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(RESEARCH ARTICLE)

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Therapeutic polyherbal soap: A natural approach for managing skin disorders

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Abstract

Background: Most of the commercial soaps have artificial ingredients and chemicals which may irritate and even damage the skin. There is a need for safe, effective alternatives and must be economical. Herbal extracts constituents Phyto-chemicals facilitates the appearance smoothing, body conditioning, nourishment and also exhibits the healing properties.

Aim: The present study is aimed to formulate and evaluate an herbal soap containing *piper betel* and *moringa oleifera* leaf extracts known for their antimicrobial and skin regenerative properties.

Methodology: The ingredients involved in the formulation of Herbal soap were coconut oil, Glycerine, *Moringa oleifera* extract, *Piper betel* leaf extract, *Punica granatum* leaf extract, jasmine oil, sodium lauryl sulphate and sodium hydroxide (lye) and the soap was prepared by hot process method. The formulation was tested for physico chemical parameters (pH, moisture content, foaming index, foam retention time and thermal stability), FTIR compatibility and antimicrobial activity against *Escherichia coli* and *Staphylococcus aureus*.

Results and Discussion: The prepared herbal soap exhibited a skin friendly pH (7.1± 0.3), Stable foam retention (480±10s), moisture content (11%). Antimicrobial studies shown significant zone of inhibition confirming the synergistic effects of the extracts.

Conclusion: The results demonstrate that the prepared herbal soap is cost effective, safe and possess antimicrobial potential, making it a suitable alternative to chemical based commercial soaps.

Keywords: *Moringa Oleifera; Piper Betel; Punica Granatum*; Herbal Extracts

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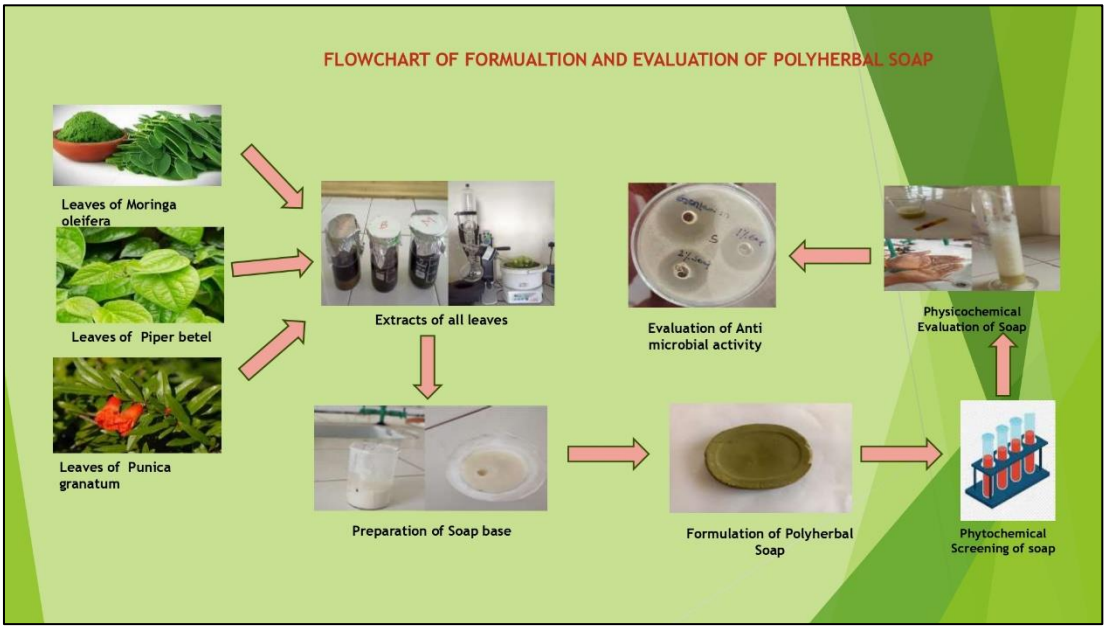
Graphical Abstract



