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CONTROL AND MANAGEMENT OF SEBORRHEIC DERMATITIS USING NOVEL HERBAL BASED FORMULATION

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ABSTRACT
Seborrheic dermatitis is a relatively common, chronic inflammatory skin disease that is related to dandruff and scalp scaling. In this present study, a formulation of polyherbal shampoo with ingredients of Glycyrrhiza glabra (Liquorice), Asparagus racemosus (Shatavari) and Thymus vulgaris (Thyme oil) were prepared and evaluated. Extracts obtained with the aid of maceration and added to shampoo formulations (F1, F2 and F3). All the formulations were tested for the following physical, chemical and microbiological characteristics such as pH, viscosity, foam stability, surface tension and antimicrobial activity. The data revealed that F2 had maximum performances as formulation with pH 7.4, good foaming and stability and good antimicrobial property. In conclusion, the herbal shampoo developed in the study is effective, safe, goodoy and can be used for treating dermopathy like dandruff and seborrheic dermatitis.

KEYWORDS: Seborrheic Dermatitis, Polyherbal Shampoo, Malassezia, *Glycyrrhiza glabra, Asparagus racemosus, Thymus vulgaris.*

1. INTRODUCTION
S. dermatitis is a long-lasting skin inflammation of the parts of the skin with high levels of oil-producing glands: the face, scalp and trunk. There is an association with the Malassezia species, Malassezia yeasts act on sebum triglycerides and this will lead to the production of free fatty acids, inflammatory reaction brings on a production of sebum and on the immune response, there are aberrations. In children, the most common symptoms of SD are yellow, scaly lesions with varying amounts of inflammatory response on the scalp, also known as "cradle cap". [1]

Malassezia yeasts inhabit the human skin, primarily on the upper body, on sebum-rich skin areas like the back, trunk, face and scalp. This is associated with the scalp disease commonly seen in humans called seborrheic dermatitis and dandruff, and has been suggested as the principal trigger factor of them.[1]

It's the combination of the action of the microorganisms living on the skin *(Malassezia spp.)* and the inflammatory reaction of the host animal. Association of environmental factors within the skin *(Malassezia spp.)* with a host inflammatory response. The treatment of SD involves reducing the production of sebum, Malassezia spp. on the skin and inflammation.[1]

Fig. 1: Seborrheic dermatitis.

These chemicals may cause a disease through any of the following mechanisms:

- Loss of normal microorganisms from the skin or shedding.
- Impaired T-cell response to Malassezia spp. that leads to a poor immune response to the yeast.
- This could result from an increase in the level of unsaturated fatty acids at the skin surface.
- The change in skin by disturbance of the cutaneo-transmitter in the skin.
- A detachment of keratinocytes occurs and there is proliferation and inflammation of skin cells.
- Congenital epidermal barrier defects due to genetic abnormalities.[2]

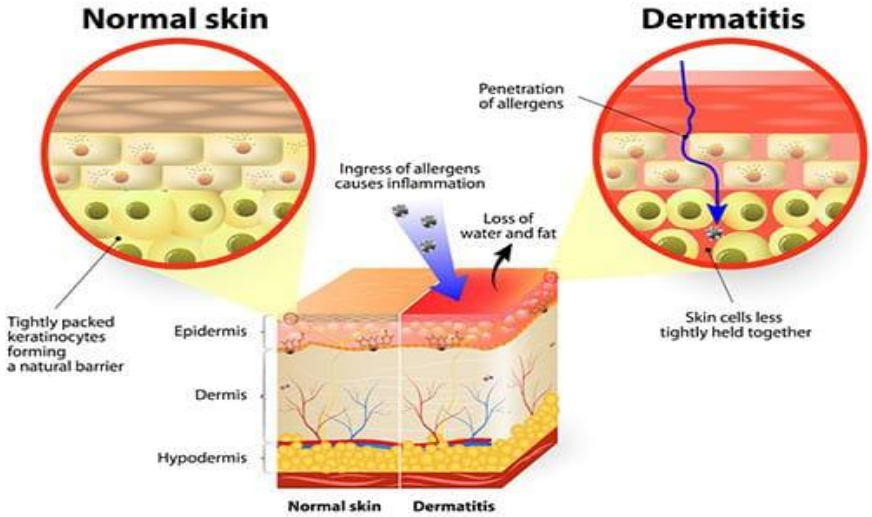


Fig. 2: Pathogenesis of Seborrheic dermatitis.

