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Development, Evaluation And Comparative Analysis Of Anti-Microbial Soap Formulations Incorporating *Cassia Alata* And *Cardiospermum Halicacabum* Extract

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ABSTRACT:

The creation of potent antimicrobial drugs has become necessary due to the rising incidence of skin infections. The purpose of this study was to assess the antibacterial activity of herbal soap formulations that included *Cardiospermum halicacabum* and *Cassia alata*. The plant extracts were used in varying amounts to create three soap compositions (F1, F2, and F3). Physical properties, antibacterial activity, and risk for skin irritation were assessed for the formulations. The findings demonstrated that F3, which had the highest concentration of extracts from *Cassia alata* and *Cardiospermum halicacabum*, had the best antibacterial action against *Candida albicans*, *Staphylococcus aureus*, and *Escherichia coli*. Additionally, F3 showed good physical properties, such as pH, consistency, and foam retention. Skin irritation was not observed in any of the formulations. According to the study's findings, the herbal soap formulation F3 may be a useful antibacterial agent for shielding the skin from germs.

Keywords: Herbal soap, *Cassia alata*, *Cardiospermum halicacabum*, antimicrobial activity, skin infections.

INTRODUCTION:

Herbal medicines that contain just herbal compounds or herbal preparations as their active constituents are known as herbal medical products. Whole or partial plants, algae, fungi, and lichens are referred to as herbal substances. These materials are usually dried; however, they might occasionally be utilised fresh. The complete scientific name and specific plant part are used to identify these compounds. The body's initial defence against microbial assaults, which can result in a number of skin infections and illnesses, is the skin. Bacteria, fungi, and viruses are among the microorganisms that can readily penetrate the skin's surface and cause dermatitis, eczema, and acne.

Researchers have resorted to natural therapies, such as plants with antibacterial qualities, to counteract these microbial attacks. Two such plants that have long been used to treat skin diseases are *Cassia alata* and *Cardiospermum halicacabum*. This study investigates how these plants might be used to create herbal soaps that successfully shield the skin from microbial invasions and encourage good skin care.

HERBAL SOAP:

The first line of defence against many infections is the human skin, which is the outermost covering of the body. Skin is vulnerable to damage because it is constantly exposed to external stimuli. Scar tissue develops during the healing process of damaged skin, frequently accompanied by depigmentation and discolouration. Soaps with harsh chemicals can make dryness and irritation of the skin worse.

Natural component cosmetics have grown in popularity recently as a more organic, eco-friendly, and healthful option. Generally speaking, ayurvedic cosmetics, sometimes referred to as herbal cosmetics, don't harm people. Herbal soap preparations are prepared from plant components such leaves, stems, roots, and fruits and include antibacterial and antifungal chemicals.