Formulation and Evaluation of Polyherbal soap

1. Introduction

The largest organ in the human body is the skin with an approximate total area of 20 square feet. It safeguards our internal organs against the environment by multi-tensed cushioning, cellular barrier and protective oils (1). Skin does more than acting as a barrier between our body and the surrounding world it is involved in keeping us healthy, with examples being sweating and flushing to keep our bodies cool when we are hot, and developing goosebumps when we are cold. Sunlight can also help it manufacture Vitamin D which is helpful to our healthy bone. It is also likely to be hit by foreign particles as it comes into contact with the environment and brings about various skin related conditions., Therefore it is more important to keep clean to avoid the invasion of the microorganisms. Hence soaps must not only remove dirt, but also preserve skin integrity and natural moisture. Since ancient times, soaps have been the main tool used for cleaning. In the past, they were made with alkaline salts and natural oils. The use of plant-based oils, extracts, and essential oils gave rise to traditional herbal soaps, which have both medicinal and cleansing properties. These formulations much importance for their anti-microbial, anti- inflammatory and soothing effects on skin without causing irritation (2). On the other hand, synthetic soaps being effective cleaners, frequently formulate using harsh surfactants, artificial fragrances and preservatives that can weaken the skin's protective layer, induce dryness or create allergic reactions (3). From a future perspective, herbal soaps hold promise as multifunctional skin-care products. Technological developments in phytochemistry and nanotechnology are making it possible to incorporate bioactive plant molecules with specific functions like UV protection, anti-aging, anti-oxidant and acne prevention (4). As of now individual herbal extracts such as *Piper betel, Moringa oleifera* and *Punica granatum* have been widely reported for their antimicrobial, antioxidant and skin- protective properties, and several formulations utilizing each plant extract have been reported as well as combinations of plant extracts have been explored for synergistic activity. As there is no polyherbal soap made with the combination of leaf extracts of *Piper betel, Moringa oleifera* and *Punica granatum* this study therefore addresses the formulation and physicochemical evaluation followed by antimicrobial activity and stability evaluation. The findings are expected to provide a scientific basis for the use of these plant herbals in affordable, skin-friendly cleansing formulations.

2. Materials and methods

Materials: Active ingridients (*Piper betel, Moringa oleifera*) were collected from local market. *Punica granatum* and *Aloevera* were collected from neighbourhood. other ingridients like Coconut oil, jasmine oil is purchased from Patanjali store. Remaining excipients like Sodium hydroxide, Glycerine, stearic acid, propylene glycol, sorbitol, Triethanolamine, Alcohol, sodium lauryl sulphate were obtained from SD fine chemicals Ltd.in Chennai, India.

Table 1 Pharmacognostic profile of active ingredients: (5,6,7,8)

S. No	Biological Source	Parts	Chemical Constituents	Uses
1.	*Piper betel* (piperaceae)	Leaves	Chavicol, Eugenol, Hydroxychavicol and Terpenes	Anti microbial, Antifungal, Antioxidant and Anti inflammatory properties
2.	*Moringa oleifera* (moringaceae)	Leaves	Vitamin A, C, E, iron, Calcium and Flavonoids	Anti microbial, Antioxidant. Anti aging and photo protective properties
3.	*Punica granatum* (Lythraceae)	Leaves	Polyphenols, Tannins, Flavonoids and Anthocyanins	Anti-microbial, Anti-oxidant, collagen stimulant, Anti-aging Properties
4.	*Aloevera* (Asphodelaceae)	Leaves	Vitamins, Minerals, Enzymes, Natural sugars, Amino acids	It softens Moisturizer and Anti-aging

3. Methodology

3.1. Method of extraction

All the gathered leaves of the *Moringa oleifera*, the *Piper betel* and the *Punica granatum* are then washed and dried under shade separately for 1 to 15 days until the leaves are completely dried. The dried leaves were poured into the mixer separately and grinded. Then the powders were sieved with sieve 85 with the aim of having a proper uniform dried powder. Each of the varieties of powders was placed in separate containers with alcohol over 3 days. This is referred to as Maceration. Once extraction has been done. This extract is placed into heating mantle and the mixture is heated to 40^0C where alcohol is evaporated leaving the extract to stay in the container. The then extracts are transferred into a proper air tight container and placed in a desiccator (9).

