INNOVATIVE DEVELOPMENT AND COMPREHENSIVE CHARACTERIZATION OF HERBAL SOAP DERIVED FROM *COUROUPITA GUIANENSIS* FRUIT

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ABSTRACT

Herbal soaps formulated with plant-based bioactive compounds have gained considerable attention due to their safety, biodegradability, and therapeutic benefits. The present study focuses on the development and characterization of a herbal soap incorporated with fruit extract of *Couroupita guianensis* (cannonball tree), a medicinal plant known for its antimicrobial properties. The fruit extract was obtained using suitable solvent extraction methods and incorporated into a soap base prepared by the saponification process. The formulated herbal soap was evaluated for various physicochemical parameters such as pH, foam height, foam retention, moisture content, hardness, and stability, which confirmed its suitability for topical application. The antimicrobial efficacy of the formulated soap was assessed against selected bacterial and fungal strains using standard microbiological methods. The results demonstrated significant antibacterial and antifungal activity, attributed to the presence of bioactive phytoconstituents in *Couroupita guianensis* fruit. The formulation showed good cleansing ability, acceptable physicochemical characteristics, and enhanced antimicrobial potential compared to the control soap base. This study concludes that herbal soap containing *Couroupita guianensis* fruit extract can serve as an effective natural alternative to synthetic antimicrobial soaps, with potential applications in personal hygiene and dermatological care.

Keywords– *Couroupita guianensis* , Herbal soap , antibacterial and antifungal activity etc.

1. Introduction

Medicinal plants have been an essential component of human healthcare since ancient times, with early civilizations depending on natural plant-based remedies to treat various diseases. Through centuries of observation and traditional practices, extensive knowledge has been gained regarding the healing properties of plants. Among these medicinally significant plants is *Couroupita guianensis* Aubl., belonging to the family Lecythidaceae, which is valued for both its therapeutic and ornamental importance. *Couroupita guianensis*, commonly known as the cannonball tree, derives its name from its large, round fruits that resemble cannonballs. It is a tall, evergreen tropical tree widely cultivated for its striking flowers and unique fruits. The plant is commonly found in rural and regions, where it has been traditionally used in indigenous medicinal systems. In India, tribal the tree is popularly referred to as the "Naga Linga" tree because the floral structure

resembles a sacred serpent protecting the Shiva Lingam. The genus *Couroupita* consists of over thirty species distributed throughout tropical regions, and the Nagalingam flower has been declared the State Flower of Puducherry.The plant possesses a broad spectrum of pharmacological activities due to its rich phytochemical composition. Recent scientific investigations have reported several biological properties of *C. guianensis*, including anti-inflammatory, immunomodulatory, and neuroprotective effects. In Ayurvedic medicine, various parts of the plant are extensively used for therapeutic purposes. The flowers exhibit significant antibacterial and antifungal activities, while the plant as a whole is known for its antibiotic, antiseptic, analgesic, and antifungal properties. Traditionally, *C. guianensis* has been employed in the treatment of ailments such as gastritis, scabies, dysentery, bleeding piles, and scorpion stings. Different plant parts, including leaves, flowers, bark, and fruits, are used to manage conditions such as hypertension, tumors, pain, inflammation, and skin disorders. Leaf extracts are commonly applied to treat skin diseases, and in South American traditional medicine, various parts of the plant are used in the management of malaria.The fruits of *C. guianensis* are large, woody, and spherical, growing in clusters directly on the trunk. Although edible, their strong odor often limits their consumption. The seeds are embedded in a jelly-like pulp, and the hard outer shells of the fruits are traditionally utilized for making containers and utensils. Due to its medicinal importance and remarkable aesthetic appeal, the cannonball tree is widely cultivated in gardens and public spaces. Its deep root system, large canopy, and fragrant pink flowers enhance its value as both a medicinal and ornamental plant.[4]Soaps are commonly used cleansing agents that aid in removing dirt, oils, and microorganisms from the skin, playing a crucial role in maintaining personal hygiene and preventing skin infections. However, many commercially available soaps contain synthetic chemicals, artificial colors, and fragrances that may cause skin irritation, dryness, or allergic reactions with prolonged use. These adverse effects have increased interest in herbal soaps formulated using natural plant-based ingredients. Herbal soaps are prepared using medicinal plant extracts that exhibit beneficial properties such as antibacterial, antifungal, anti-inflammatory, and antioxidant activities. These soaps are generally gentle on the skin, biodegradable, and environmentally friendly. Traditional medicinal systems, including Ayurveda, have long advocated the use of herbal formulations for skin care and the treatment of various skin conditions. Incorporating herbal ingredients into soap formulations enhances their therapeutic potential and makes them suitable for daily use, particularly for individuals with sensitive skin.In recent years, scientific research has increasingly focused on the development of herbal soaps containing plant extracts with proven antimicrobial properties. Such formulations provide a safe and natural alternative to synthetic soaps. Therefore, the present study aims to formulate and evaluate a herbal soap using plant-based ingredients with antibacterial and antifungal activities to promote better skin hygiene and overall skin health.[1-6]