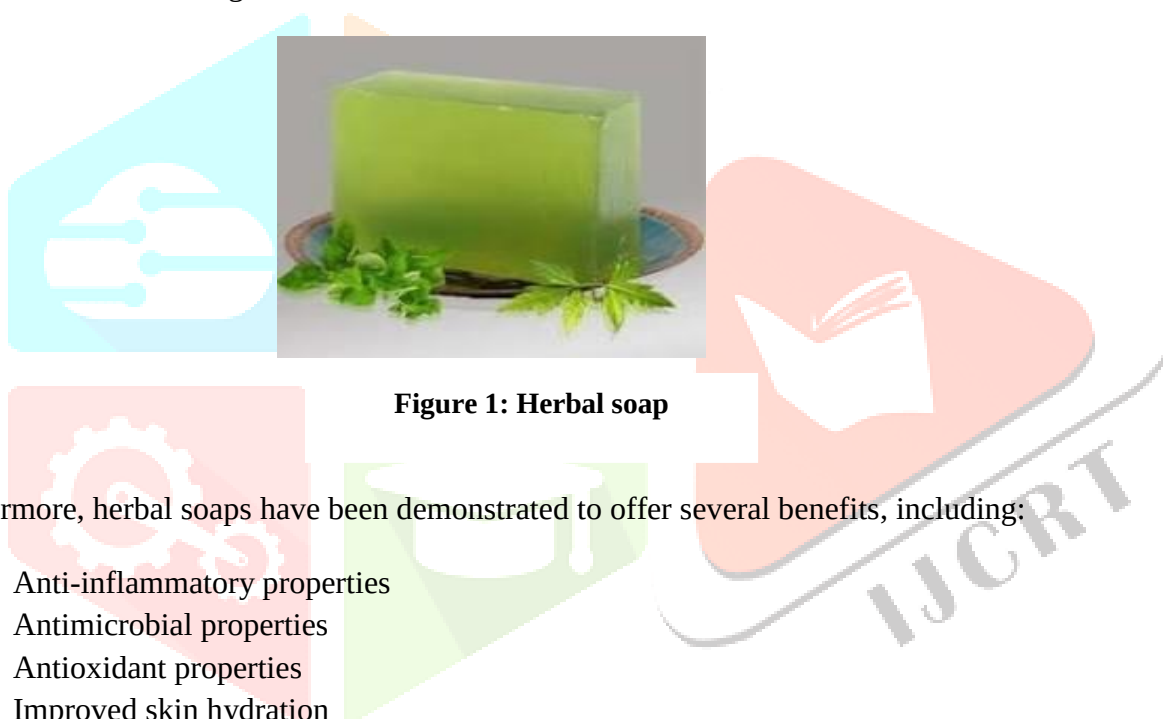


Figure 1: Herbal soap

Furthermore, herbal soaps have been demonstrated to offer several benefits, including:

- ❖ Anti-inflammatory properties
- ❖ Antimicrobial properties
- ❖ Antioxidant properties
- ❖ Improved skin hydration
- ❖ Reduced skin irritation

Types of soap:

Glycerin soap: - Glycerin is a component of oil or fat. Any handmade soap contains glycerin.

Transparent soap: - Made by hot process method. Usually added some from of alcohol to make it Transparent.

Liquid soap: - Making process is more complicated than soap bar.

HERBALS IN TOPICAL DRUG DELIVERY SYSTEMS:

These systems are made especially to deliver therapeutic substances locally through the skin to treat cutaneous conditions. These systems provide a tailored therapeutic approach and are frequently used to treat local skin infections. To meet different therapeutic demands, topical formulations come in a variety of forms, including liquids, semisolids, and solids.

AIM:

The aim of the study is to develop, evaluate and comparative analysis of anti-microbial soap formulations incorporating *cassia alata* and *cardiospermum halicacabum* extract.

OBJECTIVE:

To evaluate antimicrobial activity of the formulated soap.

To assess stability and safety of the formulated soap.

To compare antimicrobial efficacy with commercial antimicrobial soaps.

To determine potential as eco-friendly alternatives to commercial antimicrobial soaps.

MATERIALS AND METHODS:

1. Collection of plant material:

The leaves of *Cassia Alata* were collected from Ponneri, Kanchipuram district and the leaves of *Cardiospermum halicacabum* were collected from Vedanthavadi, Tiruvannamalai district in Tamil Nadu in the month of January 2025.

2. Identification and authentication of plant material:

The collected specimens were botanically identified and authenticated by Dr.N.K. Sunil Kumar, Research officer. Department of Pharmacognosy Siddha Central Research institute Chennai - 600106. The Samples were identified as *Cassia alata* belongs to the family Legumes and *Cardiospermum halicacabum* belongs to the family Sapindaceae.

3. Plant profile:

Cassia Alata (L.) Roxb.

Senna alata is an important medicinal tree, as well as an ornamental flowering plant in the subfamily Caesalpinioideae. It also known as emperor's candlesticks, candle bush, candelabra bush, Christmas candles, empress candle plant, ringworm shrub, or candletree. A remarkable species of *Senna*, it was sometimes separated in its own genus, *Herpetica*.



Figure 2: *Cassia alata*

Vernacular names:

Vernacular names of <i>Cassia alata</i>	
Scientific	Senna Alexandrina, Cassia alata
English	Candle Bush, Ringworm Plant
Sanskrit	Chakra Maida, Dadrughna
Hindi	Chakra Maida
Tamil	Rata Tora,
Kannada:	Seema Tangadi
Telugu	Sema Tangedu

Table: 1 Vernacular names of *Cassia alata***Taxonomical classification:**

Kingdom	Plantae
Phylum	Magnoliophyta
Subphylum	Angiospermae
Class	Magnoliopsida
Subclass	Rosidae
Order	Fables
Family	Fabaceae
Genus	Cassia
Species	C. alata

Table 2: Taxonomical classification

***Cardiospermum halicacabum*:**

Cardiospermum halicacabum, known as the lesser balloon vine, balloon plant or love in a puff, is a climbing plant widely distributed across tropical and subtropical areas of Africa, Australia, South Asia and North America that is often found as a weed along roads and rivers.

