanical, physical, and thermal trauma ^[1].
- In recent years, increased exposure to environmental pollutants such as polycyclic aromatic hydrocarbons, volatile organic compounds, oxidants, particulate matter, and cigarette smoke has significantly impacted skin health. These pollutants contribute to skin irritation, redness, allergies, infections and even more severe conditions like skin cancer. Such environmental factors are leading causes of poor skin health in both children and adults ^[3].

1. Ingredients

- 1) Coconut Leaves (Powder)
- 2) Tamarind Seeds (Powder)
- 3) Lemon Fruit (Powder)
- 4) Sodium Lauryl Sulphate
- 5) Rose Oil
- 6) Glycerine
- 7) Disodium EDTA
- 8) Methyl paraben
- 9) Distilled Water

2. Introduction of Ingredients

a) Coconut Leaves (Powder)

- Coconut is often referred as impressive nutritional profile, containing nearly all the essential nutrients required by the human body. It serves as a unique source of natural compounds that can be used in the development of medicines to treat various diseases, as well as in the creation of industrial products ^[3].
- Coconut (*Cocos nucifera* leaves), a tropical perennial crop, belongs to the Arecaceae family and has a wide range of uses ^[3].
- The antibacterial activity of young coconut leaf extract was tested against “*Staphylococcus aureus*” (gram-positive) and “*Escherichia coli*” (gram-negative) bacteria at a concentration of 1000 ppm. The bacterial culture, with a concentration of 10^6 - 10^7 CFU/mL, was collected using 0.1 mL of the culture and plated on MacConkey agar using the pour plate technique. A 0.1 mL sample of the extract was then applied to each well with a diameter of 6 mm. The plates were incubated at 37°C for 24 hours. The antibacterial activity was assessed by measuring the diameter of the clear zone formed around each well. This test evaluated the extract's effectiveness against both gram-positive and gram-negative bacteria ^[4].
- The constituents of “*Cocos nucifera*” (coconut) exhibit various biological effects, including anthelmintic, anti-inflammatory, antioxidant, antifungal, antimicrobial and antitumor activities ^[5].

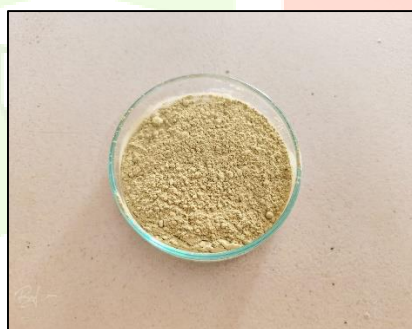


Figure 1: Coconut Leaves (powder)

b) Tamarind Seeds (Powder)

- Tamarind seed powder, also known as tamarind gum or tamarind kernel powder (TKP), is derived from the endosperm of the tamarind seed. The preparation process involves decorticating the seed, which includes roasting and de-hulling to remove the seed coat. Afterward, the decorticated seed is ground using machines to the desired mesh size, resulting in a fine powder. TKP is rich in high molecular weight polysaccharides, and the water-soluble polysaccharides extracted from it contain glucose, xylose, and galactose, collectively referred to as xyloglucan ^[8].
- Tamarind seed kernel powder is a significant by-product of the tamarind pulp industry. It contains a polysaccharide called xyloglucan, also known as 'tamarind gum.' This natural gum is widely used as a thickening, stabilizing, and gelling agent in processed foods ^[9].



Figure 2: Tamarind Seeds (Powder)

c) Lemon Fruit (Powder)

- Citrus Limon has garnered significant attention in cosmetology due to its wide range of bioactive compounds. This review highlights its cosmetic applications, focusing on its antioxidant, anti-inflammatory, antimicrobial, skin-brightening, preservative and substance-penetrating properties ^[10].
- Limon's powerful antimicrobial properties make it effective against various bacteria, helping to treat skin issues like acne while also acting as a natural preservative in cosmetics. Rich in limonene and vitamin C, C. Limon inhibits tyrosine activity and reduces melanin production, making it a promising ingredient in cosmetics for managing skin pigmentation and promoting a more even-toned, brighter complexion. The review also covers important safety considerations for its use in cosmetic formulations ^[11].