Figure 1 Extraction of leaves of *Moringa oleifera, Piper betel* and *Punica granatum*

3.2. Formulation of soap base

Table 2 Formulation of Soap base

S.no	Ingridients	Quantity	Purpose
1	Coconut oil	70gm	Saponifying agent
2.	Sodium Hydroxide	17gm	Lye
3.	Glycerine	17gm	Humectant
4.	Stearic acid	30gm	Hardening agent
5.	Distilled Water	34ml	Vehicle
6.	Triethanolamine	17gm	pH adjusting agent
7.	Alcohol	30gm	To dissolve fat

3.2.1. Procedure:

To prepare the soap base, 17gm NaOH was dissolved in distilled water and 17gm glycerin was added and was mixed well and left standing at 30min. In a different beaker 70gm of coconut oil was taken and heated for 2min around 40-50^{0}C. After getting the required heat, 30gm stearic acid was added to it and was allowed to heat around 10min. Added caustic lye solution to the above mixture slowly with Continuous stirring. further, 17gm of triethanolamine was added to it and stirred it for 2min, and then 30gm of ethanol was poured in to it. Lastly, solution was poured into a mould and was set aside (10).

Figure 2 Prepared Soap base

3.3. Preparation of medicated soap

Table 3 Formulation table for medicated soap

S.no	Ingredients	Quantity	Purpose
1.	*Moringa oleifera*	2ml	Anti-inflammatory
2.	*Piper betel*	2ml	Anti-fungal
3.	*Punica granatum*	2ml	Anti-oxidant
4.	*Aloe vera*	1ml	moisturizer
5.	Jasmine oil	2ml	Fragrance
6.	Sodium lauryl sulphate	15gm	Surfactant
7.	Distilled water	100ml	Vehicle

3.3.1. Procedure

Soap base was placed in a beaker on the hot plate along with a stir bar and heated the base to less than 50^{0}c. Once the required heat was reached 15gm of sodium lauryl sulphate was added and stirred over the heat till the mixture took a clear form. Then add the necessary amount of herbal extracts such as 2ml moringaoleifera,2ml Punica granatum,2ml piper betel and aloevera extracts to the above preparation. The remaining distilled water was added to make the final volume up to 100ml. The solution was stored without any interruption in it for 1 hour and few drops of some necessary oil i.e.., jasmine oil was also added to give aroma to the soap prepared. Lastly, the mixture of the soaps was poured into available shaped moulds. The solidification of soap was done through keeping the moulds aside between 3-4 days (11).

Figure 3 Formulated Herbal Soap

3.4. Evaluation studies:

3.4.1. Evaluation Tests for powders

All the powders were tested for their organoleptic properties, Phyto chemical evaluation, general powder characteristics and phytochemical constituents. (10,11).

Compatibility Studies: The compatibility studies were conducted using ATIR-FTIR Spectrophotometer. Spectrum was recorded in the range 4000-400 cm^{-1} for all the extracts of active ingredients. (12,13)

3.4.2. Organoleptic evaluation

Organoleptic Characteristics: Characteristic and recording of the color, odor and appearance of the Soap were done in descriptive terms (14,15).

3.4.3. Physical assessment

Foam retention: 25ml of 1% soap solution was pipetted into a 100mL graduated measuring cylinder. It was covered with hand and shaken for10 times. The amount of foam that was produced after every 1 min interval was measured over a 4-min period. (14,15).

Foam height: In taking it into the test tube and shaking it by thrusting the thumb on the mouth of the test tube, the foam to be produced. Foam height is measured by dragging the measure scale (14,15).

P^H: The pH of the soap was determined using two methods: by directly applying a pH indicator strip to the surface of soap, and by dissolving 1g of soap in 10ml of water and measuring the pH of the solution using a digital pH meter (16).

Saponification value: Saponification value is the measure of the content of ester linkages. It is measured through back titration of potassium oxide using 0.5N sulphuric acid or Hydrochloric acid in presence of phenolphthalein indicator (17)

Percentage of free alkali: nearly 5gm of a sample was put into a conical flask and into it 50ml of neutralized alcohol was added. It was boiled on water bath under reflux for 30 minutes, cooled and 1ml of the phenolphthalein solution was added. This was titrated straight away with 0.1N HCL (17).

