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Research Article

Formulation and Evaluation of a Solid Shampoo bar Enriched with Moringa Powder and Flaxseed Gel

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ABSTRACT

The goal of this study was to formulate and evaluate a solid shampoo bar enriched with moringa powder and flaxseed gel for effective hair cleansing and conditioning. The study involved the selection of suitable cleansing agents, conditioning agents, herbal ingredients and other excipients, followed by formulation, evaluation and comparison of the prepared solid shampoo bars with a marketed product. Moringa powder and flaxseed gel were prepared and subjected to preliminary phytochemical screening. Suitable formulation ingredients were selected, and three formulations, F1, F2 and F3, were prepared by varying the concentrations of selected surfactants while incorporating moringa powder and flaxseed gel. The prepared formulations were evaluated for their physical, physicochemical and performance characteristics, including appearance, pH, dirt dispersion, foamability, foam stability, moisture content, wetting ability, conditioning properties and surface tension. FTIR studies were also carried out to identify characteristic functional groups and assess the compatibility of the selected ingredients. Based on the combined performance of the evaluated parameters, Formulation F1 was selected as the optimized formulation. It delivered the most balanced performance across all physical and cleansing tests, presenting a skin-compatible pH of 5.23, an initial foam height of 9.5 cm with 90.6% stability, a practical wetting speed, and a high surface tension reduction of 34.90 dyn/cm. The findings also supported the chemical compatibility and integrity of the ingredients incorporated into this optimized formulation based on the FTIR study.

INTRODUCTION

A shampoo bar is a solid hair cleanser that contains surfactants and conditioning agents that clean and nourish the hair and scalp effectively.

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Hair is the thin, thread-like structure made primarily of a protein called keratin that grows from follicles embedded in the dermis of mammals. Hair helps with protection, temperature regulation, and sensory

perception. The hair shaft itself is composed of three concentric layers of keratinised cells: the medulla, cortex, and cuticle.

Figure 01: Anatomy of Hair

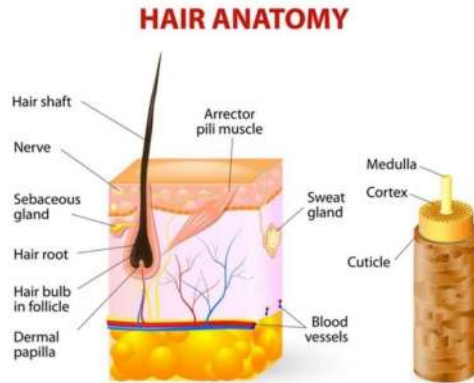


Figure 02: Hair root



Figure 03: Hair shaft

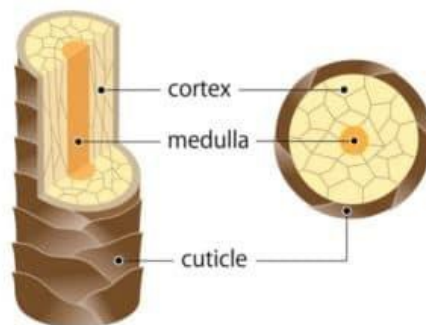


Figure 04: Scalp circulation and sensation

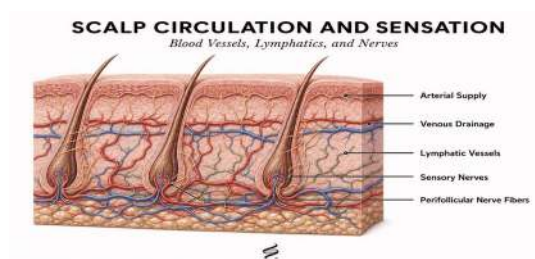


Figure 05: Sweat glands

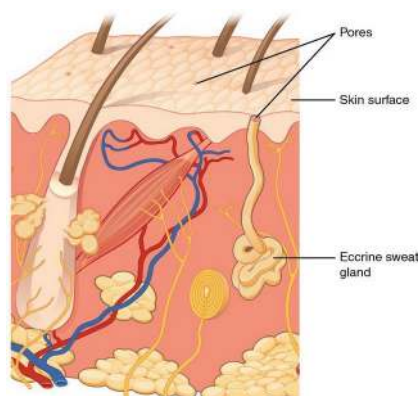


Figure 06: Hair growth cycle

Hair Cycle each sort of hair undergoes repeated cycle of active growth and rest. The cyclic phase of the follicle is identified by a lively growth period referred to as anagen, catagen and telogen a resting stage.