Figure 3: Lemon Fruit (powder)

d) Sodium Lauryl Sulphate

- ❖ Sodium lauryl sulphate (SLS) is a versatile compound with several unique properties, including its function as an anionic emulsifier, detergent, solubilizes tablet and capsule lubricant, wetting agent, and excipient in dissolvable dosage forms. Derived naturally from coconut and/or palm kernel oil, SLS typically consists of a mixture of sodium alkyl sulphates, primarily lauryl alcohol. It is widely used in non-parenteral formulations, cosmetics, and food additives ^[12].

❖ Cosmetic Applications

1. Facewash
2. Shampoos
3. Bath products
4. Hair colourings
5. Facial makeup
6. Deodorants
7. Shaving preparations

- ❖ **Use in Medicinal Products:** SLS serves various functional roles in pharmaceutical preparations, particularly as a skin cleanser in topical applications, typically at a concentration of 1% w/w ^[12].



Figure 4: Sodium Lauryl Sulphate

e) Rose Oil

- ❖ **Biological Source:** Rose oil is derived from the flowers of *Rosa damascene*.
- ❖ **Uses:** Rose oil is primarily used in the preparation of scented and perfumed products. The flowers are a key ingredient in perfumes and other fragrant items due to their natural, aromatic fragrance. Roses are widely utilized in the production of perfumes, room fresheners, and various other scented products ^[13].

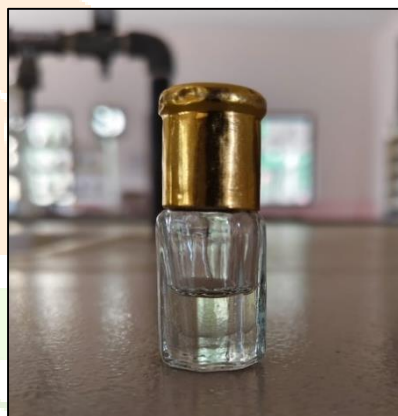


Figure 5: Rose Oil

f) Glycerine

- Glycerine is commonly used in face wash formulations due to its humectant properties, which means it attracts moisture from the air and helps retain it in the skin. This makes glycerine an excellent ingredient for keeping the skin hydrated and preventing dryness ^[14].
- In face wash products, glycerine works as a moisturizing agent, ensuring that while the product cleanses the skin, it also maintains skin hydration and prevents it from becoming too dry or tight. It also helps improve the texture of the product, making it smoother and more gentle on the skin. Additionally, glycerine can aid in soothing and softening the skin, making it a popular choice in facial cleansers, especially for those with sensitive or dry skin ^[15].

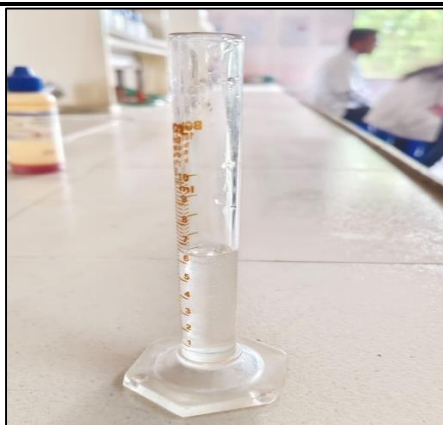


Figure 6: Glycerine

g) Disodium EDTA

- **Disodium EDTA** is a versatile compound used across various industries due to its ability to act as a preservative, colour retention agent, antioxidant, and chelating agent.
- **Chelating agent:** Helps to neutralize metal ions in products, preventing them from affecting product stability or performance.
- **Antioxidant:** Prevents metal-catalysed oxidative breakdown, enhancing the shelf life of cosmetics.
- **Preservative:** Helps extend the shelf life by preventing microbial growth.
- **Cleaning agent:** Used in cleaning agents for metal surfaces, preventing corrosion and build up ^[16].

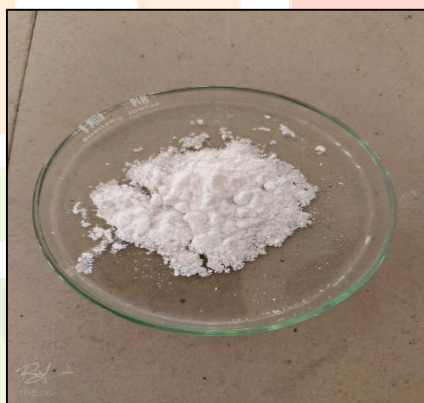


Figure 7: Disodium EDTA

h) Methyl paraben

- ❖ Methyl paraben is commonly used as an antimicrobial preservative in cosmetics, food products, and pharmaceutical formulations. It can be used on its own, in combination with other parabens, or alongside other antimicrobial agents ^[17]. In the cosmetics industry, methyl paraben is the most frequently used preservative due to its effective antimicrobial properties, helping to prevent the growth of bacteria, mould and yeast in cosmetic products ^[18].