1.1 Herbal Shampoo: This kind of cosmetic products is also ayurvedic shampoo which is a natural cleanser to clear up the hair and scalp in much the same manner as they would be washed with regular shampoo. Accomplish task of removing oil, dandruff and other substances from an environment.

1.2 Types of Shampoo[3]

- **Medicated Shampoo**: Made special for therapeutic use, medicated shampoo comprises of active ingredients that address specific conditions of a person's scalp -- e.g., dandruff, seborrheic dermatitis, psoriasis, and fungal infections.
- **Cream Shampoo**: Cream shampoos / cream paste shampoos that cause shampoo to thicken and appear opaque when used due to the suspension of solids are also preferred by many users because of their plastic consistency and cosmetic look.
- **Conditioning Shampoo (also referred to as a 2 in 1 conditioner shampoo)**: Conditioning shampoos are shampoos that cleanse the scalp while simultaneously providing conditioning agents that make hair softer, sooth, clean and shinier.
- **Anti-dandruff Shampoo**: Anti-dandruff shampoos contain an effective antimicrobial agent whose action is specifically directed to reduce the growth of microorganisms, which consist of some fungi, on the human scalp and prevent dandruff.
- **Baby Shampoo:** Baby shampoo is a special formulation of hair cleaners that is meant for use on babies and young children, mainly to clean without harming sensitive skin and eyes.
- **Liquid Shampoo**: A viscous water-based hair cleaner that contains 70-90% water along with surfactant, conditioning agents and preservative in order to clean the hair of dirt and oil.
- **Powder Shampoo**: Powder shampoo is a water-proof powder formulation which will work as a lather as soon as it comes into contact with water, producing the washing and cleaning of the hair and scalp.
- **Gel Shampoo**: Usually transparent and rich shampoos that contain a gelling agent (such as cellulose) are called gel shampoos. There's significant worth in beauty salons and beauty parlors.
- **Aerosol Shampoo**: These are called aerosol shampoos since the product is contained in an aerosol can. They are complicated to formulate, prepare and pack because an additional propellant is added to them.

1.3 Functions of Shampoo[3]

- To condition the hair to make it smooth and shiny.
- Shall not be an eye, skin and scalp irritant.
- Removes 100% of dirt and is effective at cleaning.
- Perfumes the hair with a good smell.

1.4 Ideal Characteristics of Shampoo[3]

- Should effectively wash hair.
- Create a tolerable volume of foam.
- The shampoo is easily rinsed out with water.
- Provides a pleasant odor to the hair.
- Should not dry or roughen the skin.
- Does not dry or make the skin rough.

1.5 A Herbal Shampoo Has Many Advantages, Some of Which are Listed Below[3]

- Herbal Shampoos are eco-friendly and environmentally-friendly.
- The eyes are not irritated by it.
- it has a reasonable price and has a cost-effective implementation.
- Daily application of the herbal shampoo really revives your hair!

1.6 Need of Shampoo

Sebum is a natural oily secretion, which keeps skin and hair hydrated. But if you shampoo less frequently, you may end up with an excessive production of oil and oily hair. Sebum can also create a bacterial imbalance, triggering dandruff and other problems with the condition of the hair. Clean hair is a must in taking off sebum and other hair care product residue from the scalp. Used extensively in the market place. Oil-draining shampoos can flake you by eliminating the oil. An issue with a dry scalp might manifest as redness, puffiness, and it.[3]

2. PLANT PROFILE[4,6,8]

Table 1: Plant Profile.