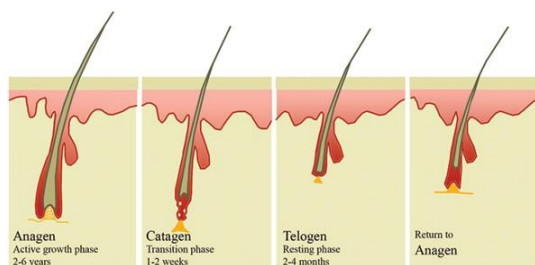


Figure 07: Types of split ends on hair

Hair breakage and split ends are common hair problems caused by weakening and damage to the hair shaft and

protective cuticle. Frizz and roughness are common hair problems characterized by dry, coarse, uneven, and difficult-to-manage hair. Hair loss (also known as alopecia) for several men, it's getting to be male pattern balding. Dandruff is characterized by flaking of the scalp.



Figure 08: Frizzy and rough hair



Figure 09: Hair loss pattern



Figure 10: Healthy scalp v/s dandruff scalp



Figure 11: Solid shampoo bar

Ideal Characteristics of a Solid Shampoo Bar:

- Good cleansing ability – Should effectively remove dirt and excess oil without damaging the hair.
- Mild and skin-friendly – Should have a balanced pH and be gentle on the scalp.
- Long-lasting and firm – The bar should maintain its shape and not dissolve quickly when stored properly.
- Rich lather and easy rinsing – Should produce adequate foam and wash out without leaving residue.
- Environmentally safe – Should be biodegradable and packaged in sustainable, plastic-free materials.

Aim and Objectives

To carry out formulation and evaluation of a solid shampoo bar enriched with moringa powder and flaxseed gel.

- To identify the important phytochemical constituents present in moringa and flaxseed powders by preliminary phytochemical screening.
- To identify the functional groups and study the compatibility of the formulation ingredients using FTIR spectroscopy.

- To formulate solid shampoo bars enriched with moringa and flaxseed powder by varying the concentration of excipients.
- To study the evaluation parameters such as appearance, pH, foamability, foam retention, wetting time, dirt dispersion, moisture content, hardness, percentage solid content, stability, and other standard physicochemical tests of the formulated solid shampoo bars.
- To compare the evaluation results of all the formulations and select the optimized formulation.
- To study the stability of the optimized solid shampoo bar.
- To compare the formulated solid shampoo bar with marketed product.

Review of Literature

Silva de Lima L. et al., have reviewed and evaluated the development of solid shampoo bars as an alternative to conventional liquid shampoos. This article mainly focuses on the formulation, stability, physical characteristics, and cleansing and conditioning performance of solid shampoo bars. Different formulations were prepared by varying the concentration of solid surfactants and were evaluated for their physical appearance, pH, foaming properties, cleansing ability, hardness, consistency, and hair combability. The study showed that the selected formulations remained stable under different storage conditions and exhibited good foam formation, cleansing, and conditioning properties. (9)

Patel H et al., formulated and evaluated a herbal solid shampoo bar using *Psidium guajava* (guava) leaf powder as an anti-dandruff agent. The study aimed to develop a herbal alternative to conventional shampoo bars with cleansing and conditioning properties. The shampoo bar was prepared using the hot-process method, followed by incorporation of guava leaf powder. The prepared formulations were evaluated for physical appearance, dirt dispersion, washability, foaming ability, pH, solid content, conditioning properties, and stability. (10)