A. **Advantages of Herbal Soap over Synthetic Soaps-**

Herbal soaps offer several benefits when compared to synthetic soaps due to the presence of natural ingredients such as plant extracts, herbs, and essential oils.

a) **Gentle on the skin:** Herbal soaps are generally mild and soothing, making them suitable for people with sensitive or delicate skin.

b) **Natural ingredients:** These soaps contain naturally nourishing and moisturizing components such as shea butter, coconut oil, olive oil, and aloe vera, which help maintain skin health.

c) **Free from harsh chemicals:** Herbal soaps do not contain artificial fragrances, synthetic colors, or harmful chemicals, thereby reducing the risk of skin irritation and allergic reactions.

d) **Eco-friendly:** Since they are made from natural substances, herbal soaps are biodegradable and cause less harm to the environment compared to synthetic soaps.

e) **Aromatherapy benefits:** The presence of essential oils in herbal soaps provides calming effects, helps reduce stress, improves mood, and promotes relaxation.

f) **Natural antimicrobial action:** Some herbal ingredients, such as neem and tea tree oil, possess antibacterial properties that help protect the skin from infections and keep it clean.[7]

2. Introduction of plant

Figure 1 Couroupita guianensis tree

Botanical Name: *Couroupita guianensis*Aubl

Family: Lecythidaceace

Common Name: Cannonball tree

Taxonomical Classification

Kingdom: Plantae

Division: Angiosperms

Class: Dicotyledonae

Order: Ericales

Genus:*Couroupita*

Species:*Couroupita guianensis*

Geographical Distribution- *Couroupita guianensis* is native to the tropical regions of South America and is widely distributed in tropical and subtropical regions, including India, Sri Lanka, Malaysia, and Southeast

Asia. In India, the tree is commonly cultivated in temples, gardens, and public places for ornamental and medicinal purposes. The Nagalingam flower has been recognized as the State Flower of Puducherry.

Botanical Description-*Couroupita guianensis* is a large evergreen tropical tree characterized by a straight trunk and deep root system. The leaves are simple, large, glossy, and arranged in clusters. The flowers are large, showy, and pink to purplish in color with a distinct fragrance. The fruits are large, spherical, woody structures resembling cannonballs and are borne in clusters on the trunk. The seeds are small, white, and embedded in a jelly-like pulp with a strong odor.[10]

Phytochemical Constituents- Phytochemical investigations of *C. guianensis* have revealed the presence of various bioactive compounds such as flavonoids, alkaloids, tannins, glycosides, saponins, terpenoids, and phenolic compounds. These constituents are responsible for the diverse pharmacological activities of the plant.[10]