Sr. no.	Drug	Synonym	Biological source	Family	Chemical constituent	Figure
1.	Liquorice	Mulethi, sweet wood, jothi-madh	*Glycyrrhiza glabra L.*	Leguminosae	glabridin, butin, quercetin, glycyrrhizic acid	
2.	Shatavari	Shatamuli, narayani, abhiru, pivari,	*Asparagus racemosus.*	Asparagaceae	steroidal saponin, sterol, shatavarins I-IV	
3.	Thyme oil	Origanum thymus Kuntze, Thymus collinus Salisb	*Thymus vulgaris*	Labiatae	Thymol, terpinene, carvacrol	

2.1 Part used

- Roots of Liquorice
- Roots of Shatavari
- Oil of thyme leaves

2.2 Bioactive Rationale

The selection of ingredients was based on their documented pharmacological activities:

- Liquorice (*Glycyrrhiza glabra*): Flavonoids and glycyrrhizin can antagonize pro-inflammatory mediators such as prostaglandins, which help to lessen swelling and redness.[5]
- Shatavari (*Asparagus racemosus*): Full of steroidal saponins (Shatvarins I-VI) and alkaloids, which can be used to nourish the scalp, strengthen roots and impart an effect of immunity.[7]
- Thyme Oil (*Thymus vulgaris*): Thymol has been shown to disrupt fungal cell membranes resulting in leakage of the intracellular components and subsequently inhibiting the *Malassezia growth*.[8]

3. MATERIALS AND METHODS

3.1 Materials

Liquorice (roots powdered), Shatavari (roots powdered), Thyme oil were employed as active ingredients. Excipients included:

- Sodium Lauryl Sulphate (surfactant),
- Methyl Cellulose (thickening agent),
- Sodium Benzoate (preservative),
- Citric Acid (pH adjuster).

3.2 Extraction Process of liquorice & shatavari:

The maceration method was used with 90% ethanol as a solvent to obtain the active compounds from the herbal materials. A rotary shaker was used to facilitate the successful production of bioactive and leave the mixture at room temp. for 24-48 hours.

- Weigh accurately 10 gm powder
- Pour some powder into a clean, dry conical flask.
- Add 100 ml solvent (ethanol) in it (ratio 30:70)
- Stir properly to ensure complete wetting of powder.

- Close and keep it for 48-72 hours at room temp. with occasionally shaking on rotary shaker to improve extraction.
- Filter process after maceration, by muslin cloth or WhatmanNo.1 filter paper.
- Use an rotary evaporator to fix the concentration and evaporation at 40°C to collect the filtrate and concentrated to collect the remaining residue, which was stored in a refrigerator for further use in the lab.[9]

Fig. 3: Extraction Process of liquorice & shatavari.

4. PRE-FORMULATION STUDIES OF POWDERS[10]

4.1 The moisture content determination

1. Precisely weighed a sample of powder 2g
2. Pour the aliquot into a pre weighed moisture dish. Dried at 105°C in hot air oven.
3. Cooled in desiccator until room temp. is reached.
4. Measure the mass of the dried out sample.
5. Determined the moisture content as per the following formula::

$$LOD\% = \frac{Initial\ wt. - Dried\ wt.}{Initial\ wt.}$$

4.2 Total Ash Value

1. Measure out 2gm of powder drug sample and we depose it into a tarted silica crucible.
2. Completely burn in a Muffle Furnace at 400-420̊c till carbon is removed.
3. Cooled at room temp. in a desiccator.
4. Measure the mass of the residue ash.
5. Use the formula to determine the ash:

$$Total\ ash\ value = \frac{Weigth\ of\ ash}{Weight\ of\ sample}$$

4.3 Acid-Insoluble Ash Value

1. Boil 2 g of ash for 5 min with 25 ml of 2 M HCL.
2. The filtrates were then washed by hot water and washed filter paper and the filtrates were heated in hot water with a tarred crucible for 4 hours till 450° was reached.
3. The insoluble material was cooled in dessicator and weight was taken.
4. The calculation for the acid-insoluble ash was done in the following manner:

$$Acid\ insoluble\ ash\ value\ (\%) = \frac{100 \times a}{y}$$

4.4 Sulphate Ash Value

1. Accurately weigh out approx. 1-2g on a weighed-out crucible, gently burn until the substance begins to char.
2. Cooled and add 1ml of sulphuric acid, warm carefully and allow to effervesce, and then burn at 800oc +25oc until white fumes are no longer observed, and black particles are no longer observed.
3. Cool, then pour in some sulphuric acid, and heat up. Repeat igniting and cooling process and weigh.
4. Continue until the weight measurements are within 0.5 mg of each other two times in a row.