Figure 8: Methyl paraben

2. MATERIALS AND METHOD

1. MATERIALS

❖ Plant Materials

a) Collection and drying of plant parts

The leaves of *Cocos nucifera* leaves and Dried seeds of *Tamarindus indica* L. were collected from plants and local market. The plant specimens dried in pharmaceutical hot air oven. The leaves of *Cocos nucifera* leaves, the seeds of *Tamarindus indica* L. ground to get powder [3].

2. Preparation of Plant Extract

a) Extraction of leaves of *Cocos nucifera* Leaves powder

- ❖ A quantity (0.2g) of the powder was boiled with 5ml of 2% HCl on a steam bath. The mixture was filtered [3].

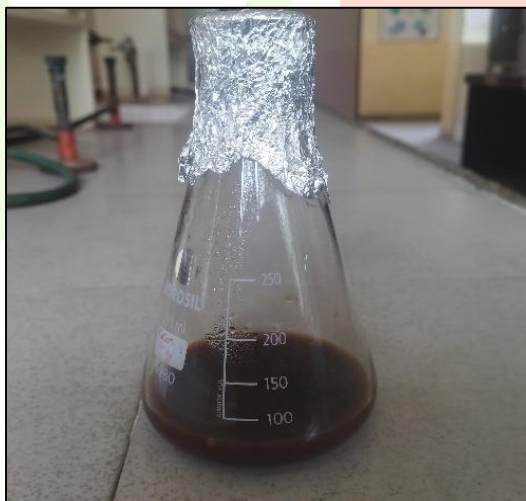


Figure 9: Extraction of leaves of *Cocos nucifera* leaves powder

b) Extraction of Fruit of Citrus Limon

❖ Method: Solvent Extraction

1. **Juice extraction:** Fresh lemons are juiced to extract the lemon juice.
2. **Filtration:** The lemon juice is filtered to remove any impurities or sediment.
3. **Solvent extraction:** The filtered juice is mixed with a solvent, such as ethanol or glycerine, to extract the bioactive compounds.
4. **Filtration:** The solution is filtered to remove any impurities or sediment.

5. **Concentration:** The filtered solution can be concentrated through evaporation or heat treatment to create a liquid extract [5].

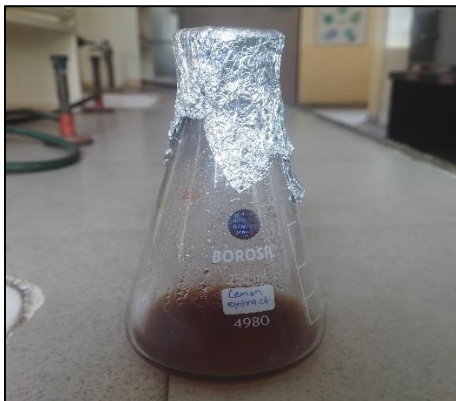


Figure 10: Extraction of Fruit of Citrus Limon

c) Tamarind Seeds Powder

- ❖ Making tamarind seed powder involves several steps to ensure the seeds are clean, dried and finely ground. Here's a step-by-step procedure.

❖ Steps:-

1. **Collection of Tamarind Seeds:** Begin by collecting tamarind seeds from the ripe tamarind pods. Ensure the seeds are clean and free from any pulp or other impurities.
2. **Cleaning:** Rinse the tamarind seeds thoroughly with water to remove any dirt, debris, or pulp residue. This ensures the seeds are clean before drying and grinding.
3. **Drying:** Spread the cleaned tamarind seeds in a thin layer on a tray or drying surface. Allow the seeds to dry completely in a well-ventilated area, preferably under the sun. This process can take anywhere from 2-3 days, depending on the weather. Alternatively, you can dry the seeds in an oven at a low temperature (around 40–50°C or 104–122°F) for a few hours, ensuring they are fully dried and crisp.
4. **Removing the Seed Shells (Optional):** Once the seeds are dry, you can remove the hard outer shells. This can be done manually by cracking the seed or using a mechanical seed de-shelling machine. If you prefer to keep the shell intact for grinding, you can skip this step.
5. **Grinding:** After drying and possibly de-shelling, place the tamarind seeds into a grinder or mill. Grind the seeds into a fine powder. You may need to grind in batches, depending on the capacity of your grinder.
6. **Sieving:** For a smoother texture, pass the powder through a fine sieve no.100 for getting fine particles [8-9].