**Figure 3: *Cardiospermum halicacabum***

Vernacular names:

Tamil	Moedakottan
English	Balloon vine
Malayalam	Jyotishmati
Telugu	Buddakaakaraeega
Bengali	Lataphatkar
Hindi	Kanphuti
Sanskrit	Jyotishmati
Assam	Kopalphuta

Table 3: Vernacular names of *Cardiospermum halicacabum*

Taxonomical classification:

Kingdom	Plantae
Phylum	Tracheophytes
Subphylum	Angiosperms
Class	Eudicots
Order	Sapindales
Family	Sapindaceae
Genus	Cardiospermum
Species	Halicacabum

Table 4: Taxonomical classification of *Cardiospermum halicacabum*

4. Extraction of plant material:

Maceration Extraction of *Cassia Alata* Leaf Powder:

The powdered *Cassia alata* leaves were precisely weighed in a predetermined amount. The powder was mixed with ethanol in a 1:5 (w/v) ratio. With periodic stirring, the mixture was left to macerate for 72 hours at room temperature ($25^{\circ}\text{C} \pm 2^{\circ}\text{C}$). The liquid extract was separated from the solids by filtering the mixture through a cotton cloth. To create a crude extract, the filtrate was concentrated in a water bath at $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

Maceration Extraction of *Cardiospermum halicacabum* Leaf Powder:

After precisely weighing a measured amount of powdered *Cardiospermum helicacabum* leaves, ethanol was added in a 1:3 (w/v) ratio. The mixture was then left to macerate for 72 hours at room temperature ($25^{\circ}\text{C} \pm 2^{\circ}\text{C}$) with periodic stirring. The liquid extract was separated from the solids by filtering it through a muslin cloth, and the filtrate was concentrated using a water bath ($40^{\circ}\text{C} \pm 2^{\circ}\text{C}$) to produce a crude extract.

5. Phytochemical Screening:

Preliminary qualitative examination of bioactive substances, including tannins, saponins, alkaloids, flavonoids, and phenols.

FORMULATION OF HERBAL SOAP:

Step 1: Preparation of Herbal Extract Mixture: Combine 2ml of *Cassia alata* extract, 3ml of *Cardiospermum halicacabum* extract, 1ml of Vitamin E oil, and 1ml of rosewater in a beaker.

Step 2: Melting of Glycerin Soap Base: Melt 50gm of glycerin soap base using the double boil method.

Step 3: Incorporation of Herbal Extract Mixture: Add the prepared herbal extract mixture to the melted glycerin soap base and mix well.

Step 4: Addition of Lavender Essential Oil: Add 1ml of lavender essential oil to the mixture and stir well.

Step 5: Pouring into Mold: Pour the mixture into a soap mould.

Step 6: Setting and Hardening: Allow the soap to set and harden..

Step 7: Packaging: Once hardened, remove the soap from the mould and package it in paper.

HERBAL SOAP				
S.NO	INGREDIENTS	Quantity		
		F1	F2	F3
1	Glycerin soap base	50gm	50gm	50gm
2	<i>Cassia alata</i> extract	2ml	3ml	4ml
3	<i>Cardiospermum halicacabum</i> extract	3ml	4ml	5ml
4	Lavender oil	1ml	1ml	1ml
5	Vitamin E oil	1ml	1ml	1ml
6	Rose water	1ml	1ml	1ml

Table: 5. Ingredients of Herbal soap

EVALUATION:**1. Determination of the weight of soap:**

Placing the soap on a weighing balance and noting its weight in grammes allowed for the determination of its weight.

2. Foam Height Measurement:**Procedure:**

In 25 ml of distilled water, dissolve 0.5 g of the sample. Pour the mixture into a cylinder that holds 100 ml. Pour in enough distilled water to make 50ml. Use 25 strokes to shake the cylinder for one minute. Measure the foam height right away and mark it as F1. Measure and note the foam height once more as F2 after 10 minutes.