$$Sulphated\ ash\ Value\ (\%) = \frac{100 \times a}{y}$$

4.5 Water Soluble Extractive value

1. Evaluation of Water-Soluble Extractives content is performed by macerating the air dried coarse powder drug into 100ml of water and shaking periodically (every 6h for first 6h) for 24h.
2. The filtered mixture is evaporated to dryness and the dried mixture measured as 25cm³.
3. The dish is dried at 105°c and the mass of the dried dish is measured in a desiccator to determine the mass of its residue**.**
4. The number of water-soluble extractives is in percentage calculated from water soluble extract mass which is determined as:

$$Water\ soluble\ extractive\ value\ (\%) = \frac{Weight\ of\ residue \times 100}{Weight\ of\ drug}$$

4.6 Alcohol Soluble Extraction Value

1. Powder 5 g of the drug (Type: Air dried) and were weid with alcohol (100 ml) in closed flask for 24 hrs.
2. Shake often, let stand for 18 hours, during 6 hours.
3. Quickly filtered with care taken to avoid solvent loss.

$$Alcohol\ soluble\ Extractibve\ Value\ (\%) = \frac{Weight\ of\ Residue \times 100}{Weight\ of\ sample}$$

5. PRELIMINARY PHYTOCHEMICAL SCREENING[10]

5.1 Tests for Carbohydrates

a) Molisch's Test (General Test)

Add small quantities (2-3 ml) of the face wash solution in alcohol to α-naphthol solution in alcohol. Slowly drop conc. H_2SO_4 in test tube down the sides. Violet ring where two liquids meet, means that there are carbohydrates present.

b) The Fehling's Test (Test For Reducing Sugars)
Add 1 ml of Fehling's A solution, followed by 1 ml of Fehling's B solution and bring the mixture to boil for 1 minute. Add equal volume to test solution and cook for 5-10 minutes in a boiling water bath, to the same volume. In the test of reducing sugar if the precipitates turn colour yellow to brick-red, then the sugar is called reducing sugar.

c) Benedict's Test
Transfer equal volumes of sample solution into test tube and add Benedict's reagent. Place equal volume of your sample solution into a test tube and add Benedict's reagent. Pour an equal amount of Benedict's solution and sample solution into a test tube. Heat to boiling, and simmer for 5 minutes. If no green, yellow or red colored precipitate occurs, then it means that there are no reducing sugars present.

5.2 Tests for Alkaloids
a) Dragon Dorff 's Test
Place 2 mL of the plant extract into a test tube to which a couple drops of 'Dragon Dorff' reagent has been added. If the colour of the precipitate comes out orange-red than it indicates presence of chemicals of the alkaloids type in the extract.

b) Wagner's Test
Pour some drops of Wagner's reagent to the extract solution. Precipitates will appear, which will be reddish–brown, if present in the presence of alkaloids.

5.3 Tests for Flavonoids
a) Shinoda Test
An add some of magnesium ribbon to the extract, a few drops of the concentrated hydrochloric acid (HCl). The presence of flavonoids are indicated by appearance of pink or red colour.

5.4 Tests for Saponins
a) Foam Test
Vigorously shake in a test tube with water. The foam forms persistently and remains stable – Saponins are present.

5.5 Tests for Tannins
a) Ferric Chloride Test
Add 5% $FeCl_3$ solution to the extract, a few drops. Tannins are determined with blue black or green colour.