Bawanthade et al., formulated and evaluated a polyherbal shampoo bar containing flaxseed and other

herbal ingredients. The formulations showed satisfactory physical properties, cleansing, foaming, conditioning, and antimicrobial activity. The study concluded that polyherbal shampoo bars have potential as a natural and environmentally friendly alternative to conventional shampoos. (11)

Nandhini J et al., formulated and evaluated a naturally derived shampoo bar using ingredients obtained from natural sources. The prepared shampoo bars were evaluated for visual appearance, pH, foamability, stability, dirt dispersion, and surface tension. The results indicated satisfactory cleansing and physicochemical properties, showing that naturally derived ingredients can be successfully incorporated into solid shampoo bars. (12)

Akash Kumar Pal et al., formulated a herbal shampoo using *Moringa oleifera* leaves and flax seeds (*Linum usitatissimum*) for natural hair care. The formulation was prepared using a mild, sulphate-free base along with natural surfactants and conditioning agents. It was evaluated for pH, viscosity, foamability, wetting time, dirt dispersion, surface tension, and conditioning performance. The formulated shampoo showed satisfactory cleansing and conditioning properties, indicating the potential of moringa and flaxseed as useful herbal ingredients for hair-care formulations. (13)

Nandini Harish Thakare et al., reviewed the formulation and evaluation of shampoo bars as an alternative to conventional liquid shampoos. The study discussed the use of different ingredients such as surfactants, conditioning agents, and herbal ingredients in the preparation of solid shampoo. Various evaluation parameters, including pH, foam stability, dirt dispersion, and other physicochemical properties, were discussed. (14)

Snehal P. Patil et al., formulated and evaluated a multipurpose herbal solid shampoo and conditioner using herbal ingredients such as neem, amla, brahmi, jatamansi, shikakai and behada. The herbal extracts were incorporated into a solid base, and the prepared formulations were evaluated for their organoleptic and physicochemical properties. The study focused on properties such as pH, foaming ability and moisture content, along with the beneficial antimicrobial and conditioning effects of the herbal ingredients. (15)



MATERIALS AND METHODS**METHODOLOGY****Table 1: List of Materials**

Ingredients	Manufacture/Supplier
Sodium Cocoyl Isethionate (SCI)	BRM Chemicals, Delhi 110006
Sodium Lauryl Sulphoacetate (SLSA)	Formulation Inc. Art Mart
Cocamidopropyl Betaine (CAPB)	BRM Chemicals, Delhi 110006
BTMS-50 Conditioner	BRM Chemicals, Delhi 110006
Cetostearyl Alcohol	Loba Chemie Pvt.LTD.
Cocoa Butter	yuccaenterprises@yahoo.com
Hydrolysed Protein (Wheat)	BRM Chemicals, Delhi 110006
Panthenol (Vitamin B5)	BRM Chemicals, Delhi 110006

Ingredients	Manufacture/Supplier
Glycerine	Sd fine – chem limited
Fragrance or Essential Oil	yuccaenterprises@yahoo.com
Moringa Powder	Local market
Flaxseed Gel	Local market

Table 2: List of Equipment's

Equipment	Model/company
Analytical weighing balance	Shimadzu Corporation, Japan
Digital pH meter	Systronicsnarods, Ahmedabad, India
Water bath	Jaideep engineers, gurudwara
Stalagmometer	Jain Scientific Glass Works (JSGW)
FTIR	PerkinElmer FTIR Spectrometer Spectrum two

EXTRACTION METHODS**Figure 12: Moringa leaf powder****Figure 13: Flaxseed**

1. Extraction of flaxseed
 10g of flaxseed is weighed
 Rinse with distilled water

Add purified water into 1:7 ratio

Boil it for 7 mins on a medium flame or until the gel forms

Strain it by using muslin cloth



Cool it to room temperature

Flax seed gel can be used for formulation. (32)