Total fatty matter: 5gm sample of soap is dissolved in 100 ml of hot water. It is acidified with 40 ml of 0.5N HNO3. The mixture is warmed up so that fatty acids are turning into a layer on top of the solution. Out of that it is cooled in ice water to entrench the fatty acids (17).

Moisture content: The moisture content was employed to determine the percentage of water in the soap by drying it to congruent weight. The soap was weighed and noted as the wet weight of the sample before being dried in a dryer at temperature of 100 to 115^0C. The sample was weighed in a refrigerator to ascertain the value of the sample that was the dry weight of the sample (17,18).

Alcohol insoluble matter: 5gm of soap was weighed and placed in a conical flask and 50ml warm ethanol was added and shaken vigorously until the soap dissolved. A filter paper was used to filter 20 ml of the solution on a warmer until it was evaporated to dryness at 1050c in 1 hour. Weight of the dried residue paper was taken (19,20).

Skin irritation Test: The formulated herbal soap was rubbed on the hands and left on the hands for 10 min. rubbed area was tested for redness, inflammation, burning and itching for 24hrs and then reported (22).

3.5. Anti-microbial activity

3.5.1. Pour plate technique

The tubes are filled with nutrient agar and then liquefied. Refrigerate the tubes up to 45 o C and prepare them to be poured into petri plate. Mark on the tubes and on the Petri plates. Serial dilute the given mixed culture and take 1ml sample out of each dilution. Add agar medium in the sample to mix the sample with the agar medium by rotating the tubes through the palms. Empty the tube into Petri plates and let it settle. Cultivate the Petri plates at 37 o C in 18-24 hours (21, 23)

Stability studies: Formulated polyherbal soap was tested for accelerated stability studies for one month at 40^0c and 75% RH. The results for the soap tested after stability studies were tabulated. (24, 25).

4. Results and discussion

4.1. Organoleptic evaluation of powders:

Table 4 Organoleptic evaluation of powders

S.no	Properties	Interferance
1.	Nature	Powder
2.	Colour	Light green
3.	Odour	Slightly bitter aroma

4.2. Physico-chemical evaluation of powders

Table 5 Physico-chemical evaluation of powders

S.no	Tests	Interference
1.	Ash values Total ash Acid insoluble ash Water soluble ash	 41% 17.3% 21%
2.	Moisture content	4%
3.	$_P^H$	Neutral

4.3. General powder characteristics

Table 6 General powder characteristics

S.no	Parameters	Results	Interference
1.	Bulk density	0.40	-
2.	Tapped density	0.52	-
3.	Carr's index	21.76%	Passable
4.	Hausner's ratio	1.18	Passable
5.	Angel of repose	39.43	Good