5.6 Tests for Phenolic Compounds
a) Lead Acetate Test
Determine the volume of the extract of lead acetate solution. The number of drops of lead acetate solution in the extract. This is an indication of phenolics since the addition of the precipitate causes it to swell.

5.7 Tests for Steroids
a) Liebermann–Burchard Test
To the extract add acetic anhydride (2ml) and concentrated H_2SO_4. If blue green color is formed then they are present, which represents the presence of steroids.

5.8 Determination of proteins and amino acids
a) Biuret Test
To a volume of 2ml of the extract, add 1ml of 10% NaOH solution and a few drops of 0.1% $CuSO_4$ solution. Pink or Purple colour means there is protein present.

b) Ninhydrin Test
Dilute the extract to 2 mL in water bath, and add ninhydrin reagent, a few drops. Place 2 mL of extract into water bath and add the ninhydrin reagent, a few drops, and then heat the mixture for 1-2 minutes. The colour changes to blue/purple color means that the presence of amino acids is noted.

5.9 Tests for Terpenoids
a) Salkowski Test
Carefully pour 2ml of extract to a test tube and add half the chloroform and then tip in concentrated H_2SO_4 down the side of the test tube. If there is the presence of terpenoids, it takes place as reddish-brown formation at the interface.

5.10 Tests for Glycosides
a) Keller–Killian Test (Cardiac Glycosides)
Take glacial acetic acid with ferric chloride and slowly add concentrated H_2SO_4 drop wise from the side of the test tube. Cardiac glycosides will be shown if there is brown ring at the interface point.

6. PREPARATION OF HERBAL SHAMPOO[11]
To prepare the shampoo base, Sodium Lauryl Sulphate (SLS) was dissolved in distilled water. Adding the Herbal extracts and Thyme oil was done with stirring, stirring again. A thickening agent, namely methyl cellulose was added and the pH was adjusted by citric acid.

Preparation of Shampoo Base (Dissolve surfactant e.g., SLS in water)
↓
Addition of Herbal Extracts
(Liquorice extract +Shatavari extract + Thyme oil with continuous stirring)
↓
Addition of Excipients
↓
pH Adjustment (Adjust to pH 5.5–6.5 using citric acid)
↓
Homogenization (Uniform mixing, avoid air entrapment)
↓
Quality Evaluation (pH, viscosity, foam stability, appearance)
↓
Filling & Packaging (Plastic bottles, labelled and stored)

7. FORMULATION TABLE OF SHAMPOO

Three formulations: F1, F2 and F3 that have different concentration of herbal extracts and surfactants were formulated.

Table 2: Formulation Table of Shampoo.

Ingredients	F1	F2	F3
Liquorice extract	0.50gm	1.00gm	1.50gm
Shatavari extract	0.50gm	1.00gm	1.50gm
Thyme oil	0.20ml	0.30ml	0.50ml
Sodium benzoate	0.02gm	0.03gm	0.02gm
Sodium lauryl sulphate	2.00gm	1.50gm	2.50ml
Citric acid	0.01gm	0.02gm	0.01gm
Methyl cellulose	5.00gm	5.30gm	4.90gm
Rose water	0.20ml	0.20ml	0.20ml
Distilled water	q. s	q. s	q. s
Total	20.00ml	20.00ml	20.00ml

8. EVALUATION OF SHAMPOOO[11,12]

The prepared polyherbal shampoo formulations (F1, F2 & F3) were tested for the following physicochemical and biological evaluations:

a. Organoleptic Evaluation

The physical properties or the formulation (colour, smell, state and texture) were inspected visually. This kind of assessment was made on the basis of smell for the odor. These important for consumer acceptability and esthetic..

b. Physicochemical Analysis (pH, Surface Tension, and Viscosity)