Pharmacological Activities-Various studies have reported that *Couroupita guianensis* exhibits multiple pharmacological properties, including antibacterial, antifungal, anti-inflammatory, analgesic, antioxidant, immunomodulatory, and neuroprotective activities. The flowers and leaves, in particular, have shown significant antimicrobial potential.[10]

Traditional and Medicinal Uses- In traditional systems of medicine, different parts of *C. guianensis* such as leaves, flowers, bark, and fruits are used for the treatment of skin diseases, wounds, inflammation, gastritis, dysentery, hypertension, and infections. Leaf extracts are commonly applied for skin ailments, while the plant is also used traditionally for the management of scorpion stings and malaria.[10]

Ethnobotanical Importance-The plant holds religious and cultural significance in India, where it is known as the "Naga Linga" tree. The floral structure is believed to symbolize a sacred serpent protecting the Shiva Lingam, contributing to its widespread cultivation near temples.

Application in Herbal Formulations- Due to its antimicrobial and skin-protective properties, *Couroupita guianensis* is widely explored for use in herbal formulations such as soaps, ointments, creams, and topical preparations aimed at improving skin health and preventing microbial infections.

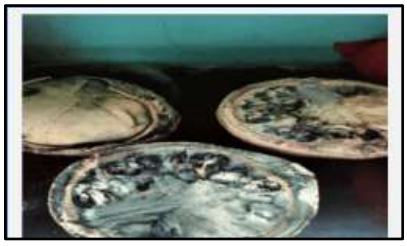
3. Ingredient profile[8]

Table No 1: Ingredients

Sr. No.	Ingredients	Use	Picture
1.	Fruit extract of couroupita guianensis	AntimicrobialAntibacterial Antibiofilm, Antifungal.	
2.	Neem (Azadirachta Indica)	Nourishes skin. Treat Fungal Infections. Treat acne.	
3.	Tulsi (Ocimum Tenuiflorum)	Helps clear out the skin of blemishes and acne Skin contains high levels of vit C	
4.	Turmeric (Curcuma Longa)	Deals with Dull skin. Reduces dark circles.	
5.	Aloevera	Helps to moisturize the skin. Reduces infection and acne.	

6.	Almond	Moisturize and brighten skin,calms irritation.	
7.	Rose oil	Soothes skin irritation. Heals cuts,scars,burns. Antiaging and antioxidant.	

4. **Preparation of plant extract** – By maceration process[11]



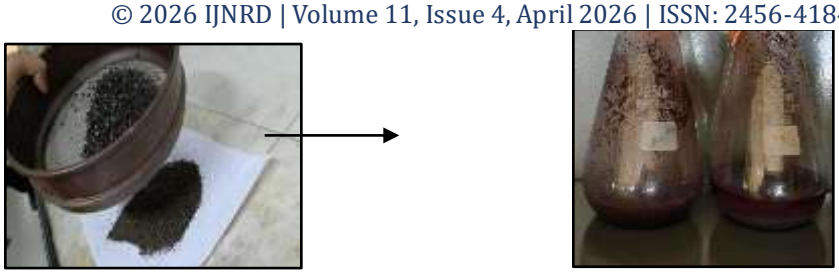
Collected fruit

Finely choped into small piece

After removing their peel

Shade dry for 10-15 days

Fine powder was obtained mechanically using commercial electrical stainless-steel blender