3. Determination of Moisture Content:**Procedure:**

5g of the sample was weighed, then moved to a porcelain dish and heated in a hot air oven set to 105°C for two hours. The initial weight of the sample and dish together was measured using a tarred China dish, and after the sample was heated and allowed to cool, the final weight of the sample and dish together was measured.

Calculation:

$$\% \text{ Moisture Content} = ((\text{Initial Weight} - \text{Final Weight}) / \text{Final weight} \times 100)$$

4. Determination of pH**Calibration of pH Meter:**

1. Rinse the electrode of the pH meter with purified water.
2. Use the pH buffer solutions to calibrate the pH meter.

1. Set the pH meter to read 4.01 after submerging the electrode in the pH 4.01 buffer solution.
2. Submerge the electrode in the pH 9.18 buffer solution after rinsing it with distilled water. The pH meter should register 9.18 after adjustment.

Procedure:

After weighing 2 g of soap, dilute it in 10 ml of purified water.

pH Measurement using pH Meter:

Wait for the pH value to stabilise after dipping the electrode of the pH meter into the soap solution. Note the pH value.

pH measurement using pH paper:

The substance being examined is said to be alkaline (basic) when a red litmus paper turns blue.

5. Foam Retention Test:

Procedure:

Make a 1% soap solution in 25 ml. Fill a 100 ml measuring cylinder with the solution.

Foam Generation:

Give the cylinder ten shakes. Note the volume of the initial foam.

Foam Retention Measurement:

For four to five minutes, measure and note the volume of foam every minute.

6. Solubility Test for Soap:

Procedure:

A 1.5g sample of soap was weighed and mixed with 10ml of distilled water. For three minutes, give the mixture a good shake to aid in dissolution. observed and noted the outcome.

7. Skin Irritation Test:

Procedure:

For the test, three individuals were chosen. The skin was marked in a 2 cm by 2 cm region. The designated area was treated with the prepared soap sample. Over the course of two to four hours, observations were made at regular intervals.

Observations:

Irritation: Look for any symptoms of irritation, like burning, itching, or redness.

Oedema: Examine the test location for any indications of oedema, or swelling.

8. Evaluation for Ingredients:

Ingredients' organoleptic properties were assessed.

9. Evaluation of Anti-microbial activity for Soap Formulations:

Objective:

To evaluate the antibacterial efficacy of different soap formulations against *Escherichia coli*, *Staphylococcus aureus*, and *Candida albicans*.

Methodology:

1. Preparation of Agar Plates: Mueller Hinton Agar, weighing 7.8g, should be transferred to a flask. Fill the flask with 200 millilitres of distilled water. To fully dissolve the agar, heat the mixture in a water bath for ten minutes. To sterilise the mixture, autoclave it for 30 minutes at 121°C (250°F). Let cool and harden the mixture.

2. Inoculum Spreading: To ensure that the bacteria are distributed evenly, streak the inoculum onto the agar plates. Give it three hours to dry.

3. Creating Wells: Fill the agar plates with sterilised wells.

4. Preparing Soap Solutions: To obtain concentrations of 0.25g/mL, 0.5g/mL, and 1g/mL, dissolve soap in distilled water.

5. Controls:

Positive controls: Ampicillin (bacteria) and ketoconazole (fungi)

Negative control: Soap base solution (1g/mL in distilled water)

6. Incubation: To enable the bacteria to grow, incubate the agar plates for 24 hours at 37°C.

7. Evaluating Antimicrobial Activity: To assess antimicrobial activity, measure the diameter of the clear zone of inhibition that encircles the well.

RESULT AND DISCUSSION:

1. Determination of the weight of soap:

The weight of F1, F2 and F3 was found to be;

S.NO	FORMULATION	WEIGHT
1.	F1	50.85 gms
2.	F2	55.41 gms
3.		56.24 gms

Table 6: Weight of Soaps

Figure 4: Weight of Soaps

2. Foam Height Measure

The foam height of F1, F2 and F3 was found to be;

S.NO	FORMULATION	FOAM HEIGHT
1.	F1	90 ml
2.	F2	100 ml
3.	F3	83 ml

Table 7: Foam height measurement of soap



Figure 5: Foam height measurement

3. Determination of Moisture Content:

Moisture content of F1, F2 and F3 was calculated by using the following formula:

$$\% \text{ Moisture Content} = ((\text{Initial Weight} - \text{Final Weight}) / \text{Final weight} \times 100)$$