- **pH Determination:** 1% and 10% (v/v) aqueous solutions were pH determined by a pH meter which is calibrated at a room temp. (25 ± 2 °C).
- **Surface Tension:** Measurements were made on 10% dilution of shampoo sample with the help of stalagmometer method. The apparatus was cleaned by using chromic acid for good accuracy. The surface tension was calculated using:

$$\gamma_2 = \frac{\gamma_1 (n_1 \times d_2)}{n_2 \times d_1}$$

Where: γ_1, γ_2 = surface tension of test liquid and water, N/m

n_1 , n_2 = number of drops of test liquid and water from same volume

d_1, d_2 = density of test liquid, and of water in kg/m³

- **Viscosity:** The rheological behaviour was determined using a Brookfield viscometer. The shampoo being tested was poured into a beaker glass of volume (±200 mL) followed by the installation of the correct spindle to the Brookfield DV-E model viscometer. It is then placed in a preparation until it is immersed in it, at varying spindle speeds (1-20 rpm). Measurements were taken after it.[13,14]

c. Foaming and Detergency Trials

- **Foaming Ability and Stability:** A graduated cylinder with a capacity of 250 ml was filled with 50 ml of shampoo solution and shaken upside down 10 times. The foam volume after 1 minute when it is built (ability) and after 20 minutes when it stays (stability) was taken.

$$Foaming\ ability = \frac{Foam\ height\ \times 100}{Total\ height}$$

$$Foam\ stability = \frac{Foam\ height\ at\ time\ \times 100}{Initial\ foam\ height}$$

- **Dirt Dispersion:** Two drops of the India ink were placed into 10 ml of a 1% shampoo solution. The distribution of ink was measured after shaking. A good shampoo will not release the ink into the water, and will have low ink content in the lather, or foams.

d. Biological and Chemical Stability

- **Skin Irritation Test:** Formulations were placed on the skin for 5 minutes and then the animals were washed with water. The presence of erythema, edema or inflammation was monitored at the site.
- **Antimicrobial Activity:** Estimated by Agar Well Diffusion method. Evaluation on inoculated plates was done in 9 mm wells containing the formulation. Incubation period was 48-72 hrs and zone of inhibition was measured.
- **Rancidity Test:** 10 ml of the sample was added with 10 ml concentrated HCl and 10 ml Phloroglucinol solution. When there was no pink colour it means there were no oxidized fats.
- **Accelerated Stability Studies:** Certain formulations have been kept at room temperature and also under accelerated conditions of temperature (40 ± 2°C RH) for 20 days.Some formulations have been kept at room temperature and also under high RH (75 ± 5% RH) at accelerated temperature for 20 days.

9. RESULT AND DISCUSSION

9.1 Results

Table 3: Pre-formulation Studies.

Sr. No.	Property	Result	
		Liquorice	Shatavari
1.	Moisture Content Determination [LOD]	7.5%	7.6%
2.	Ash value (Total)	8.5%	3.5%
3.	Acid insoluble ash value	2%	2.4%
4.	Sulphated ash Value	6.36%	1.5%
5.	Water Soluble Extractive Value	12%	9.95%
6.	Alcohol Soluble extractive Value	12.5%	13.8%

Table 4: Pre-liminary Phytochemical Screening.

Sr. No.	Phytochemical screening	Test performed	Observation		Inference	
			Liquorice	Shatavari	Liquorice	Shatavari
1	Carbohydrate	A) Molisch's Test	Violet ring	No violet ring	+	-
		B) Fehling's Test	Brick red ppt	No brick red ppt	+	-
		C) Benedict's Test	Yellow ppt	Yellow ppt	+	+
2	Alkaloids	D) Dragan Dorf's test	Orange red	Orange red	+	+
		E) Wagner's reagent	Reddish brown ppt	Reddish brown ppt	+	+
3	Flavonoid	F) Shinoda test	Orange color	Orange color	+	-
4	Saponin	G) Foam Test	Foam formation	No foam formation	+	-
5	Tannins	H) Ferric Chloride Test	No Blue-black color	Blue black	-	+
6	Phenolic C.	I) Lead Acetate Test	White ppt	White ppt	+	+
7	Steroids	J) Liebermann–Burchard Test	No Green color	No green color	-	-
8	Proteins and amino acids	K) Biuret Test	No Violet colour	Violet colour	-	-
		L) Ninhydrin test	No Purple colour	No purple colour	-	-
9	Terpenoid	M) Salkowski Test	No Green colour	No green colour	-	-
10	Glycoside	N) Killer Kilani Test	No Blueish green layer	No Blueish green layer	-	-

Fig. 4: Sample Test Results.