Then powder pass through Sieve no 80

Extraction of Couroupita guianensis fruit by maceration

Fig. No 2: Extraction Process

5. Phytochemical Screening of Plant Extract

1. **Test for Carbohydrates:** To 0.5 ml of the filtrate, 0.5 ml of Benedict's reagent was added. The mixture was heated in a boiling water bath for about 2 minutes. The formation of a characteristic coloured precipitate indicated the presence of carbohydrates.
2. **Test for Alkaloids:** A few drops of the plant extract were taken in a test tube, and two drops of Mayer's reagent were added along the sides of the tube. The appearance of a white or creamy precipitate confirmed the presence of alkaloids.
3. **Test for Amino Acids:** To 2 ml of the aqueous filtrate, two drops of ninhydrin solution were added. The development of a purple or violet colour indicated the presence of amino acids.
4. **Test for Saponins:** The extract was diluted with distilled water to a volume of 20 ml and shaken vigorously for 15 minutes. The formation of stable foam indicated the presence of saponins.
5. **Test for Glycosides:** To 2 ml of the filtered hydrolysate, 3 ml of chloroform was added and the mixture was shaken well. The chloroform layer was separated, and 10% ammonia solution was added. The appearance of a pink colour confirmed the presence of glycosides.
6. **Test for Flavonoids:** The extract was treated with a few drops of lead acetate solution. The formation of a yellow-coloured precipitate indicated the presence of flavonoids.
7. **Test for Tannins:** A few drops of the extract were treated with 2 ml of 5% dilute ferric chloride solution. The appearance of a violet colour indicated the presence of tannins.
8. **Test for Terpenoids:** To 2 ml of the extract, a few drops of saturated trichloroacetic acid solution were added. The formation of a coloured precipitate confirmed the presence of terpenoids.[12-14]

Table No 2: Composition of herbal soap[2]

Sr.no	Ingredients	Quantity		
		F1	F2	F3
1	Extract of couroupita guianensis	3ml	3ml	3ml
2	Tulsi Powder	1.5g	2g	2.5g
3	Neem Powder	0.5	1g	1.5g
4	Turmeric Powder	0.5g	1g	1.5g
5	Aloe vera	1.5g	2.5g	3g
6	Rose oil	2ml	2ml	2ml
7	Almond oil	3ml	3ml	3ml
8	Glycerin	3ml	3ml	3ml
9	SLS	2g	2g	2g
10	Goat milk soap base	50g	50g	50g

6. Procedure

1. Take the 50 gm goat-milk soap base in a beaker.
2. Adjust and maintain the temperature for providing heat to the soap base via using water bath.
3. After heating a soap base will get converted into the liquid form.
4. Then add material mentioned in formulation table.
5. Boil the mixture using water bath.
6. Achieve proper mixture without stirring.
7. This mixture is poured into soap mold.
8. Cooled it on room temperature up to 2-3 hrs.
9. Soap is formed.[8]

Figure No.3: Prepared Herbal Soap

7. Evaluation of herbal soap

1. Determination of Organoleptic Characteristics: Clarity and color was checked by naked eyes against the white background, and the odor was smelled.

2. Size and shape Determination: The soap diameter of the size of 8.4 cm, with a thickness of 2.6 cm, which is oval-shaped, was chosen for the preparation of soap bars. This was chosen, as this size is ideal in regular usage to apply on the affected skin parts of the body.

3. Thickness determination: The thickness was determined with the help of a screw gauge which is pre-calibrated. The thickness was measured, by observing the thickness at five different parts of the soap.

4. Weight determination: The weight was determined by using a Digital weighing balance.[8]

5. Foam Height: 0.5gm of the sample of soap was taken and dispersed in 25 ml of distilled water. Then, transferred it into 100 ml measuring cylinder; the volume was made up to 50 ml with water. 25 strokes were given and stand till aqueous volume was measured up to 50 ml and measured the foam height, above the aqueous volume.[8]

6. Foam Retention: Prepared the 25 ml of the 1% soap solution and transferred it into the 100 ml measuring cylinder. Then the cylinder was shaken 10 times. The volume of foam was recorded at one minute for 4 to 5 minutes.[8]

7. pH Test: The pH test was performed for all the formulations. Each formulation of soap solution was dissolved in 20ml of distilled water and tested for pH with the help of a digital pH meter. The measurement of pH of all the formulations was done in the calibrated pH meter.[8]