4.4. FTIR spectra analysis

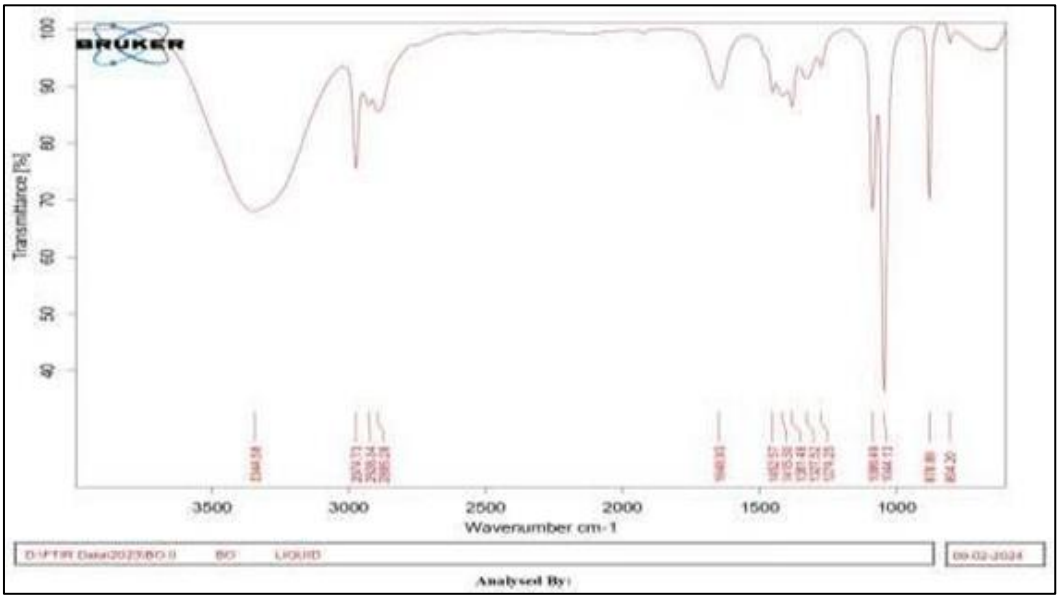


Figure 4 Spectra Analysis of *Piper betel*

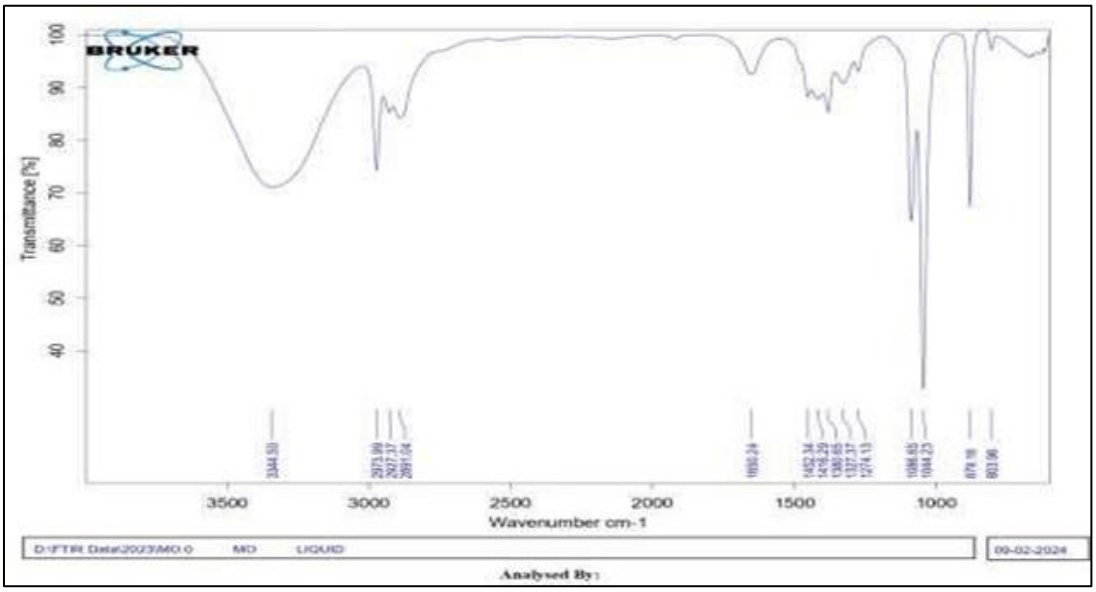


Figure 5 Spectra Analysis of *Moringa oleifera*

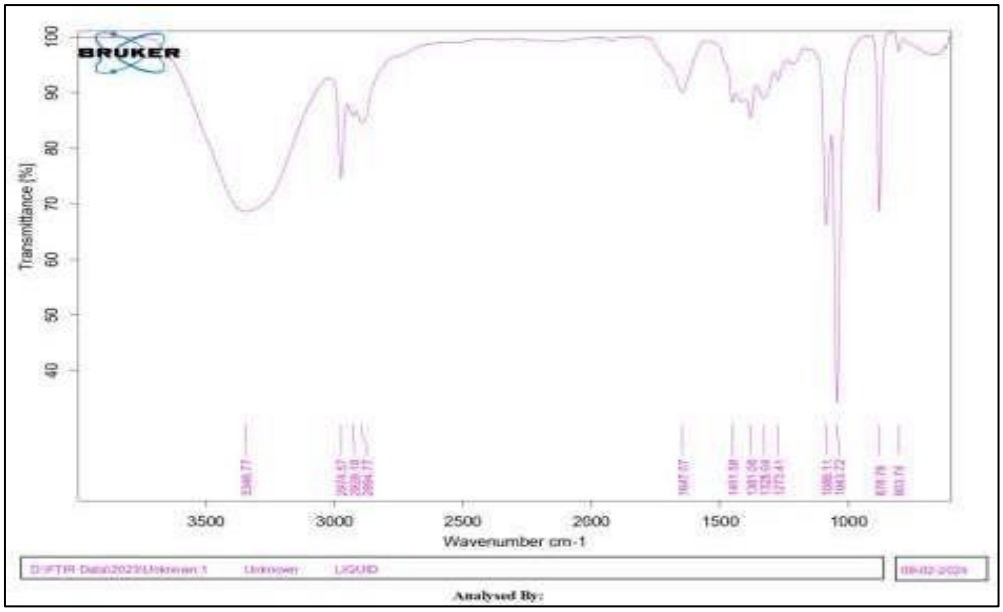


Figure 6 Spectra Analysis of Soap

Table 7 Interpretation of Piper betel, Moringa oleifera and Soap

Piper betel	***Moringaoleifera***	**Soap**	**Interpretation**
3344.58	3344.50	3346.77	'OH' stretch ofCOOH
2974.73	2973.99	2974.57	C-H stretch alkanes
1648.93	1650.24	1647.07	-C=C- stretch alkenes
1086.49	1086.11	1086.11	-C-N stretch of aliphatic amines
1044.13	1044.23	1043.72	-C-N stretch of aliphatic amines
878.89	879.96	878.78	Aromatic bending

The FTIR spectra of the Soap was analyzed and compared with the reference compounds, *Piper betel* and *Moringa oleifera*, to identify characteristic functional groups and assess chemical compatibility. The broad absorption observed at 3346.77 cm^{-1} corresponds to the –OH stretching vibration of the carboxylic acid group, consistent with the reference values of 3344.58 cm^{-1} (*Piper betel*) and 3344.50 cm^{-1} (*Moringa oleifera*). Peaks around 2974–2975 cm^{-1} are attributed to the C–H stretching vibrations of alkanes, while the signal at 1647.07 cm^{-1} is assigned to the C=C stretching vibration of alkenes, confirming unsaturation in the molecular framework. The absorptions at 1086.11 cm^{-1} and 1043.72 cm^{-1} are characteristic of C–N stretching in aliphatic amines, and