2. Extraction of moringa leaf powder

Collection of fresh Moringa oleifera leaves



Thorough washing with distilled water



Removal of stalks and damaged portions



Shade drying at room temperature until completely dry



Grinding of dried leaves into fine powder



Sieving through a suitable sieve to obtain uniform fine powder



Collection and storage of Moringa leaf powder in an airtight container



Moringa powder used in solid shampoo bar formulation. (33)

FORMULATION

Collection and weighing of raw materials

Preparation of Phase A

SCI + CAPB → Heated at 80°C with continuous mixing until a homogeneous softened mass was obtained

Preparation of Phase B

Cetearyl alcohol + BTMS-50 + Cocoa butter → Heated at 75°C until completely melted

Addition of SLSA

SLSA was added to Phase B and mixed thoroughly

Preparation of Phase C

Panthenol + Hydrolyzed wheat protein + Glycerin + Sodium benzoate + Essential oil → Mixed uniformly

Incorporation of Phase C into Phase B

Phase C was gradually added to Phase B with continuous mixing

Incorporation of Phase B into Phase A

Phase B was gradually added to Phase A and mixed thoroughly

Incorporation of herbal ingredients

Moringa powder + Flaxseed gel → Gradually incorporated and mixed thoroughly

Moulding

The homogeneous mass was transferred into suitable moulds and compressed gently

Drying

The moulded shampoo bars were dried at room temperature for 24–48 h

Demoulding and storage

The dried shampoo bars were carefully demoulded and stored in suitable containers for further evaluation. (9)

Table 03: Solid Shampoo bar Containing Moringa Powder and Flaxseed Gel.

Ingredients	F1 (100g)	F2 (100g)	F3 (100g)	Typical formulation range (%)
Sodium Cocoyl isethionate (SCI)	44	40	47	30–60
Sodium Lauryl Sulphoacetate (SLSA)	14	12	15	5–30
Cocamidopropyl Betaine (CAPB)	6	12	2	2–15
BTMS-50 Conditioner	8	8	8	2–10
Cetostearyl Alcohol	8	8	8	1–10
Cocoa butter	5	5	5	1–10
Moringa powder	4	4	4	1–5



Ingredients	F1 (100g)	F2 (100g)	F3 (100g)	Typical formulation range (%)
Flaxseed gel	4	4	4	1–5
Glycerin	4	4	4	1–10
Hydrolyzed Protein	1	1	1	0.5–5
Panthenol (Vitamin B5)	0.6	0.6	0.6	0.5–5
Sodium Benzoate	1	1	1	0.2–1.0
Fragrance/essential oil	0.4	0.4	0.4	0.3–2

IDENTIFICATION TESTS

1. Test for Flaxseed Mucilage
2. Test for Moringa Powder

1. Tests for Flaxseed Mucilage

- a. Organoleptic Properties: These Characteristics were Physically examined like Colour, odour and Taste.
- b. Omega-3 fatty acid test: Take 1 ml of bromine water and add 2 ml of flaxseed gel into test tube.
- c. Phenolic compound: Take 1 ml of ferric chloride solution and add 2 ml of flaxseed gel.
- d. Ruthenium red test: Take a 2 ml of non-hydrolyzed sample solution in a test tube add a few drops of ruthenium red solution and heat over a flame until the colour changes.

e. Phytosterol:

- i. Salkowski test: Take a 2 ml of flaxseed gel add 5 ml of conc. H_2SO_4 slowly along the side of the test tube.
- ii. Liebermann–Burchard test: Take a 2 ml of gel with chloroform add a few drops of acetic anhydride and add a few drops of conc. H_2SO_4 . (34)

2. Test for Moringa Powder

- a. Organoleptic properties: These characteristics were physically examined like colour, odour, and taste

B. Tests for moringa powder: Sample preparation

1gm of leaf powder + add 10ml of 70% ethanol + shake for 20-30 minutes and filtrate for the solution and use the filtrate for the phytochemical tests.

- b. Ferric chloride test for phenolic compounds: A few drops of 5% ferric chloride solution were added to the prepared extract and mixed thoroughly.