8. Antibacterial and antifungal activity procedure

Two general method usually employed; One is the cup-plate method [Agar well diffusion method)-The agar cup plate method depends upon diffusion of the antibiotic from a vertical agar [well] Cylinder through a solidified agar layer on a Petri dish. Sterile Agar is inoculated by suspension of the microbial inoculum. Then well with diameter of 6 to 8 mm is punched aseptically. And then of the antimicrobial solution at desired concentration is introduced into the well. Then, agar plates are incubated under suitable conditions depending upon the test microorganism. The antimicrobial agent diffuses in the agar medium and inhibits the growth of the microbial strain entirely in a zone around the cylinder containing a solution of the substance to be tested.[9]

9. Result and Discussion:

1) Phytochemical analysis of Plant Extract:

Table no 3: Phytochemical Analysis of Plant Extract

Sr.no	Secondary metabolites	Ethanolic extract
1	Carbohydrates	++
2	Alkaloids	++
3	Amino acid	+
4	Saponin	++
5	Glycoside	++
6	Flavonoid	+
7	Tannin	++
8	Terpenoid	-
9	Sterol	++

The results indicate that the ethanolic extract is rich in bioactive constituents, particularly alkaloids, saponins, glycosides, tannins, and sterols. These phytochemicals are known to possess various pharmacological activities such as antimicrobial, antifungal, antioxidant, and therapeutic properties.

The absence of terpenoids suggests that this extract may not exhibit activities primarily associated with terpenoid compounds. Overall, the plant extract shows significant phytochemical potential and may contribute to medicinal applications.

2) Evaluation of Herbal Soap

Table no 4: Evaluation of Herbal Soap

SR.NO	PARAMETER	OBSEVATIONS		
		F1	F2	F3
1	Colour	Greenish brown	Greenish brown	Greenish brown
2	Odour	Rose like	Rose like	Rose like
3	Appearance	Good	Good	Good
4	Size	6cm	6cm	6cm
5	Shape	Oval	Oval	Oval
6	Foam height	2.5cm	2.8cm	3cm
7	Foam retension	3min	3min	3min
8	pH	7.3	7	7.3

Batch F1, F2, F3 showed color greenish brown, rose like odour, good appearance.

The size herbal soap was found to be 6cm with oval shape. It also shown good foaming property and foam retation property. The pH herbal soap was found to be 7 to 7.3.

3) Antibacterial and antifungal activity :

1. Antibacterial activity:

Table No 5: ANTIBACTERIAL ACTIVITY

Sr.No	Sample	Concentration	Zone of Inhibition (mm) *E.coli*	Zone of Inhibition (mm) *S.aureus*	Zone of Inhibition (mm) *P.acne*
1.	Control		-	-	
2.	Standard Streptomycin	1mg/ml	30	29	36

3.	Sample-SA	100µL	07	12	02
		200µL	15	17	10

The antibacterial activity of the sample extract was evaluated against E. coli, S. aureus, and P. acnes using the zone of inhibition method. The control showed no zone of inhibition, confirming that the solvent had no antibacterial activity. The standard drug (Streptomycin 1 mg/ml) exhibited significant antibacterial activity with zones of inhibition.

This indicates strong antibacterial potency of the standard drug. The Sample-SA extract showed concentration-dependent antibacterial activity.

The results indicate that the antibacterial activity increased with increasing concentration of the extract. The extract showed comparatively better activity against S. aureus, followed by E. coli, and least activity against P. acnes.

Although the activity was lower than the standard antibiotic, the plant extract demonstrated moderate antibacterial potential, suggesting the presence of bioactive compounds responsible for antimicrobial action.