S.NO	MOISTURE CONTENT	INITIAL WEIGHT	FINAL WEIGHT	PERCENTAGE OF MOISTURE CONTENT
1.	F1	28.073 gms	26.680 gms	5.2%
2.	F2	28.073 gms	26.680 gms	5.4%
3.	F3	28.073 gms	26.680 gms	5.9%

Table 8: Percentage of Moisture content



Figure 6: Weighing of Moisture Content value

4. Determination of pH:

pH of F1, F2 and F3 was determined by using pH meter and pH paper;



Table 9: Determination of pH

S.NO	pH	pH PAPER	pH METER
1.	F1	Blue	8.95
2.	F2	Blue	9.01
3.	F3	Blue	9.42



Figure 7: Determination of pH by digital pH meter

Figure 8: Determination of pH by Litmus paper

5. Foam Retention Test:

The foam retention of F1, F2 and F3 was found to be;

S.NO	FORMULATION	1min	2mins	3mins	4mins	5mins
1.	F1	55	55	53	53	52
2.	F2	49	49	48	48	47
3.	F3	63	63	62	61	60

Table 10: Foam Retention Measurement

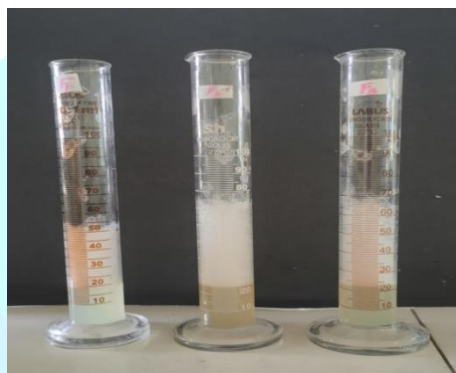


Figure 9: Foam Retention Measurement

6. Solubility Test for Soap:

The solubility of F1, F2 and F3 was found to be;

S.NO	FORMULATION	SOLUBILITY
1.	F1	Soluble
2.	F2	Soluble
3.	F3	Soluble

Table 11: Solubility Test



Figure 10: Solubility test

7. Skin Irritation Test:

F1, F2 and F3 were applied on skin to check irritancy.

S.NO	FORMULATION	SKIN IRRITABILITY
1.	F1	No irritation
2.	F2	No irritation
3.	F3	No irritation

Table 12: Skin Irritation Test

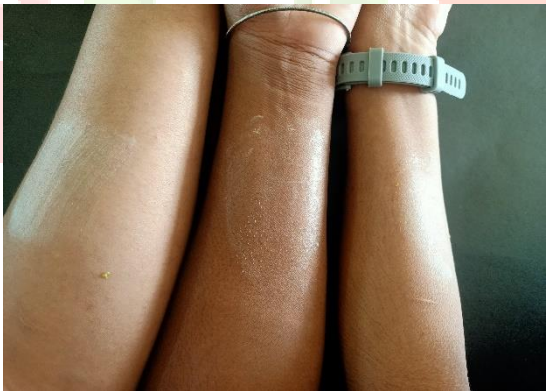


Figure 11: Skin Irritation Test

8.Evaluation for Ingredients:

Organoleptic characteristics for ingredients was found to be;

S.NO	INGREDIENTS	COLOUR	ODOUR	STATE
1.	Glycerin soap base	Transparent	Odourless	Solid
2.	Vitamin E oil	Transparent	Odourless	Viscous liquid
3.	Lavender oil	Colourless	Pleasant	Liquid
4.	Rose water	Colourless	Floral good	Liquid

Table 13: Evaluation for Ingredients



Figure 12: Glycerin soap base



Figure 13: Vitamin E oil



Figure 14: Lavender oil

Measure the diameter of the clear zone of inhibition surrounding the well to evaluate antimicrobial activity.