Table 5: Organoleptic Characteristics of Prepared shampoo.

Sr no.	Properties	Observations		
		F l	F 2	F 3
1.	Colour	Light brown	Reddish Brown	Sandy brown
2.	Odour	Aromatic	Aromatic	Aromatic
3.	State	Semisolid	Semisolid	Semisolid
4.	Texture	Fine	Smooth	Fine

Fig. 5: Organoleptic Characteristics of Prepared shampoo.

Table 6: pH Determination.

Properties	Observation		
	F 1	**F 2**	**F 3**
pH	5.50	6.86	8.61

Table 7: Viscosity Determination.

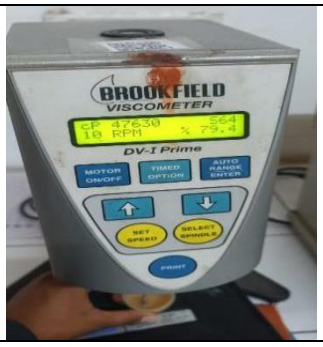
Properties	Observation		
	F 1	**F 2**	**F 3**
Viscosity	2759 CP	4763 CP	3389 CP
			

Table 8: Measurement of surface tension.

Properties	Observation		
	F 1	**F 2**	**F 3**
Foam ability	$\gamma_2 = \gamma_1 \frac{(n_1 x d_2)}{n_2 x d_1}$ $= \frac{72.8x55x1.10}{128x0.997} = 34.21$	$\gamma_2 = \gamma_1 \frac{(n_1 x d_2)}{n_2 x d_1}$ $= \frac{72.8x65x1.10}{128x0.997} = 40.54$	$\gamma_2 = \gamma_1 \frac{(n_1 x d_2)}{n_2 x d_1}$ $= \frac{72.8x59x1.10}{128x0.997} = 36.80$

Table 9: Dirt Dispersion.

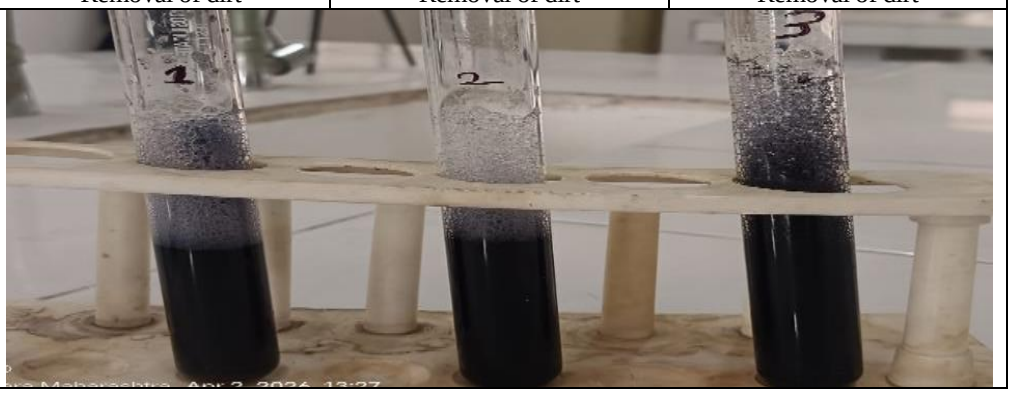
Properties	Observation		
	F 1	F 2	F 3
Dirt dispersion	Removal of dirt	Removal of dirt	Removal of dirt
			

Table 10: Foaming ability and foaming stability.