E.coli

Fig No 4 Zone of Inhibition of E.coli

S.aureus

Fig. No 5: Zone of Inhibition of S.aureus

P.acne

Fig. No 6: Zone of Inhibition of P. acne

2) ANTIFUNGAL ACTIVITY

Table N0 6: ANTIFUNGAL ACTIVITY

Sr.No	Sample	Concentration	Zone of Inhibition (mm) *Candidaalbicans*
1.	Control		-
2.	Standard Fluconazole	1mg/ml	30
3.	Sample-SA	100µL	12
		200µL	18

The antifungal activity of the Sample-SA extract was evaluated against Candida albicans using the zone of inhibition method. The control showed no zone of inhibition, confirming that the solvent had no antifungal effect.

The standard drug (Fluconazole 1 mg/ml) showed a significant zone of inhibition of 30 mm, indicating strong antifungal activity.

The Sample-SA extract showed concentration-dependent activity. The results indicate that the antifungal activity increased with increasing concentration of the extract. Although the activity was lower compared to the standard drug, the extract exhibited moderate antifungal potential against Candida albicans. This suggests the presence of bioactive phytoconstituents in the extract responsible for antifungal activity.

Candida albica

Fig. No 7: Zone of Inhibition of Candida albica

GRAPHICAL REPRESENTATION

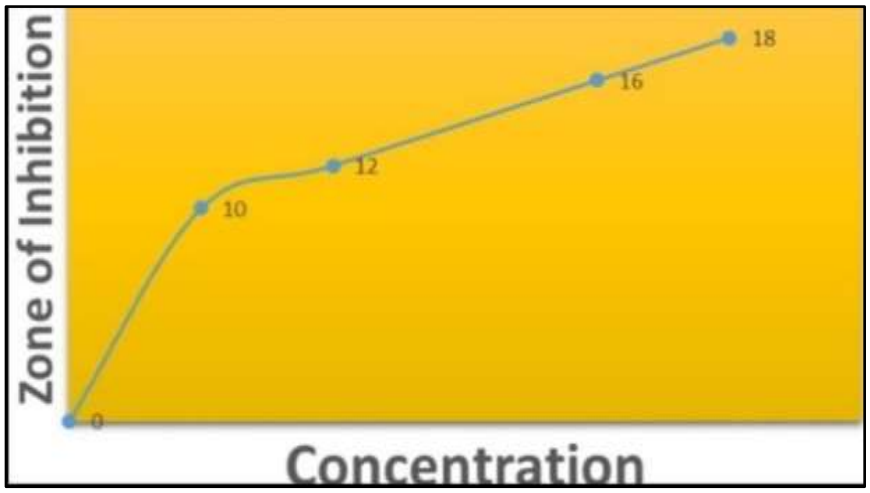


Fig. No 8: Graphical Representtion of zone of inhibition vs concentration

Graphical Representation" which illustrates the relationship between the "Concentration" of a substance and its "Zone of Inhibition".The graph shows that as concentration increases, the zone of inhibition also increases.The relationship is not perfectly linear, with a steeper initial incline that levels off.Specific data points are marked at values of approximately 10, 12, 16, and 18 on the y-axis (Zone of Inhibition).[9]

10) Conclusion

The formulated herbal goat milk soap containing couroupita guianensis fruit extract was successfully prepared and evaluated for its antibacterial and antifungal properties.

The result demonstrated that soap possesses significant antimicrobial activity against both gram positive and gram negative bacteria as well as common fungal strain confirm its broad spectrum effectiveness.The

incorporation of goat milk enriched the formulation with natural moisturizing agents, vitamins, and lactic acid, enhancing its skin-conditioning and cleansing properties.The Couroupita guianensis fruit extract, rich in flavonoids, tannins, saponins, and phenolic compounds, contributed to the strong antimicrobial effect by disrupting microbial cell walls and inhibiting growth.

The overall evaluation indicated that the soap was physically stable, mild to the skin, and environmentally safe, making it a suitable natural alternative to synthetic soaps.

Thus, the herbal goat milk soap with Couroupita guianensis extract can be considered a promising formulation for maintaining skin hygiene and preventing microbial infections naturally.

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