the peak at 878.78 cm^{-1} corresponds to aromatic bending vibrations, indicating the presence of aromatic moieties. The close alignment of absorption peaks between the Soap and reference compounds indicates chemical compatibility and structural similarity. This suggests that the components are compatible and suitable for pharmaceutical applications, as no significant chemical interactions or functional group alterations were observed, ensuring that the formulation is likely to maintain its chemical stability and integrity during development.

4.5. Phytochemical tests

Table 8 Phytochemical Tests :

S.no	Tests	Interference		
		Piper betel	*Moringa oliefera*	*Punica granatum*
1.	Test for carbohydrates	Presence	-	Presence
2.	Test for glycosides	Presence	-	-
3.	Test for alkaloids	Presence	Presence	Presence
4.	Test for tannins	Presence	Presence	-
5.	Test for phytosterols	Presence	-	-
6.	Test for flavonoids	Presence	Presence	Presence
7.	Test for terpenoids	-	Presence	Presence

4.6. Organoleptic evaluation of soap

Table 9 Organoleptic evaluation of soap

s.no	properties	Interference
1.	Colour	Green
2.	Odour	Jasmine
3.	Appearance	Good

4.7. Physical evaluation

Table 10 Physical evaluation of soap

S.no	Tests	Parameters
1.	pH	7.1±0.3
2.	Foam retention	480±10s
3.	Foam height	10cm
4.	Moisture content	11%
5.	Saponification value	161.28g/ml
6.	Alcohol insoluble matter	18
7.	Percentage of free alkali	0.53%
8.	Total fatty matter	72%
9.	Skin Irritation test	No irritation