3. FORMULATION TABLE

Sr.no.	Ingredients	Quantity				Uses
		F1	F2	F3	F4	
1	Coconut extract	3ml	3ml	3ml	3ml	Antimicrobial agent
2	Tamarind powder	2gm	3gm	4gm	5gm	Thickening agent
3	Lemon extract	0.5ml	0.5ml	0.5ml	0.5ml	Antioxidant
4	SLS ^[19]	0.5gm	0.9gm	1.2gm	1.5gm	Foaming agent
5	Rose oil	QS	QS	QS	QS	Fragrance
6	Glycerine	1ml	1ml	1ml	1ml	Humectant
7	Disodium EDTA	0.5gm	0.5gm	0.5gm	0.5gm	Chelating agent
8	Methyl paraben	0.5gm	0.5gm	0.5gm	0.5gm	Preservatives
9	Distilled water	QS	QS	QS	QS	Solvent

Table 01: Formulation table for 100gm facewash

4. Procedure:

• Step 1: Preparation of Water Phase

1. Heat the Distilled Water to approximately 60-70°C in a clean container.
2. Add the Tamarind Powder to the heated water while stirring continuously to help it dissolve. Ensure that the powder is fully dissolved and forms a uniform mixture.
3. Add the Glycerine into the water phase and stir well to blend. Glycerine helps to attract moisture and maintain skin hydration.

• Step 2: Preparation of Surfactant Phase

1. Blend Sodium Lauryl Sulphate (SLS) and Coconut Extract together in a separate container. SLS acts as the primary cleansing agent, while the coconut extract offers antimicrobial and moisturizing properties.
2. Add the Lemon Extract to this phase. Lemon extract provides natural exfoliation and skin brightening benefits.
3. Stir gently until all the ingredients in the surfactant phase are homogeneously mixed.

• Step 3: Combining Water and Surfactant Phases

1. Gradually add the surfactant mixture to the water phase while stirring continuously. This ensures proper emulsification and avoids air bubbles.
2. Continue mixing until the formulation reaches a smooth and homogeneous texture.

• Step 4: Adding Active Ingredients and Preservatives

1. Add Rose Oil to the formulation for its aromatic and skin-soothing properties. Ensure its thoroughly mixed into the formulation.
2. Add Disodium EDTA, a chelating agent that helps stabilize the formulation and improve shelf life by binding metal ions.
3. Add Methyl Paraben as a preservative to prevent microbial growth and enhance the shelf life of the product.
4. Mix all ingredients gently, ensuring the uniform distribution of all components.

• Step 5: pH Adjustment

1. Measure the pH of the formulation using a pH meter. The ideal pH for a face wash is between 4.5 and 5.5.
2. If necessary, adjust the pH by adding small amounts of citric acid (to lower pH) or sodium hydroxide (to raise pH). Stir thoroughly after adjustments.

• Step 6: Cooling and Final Mixing

1. Allow the face wash formulation to cool down to room temperature, stirring occasionally to maintain consistency.
2. Ensure the final product is uniform and free from any separation.

• Step 7: Packaging

1. Transfer the cooled face wash into clean, sterilized containers, such as plastic or glass bottles.
2. Seal the containers tightly to prevent contamination and ensure the product remains effective during use.

• Step 8: Quality Control

1. Conduct necessary quality control tests to ensure the product meets the required standards for safety, efficacy and shelf life.

5. Evaluation Test

- a) pH test
- b) Skin irritation test
- c) Wash ability test
- d) Antimicrobial test
- e) Evaluation of extract
- f) Phytochemical Screening of coconut leaves extract

a) pH test

- Beaker and pH meter was taken. 3 readings of pH were taken. First the sample was taken in the beaker. 100ml water poured in beaker to that 1-2gm of sample was poured and stirred until it form solution. Then pH paper was dipped into beaker and reading were rewarded. It was found that pH was 5-6 range [6].