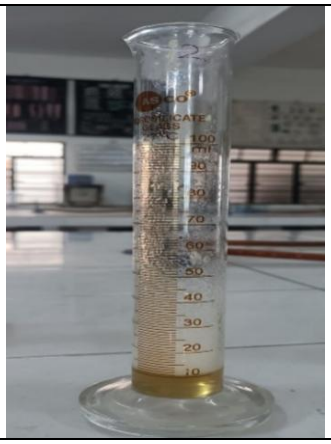
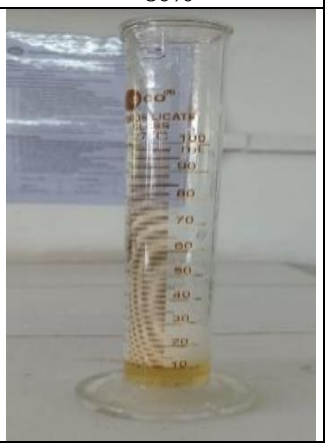
Properties	Observation		
	F 1	F 2	F 3
Foam ability	Foam height = 35/45 x100 = 70% Foam stability =28/35x100 = 80%	Foam height= 45/55 x100 = 80% Foam stability =37/45x100 = 80%	Foam height= 45/50 x100 = 90% Foam stability=38/45x100 = 80%
			

Table 11: Skin Irritancy Testing.

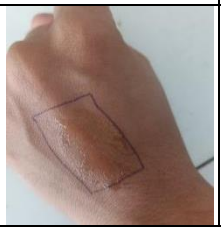
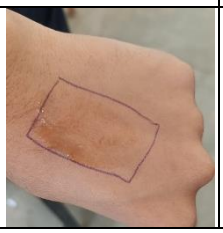
Sr no.	Skin irritancy test	Observations		
		F l	F 2	F 3
1.	5min	No Reaction	No Reaction	No Reaction
	15min	No reaction	No Reaction	No Reaction
	30min	No Reaction	No Reaction	No Reaction
				

Table 12: Rancidity testing.

Sr.No.	Test	Method	F 1	F 2	F 3
1	Rancidity Test	Phloroglucinol + conc. HCl	No pink colour	No pink colour	No pink colour
2	Odour Change	Storage observation	No change	No change	No change
3	Colour Change	Visual observation	Slightly change	No change	No change

Table 13: Anti-microbial Evaluation.

Sr. No	Microorganism Name	Conc.	Zone of Inhibition			
			Std	Fl	F2	F3
1	*E. coli*	100 µg/ml	10.0mm	6.0mm	8.0mm	9.0mm
2	S. *aureus*	100 µg/ml	8.0mm	6.0mm	7.0mm	8.0mm

Table 14: Stability Testing.

Sr. No.	Parameter	Condition	F 1	F 2	F 3
1	Appearance	30 ± 2°C / 65 ± 5% RH	No Change	No Change	No Change
2	Appearance	40 ± 2°C / 75 ± 5% RH	Slight thickening	No change	Thin
3	pH	After 1 month	5.48	6.80	8.55
4	Viscosity	After storage	Slight increase	Stable	Slight decrease
5	Phase Separation	Visual	No separation	No separation	No separation
6	Odour	After storage	No change	No change	No change

Note: Stability studies were carried out at room temp. (30 ± 2°C / 65 ±5% RH) and accelerated conditions (40 ± 2°C / 75 ± 5% RH).

Fig. 6: Final formulation of shampoo (F1, F2, F3).

10. CONCLUSION

The developed polyherbal shampoo is effective, safe, and economical, and it has strong potential for use in the management of seborrheic dermatitis. F2 was found to be the most optimized formulation, showing balanced pH, better viscosity, good foam stability, and effective cleansing action. Additionally, antimicrobial studies demonstrated that the formulations possess significant activity against common microorganisms, supporting their role in controlling dandruff and scalp infection.

F2 exhibited optimum performance, showing balanced pH, good viscosity, excellent foaming ability, and stability, making it the most suitable formulation. The presence of thyme oil contributed significantly to antifungal activity against dandruff-causing organisms, while liquorice and shatavari provided soothing, anti-inflammatory, and scalp-nourishing effects.

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