ZONE OF INHIBITION OF *ESCHERICHIA COLI*:

S.NO	NAME OF THE TEST ORGANISM	NAME OF THE SAMPLE	ZONE OF INHIBITION (mm)			
			1000 mg/ml	500 mg/ml	250 mg/ml	PC
1.	<i>Escherichia coli</i>	F1	11	10	11	19
2.	<i>Escherichia coli</i>	F2	11	11	12	20
3.	<i>Escherichia coli</i>	F3	11	13	10	23

Table 14: Zone of Inhibition of *Escherichia coli*

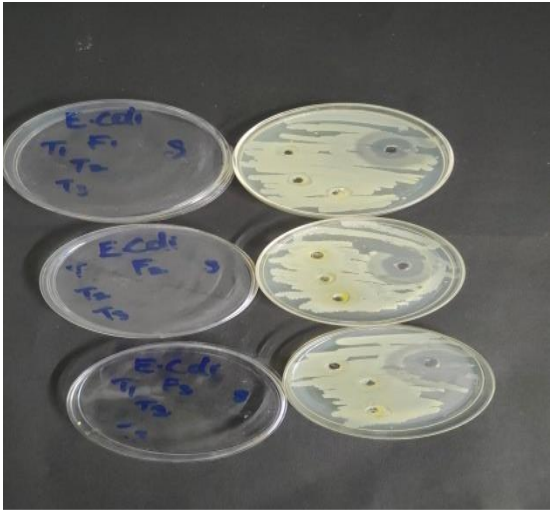


Figure 15: Zone of Inhibition of *E. coli*

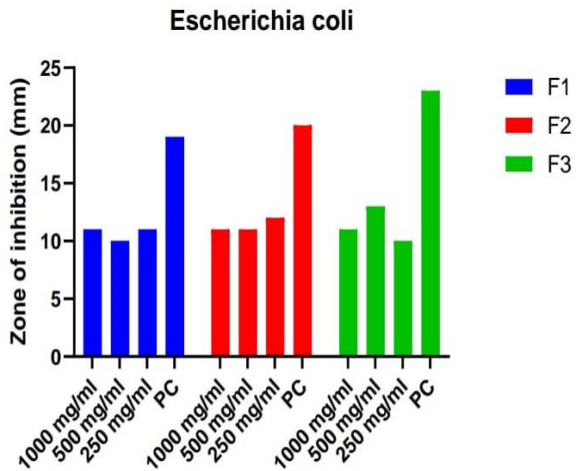


Figure 16: Graph for *E. coli*

S. NO.	TEST ORGANISM	NAME OF THE SAMPLE	ZONE OF INHIBITION (mm)			
			1000 mg/ml	500 mg/ml	250 mg/ml	PC
1.	<i>Staphylococcus aureus</i>	F1	9	10	12	24
2.	<i>Staphylococcus aureus</i>	F2	11	12	12	23
3.	<i>Staphylococcus aureus</i>	F3	13	15	16	19

Table 15: Zone of inhibition *Staphylococcus aureus*

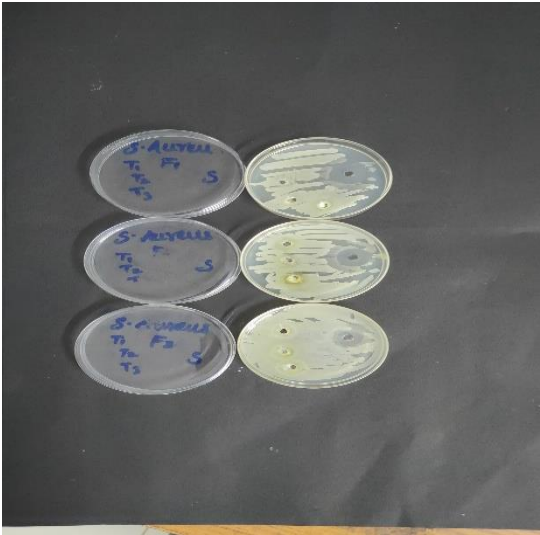


Figure 17: Zone of Inhibition of *staphylococcus aureus*

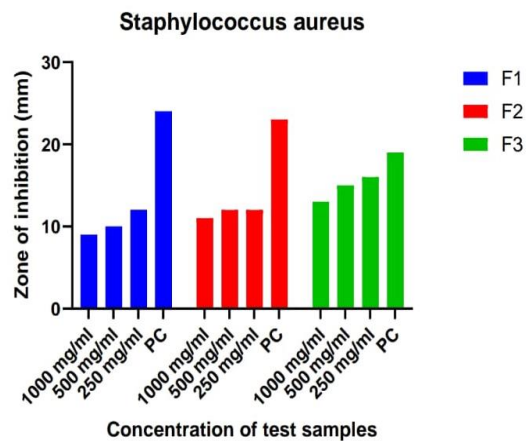


Figure 18: Graph for *staphylococcus aureus*

ZONE OF INHIBITION OF CANDIDA ALBICANS:

S.NO	NAME OF THE TEST ORGANISM	NAME OF THE SAMPLE	ZONE OF INHIBITION (mm)			
			1000 mg/ml	500 mg/ml	250 mg/ml	PC
1.	Candida albicans	F1	10	15	14	24
2.	Candida albicans	F2	9	13	14	23
3.	Candida albicans	F3	12	17	21	27

Table 16: Zone of inhibition of *candida albicans*

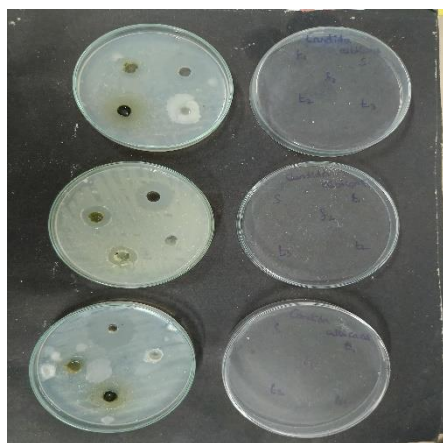


Figure 19: Zone of Inhibition of *Candida albicans*

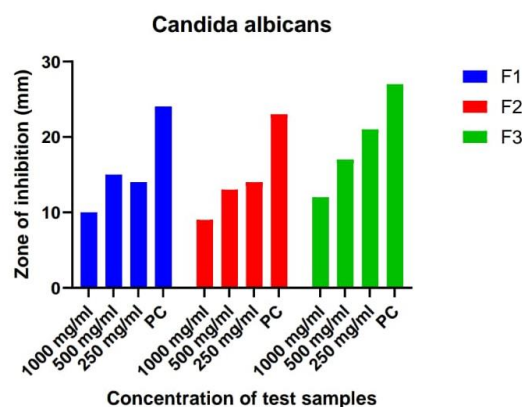


Figure 20: Graph for *Candida albicans*

ZONE OF INHIBITION OF *ESCHERICHIA COLI*, *STAPHYLOCOCCUS AUREUS*, *CANDIDA ALBICANS*:

F	<i>Escherichia coli</i> Gram positive bacteria				<i>Staphylococcus aureus</i> Gram positive bacteria				<i>Candida albicans</i> Fungi			
	T1	T2	T3	S	T1	T2	T3	S	T1	T2	T3	S
F1	11mm	10mm	11mm	19mm	9mm	10mm	12mm	24mm	10mm	15mm	14mm	24mm
F2	11mm	11mm	12mm	20mm	11mm	12mm	12mm	23mm	9mm	13mm	14mm	23mm
F3	11mm	13mm	10mm	23mm	13mm	15mm	16mm	19mm	12mm	17mm	21mm	27mm

CONCLUSION:

The present study successfully developed and evaluated anti-microbial soap formulations incorporating *Cassia alata* and *Cardiospermum halicacabum* extracts. The results demonstrated that both extracts exhibited significant anti-microbial activity against *Staphylococcus aureus*, *Escherichia coli*, and *Candida albicans*. However, *Cassia alata* extract showed a broader spectrum of anti-microbial activity and higher efficacy compared to *Cardiospermum halicacabum* extract.

The study also revealed that the combination of both extracts exhibited a synergistic effect, resulting in enhanced anti-microbial activity. The soap formulations were found to be stable and safe for use. Overall, this study suggests that *Cassia alata* and *Cardiospermum halicacabum* extracts have potential as natural anti-microbial

agents for use in soap formulations, offering a promising alternative to conventional anti-microbial soaps. Further studies are recommended to explore the scalability and commercial viability of these formulations.

The present study aimed to evaluate the antimicrobial activity of three soap formulations (F1, F2, and F3) incorporating *Cassia alata* and *Cardiospermum halicacabum*.

Overall, F3 emerged as the best formulation, exhibiting better consistency, foam retention, and antimicrobial activity. Its pH was slightly higher than F1, but still within the acceptable range. Therefore, F3 can be considered the most effective soap formulation for protecting the skin against microbes.

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