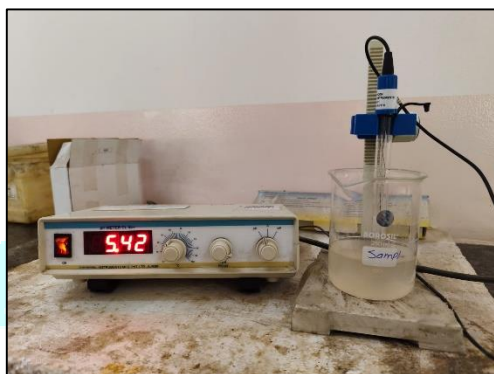


Figure 11



Figure 12

b) Skin irritation test

- The was poured on the surface of hands on 3 to 4 places and it was keep for 5 to 10 minutes. To check whether it cause irritation or not. It was found that no irritation seen or occurred [6].



Figure 13: Skin irritation test

c) Wash ability test

- The was taken on the hand and rubbed to create foam and the it was washed with water. So, it found that sample was easily washable ^[7].

**Figure 14****Figure 15****d) Antimicrobial test**

- MacConkey agar was used to produce bacterial & Culture media. All Petri plates were sterilized at 120°C for 15 min in autoclave. Then 100 ml distilled water was taken in beaker & boiled on water bath & aseptic area was cleaned by using 70% ethanol. Then MacConkey agar media was weighed (4.57 g) & fixed in boiling water bath (boiling time 1-2 min) & then this beaker kept at aseptic area and solution poured into petri plates & lid was closed & waited until it gets solidified ^[6]. The bacterial solution was prepared from soil & drainage water. Then with nichrome wire bacterial solution was streaked on solidified agar media & kept for 24-48 hrs in incubation to grow bacteria & holes was also made to pour sample. Then bacteria were grown on media then Coconut extract was poured to check antibacterial activity ^[7].

**Figure 16: Escherichia coli bacteria (Before)****Figure 17: Escherichia coli bacteria (After)**

3. RESULT AND DISCUSSION

- The formulation and evaluation of the semisynthetic facewash cleanser enriched with antimicrobial agents derived from natural sources, such as coconut leaf extract, tamarind seed powder have demonstrated with results. The facewash exhibited significant antimicrobial activity against common skin pathogens, including *Escherichia coli*, confirming the efficacy of the natural extracts as active antimicrobial agents. The inclusion of semisynthetic surfactants like Sodium Lauryl Sulphate (SLS) combined with natural humectants such as glycerine, contributed to a balanced cleansing action while maintaining skin hydration. The formulation achieved a favourable pH range of 6-7, aligning with the natural pH of human skin, thereby minimizing the risk of skin irritation. The skin irritation test confirmed that the product is gentle and safe for daily use, with no adverse reactions observed. Furthermore, the facewash exhibited excellent wash ability and foaming properties.
- Overall, the semisynthetic facewash formulation represents an effective, natural and skin-compatible Alternative to conventional facewashes. It not only meets the growing consumer demand for eco-friendly and plant-based skincare products but also offers a safe, antimicrobial daily skincare routines.

1. Evaluation of extract

- Characteristics of extract:**

Sr. no.	Characteristics	Coconut leaf	Lemon extract
1	Physical state	Liquid	Liquid
2	Colour	Brownish	Brownish
3	Odour	Pleasant	Pleasant
4	Taste	Characteristics	Bitter

Table 02: Evaluation of extract

2. Phytochemical Screening of coconut leaves extract

Sr.no.	Phytoconstituent	Coconut leaves
1	Alkaloids	+ve
2	Flavonoids	+ve
3	Glycosides	+ve
4	Steroids	+ve
5	Terpenoids	+ve
6	Saponins	+ve
7	Tannins	+ve
8	Acidic compound	+ve
9	Proteins	+ve
10	Reducing sugars	+ve

Table 03: Phytochemical Screening of coconut leaves extract

3. Antimicrobial test

Sr. no.	Characteristics	Coconut leaf	Lemon extract
1	Physical state	Liquid	Liquid
2	Colour	Brownish	Brownish
3	Odour	Pleasant	Pleasant
4	Taste	Characteristics	Bitter

Table 04: Antimicrobial test

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