4.8. Anti-microbial activity

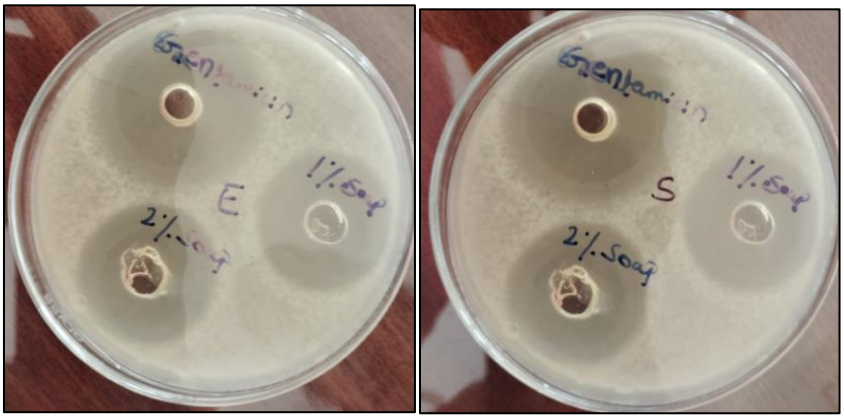


Figure 7 Anti-microbial activity

Table 11 Anti-microbial activity of soap

S.no	Formulation	Zone of inhibition (mm)	
		MICRO-ORGANISMS	
		S. aureus	*E. coli*
1.	Soap	12.8±0.3	12.3±0.5

4.9. Determination of Stability studies

Table 12 Stability studies for polyherbal soap

S. No	Parameters	Initial	Final 40^0c/75%RH (one Month)
1.	Appearance	Green	Green
2.	Feel on application	Smooth	Smooth
3.	PH	7.1±0.3	7.6±0.3
4.	Foam Retention	480±10s	407±10s
5.	Washability	Good	Good
6.	Moisture content	11%	13%
7.	Skin Irritant	No irritation	No irritation

5. Discussion

Herbal soap was made using the leaf extracts of *Piper betel, Moringa oliefera* and *Punica granatum.* The leaves were shade-dried and pulverized. Each herb was also tested individually by organoleptic, Physico chemical evaluation, Phytochemical tests and general condition of powder. All of the powders were also analyzed using FTIR. These results were compiled in the tabulation of no:12 (Interpretation of Piper betel, Moringa oleifera, Punica granatum.

The chemical constituents were extracted using maceration technique on the leaves. All the leaves extracts were incorporated in to the already prepared soap base and soaps with herbs were formulated and its color, odor and appearance was noted. The soaps produced were good looking with good odor and color.

Various tests such as foam height, foam retention, pH, Total fatty matter, Saponification value, moisture content, Percentage free alkali and alcohol insoluble matter have been conducted on prepared soaps and formulation has passed

all the tests within the boundaries. More than this the soap was being tested on human volunteer and there was no irritation on skin.

Lastly, antimicrobial activity of the soap is tested using cultures *E. coli, S. aureus* etc.

Pour plate method was used to isolate *E. coli, S. aureus* and the following formulation gave the best results which were tabulated in table no:11

6. Conclusion

This was done in an attempt to prepare an herbal soap that would effectively offer anti- acne, whitening and moisturizer using the leaf extracts of *Piper betel, Moringa oliefera* and *Punica granatum*. The soap made was presentable in form with a nice smell and colour. These soaps that have been prepared have undergone several phytochemical and physical analysis tests, in this case the F1 formulation has recorded very satisfactory test results. Anti- microbial activity is also evaluated for the formulation and it has returned positive results. In addition, it exhibits no irritancy on application on a human volunteer. It was, therefore, concluded that it is possible to treat numerous skin ailments with the help of natural herbs and further these herbs can be utilized to improve the texture of the skin at a lower cost and with minimal side effects.

Compliance with ethical standards: Not Applicable

Disclosure of conflict of interest

The authors declare no conflict of interest.

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