- c. Shinoda test for flavonoids: To the extract, a small amount of magnesium turnings was added, followed by a few drops of concentrated hydrochloric acid.
- d. Foam test for saponins: The extract was diluted with water and shaken vigorously for approximately 10–15 min.
- e. Dragendorff's test for alkaloids: A few drops of Dragendorff's reagent were added to the extract.
- f. Molisch's test for carbohydrates: A few drops of Molisch's reagent were added to the extract. Concentrated sulfuric acid was then carefully added along the side of the test tube to form a separate layer.
- g. Benedict's test for Proteins: To the 2ml of sample in a test tube add 2ml of sodium hydroxide followed by 4-5 drops of 1% copper sulphate.
- h. Ninhydrin test for amino acids: A few drops of ninhydrin solution were added to the extract and the mixture was gently heated. (35)

EVALUATION OF SOLID SHAMPOO BAR ENRICHED WITH MORINGA POWDER AND FLAXSEED GEL

Organoleptic Properties

- i) Colour: observed visually under normal light
- ii) Appearance: Examined visually for shape and surface
- iii) Odour: Assessed by smelling the sample

pH Determination

A 1% (w/v) solution of the formulated solid shampoo bar was prepared using distilled water. The Ph meter was calibrated using standard buffer solution of Ph 4.0



and Ph of the sample solution was measured at room temperature, and the readings were recorded

A 1% shampoo solution was prepared and two drops of Indian ink were added. The solution was shaken 10 times in a measuring cylinder. The distribution of ink in foam and water layer was observed and recorded.

A cotton disc (cotton fabric) with a diameter of 1 inch was placed on surface of a 1% shampoo bar solution. the time taken for the cotton disc to sink completely was recorded as wetting time

Foaming Ability

50 ml of a 1% shampoo bar solution was transferred into a 100ml measuring cylinder and shaken 10 times. after standing for 1minute, the height of the foam produced was measured and recorded.

Foam Stability

Foam stability was determined by the cylinder shake method. 50ml of 1 % (w/v) shampoo solution was transferred into 100ml measuring cylinder and shaken vigorously 10 times. The cylinder was allowed to stand undisturbed for 10min. The volume of foam remaining after 10 minutes was measured and recorded.

(Formula: Foam retention (%) = (Foam height at 10min ÷ Initial foam height) × 100)

Moisture Content

About 10g of the formulated shampoo bar was accurately weighed in a pre-weighed China dish. The sample was dried in a hot air oven at 105oC for 1 hour.

After cooling, the sample was weighed again. The moisture content was calculated from the loss in weight using the standard formula.

Formula:

Moisture content (%) = $\frac{\text{initial weight} - \text{final weight}}{\text{initial weight}} \times 100$

After washing the hair with shampoo, the conditioning impact on hair was examined. Conditioning characteristics encompassed desirable hair benefits such as improved lustres, softness, and silkiness. The conditioning effects were graded on a scale of 1–5. 1 = Very poor, 2 = Poor, 3 = Moderate, 4 = Good, 5 = Excellent.

Surface Tension Measurement: Drop Count Method

Measurements were carried out using a 10% w/v shampoo bar thoroughly cleaned stalagmometer using purified water. Drops are counted as the liquid moves from point A to point B. the average value is obtained by repeating the procedure three times. (11) (36)

Density:

$$\rho_2 = (W_3 - W_1) / (W_2 - W_1) \times \rho$$

ρ_1 = Density of the water

W_1 = Weight of the empty pycnometer

W_2 = Weight of the pycnometer filled with water

W_3 = Weight of the pycnometer filled with the sample

ρ_2 = Density of sample

Surface tension:

$$\gamma_2 = (\rho_2 \times n_1) / (\rho_1 \times n_2) \times \gamma_1$$

γ_2 = Surface tension of sample

ρ_2 = Density of sample

n_1 = Number of drops of water

ρ_1 = Density of water

n_2 = Number of drops of sample

γ_1 = Surface tension of water

Drug and Excipient Compatibility – IR Spectroscopy

IR Spectroscopy of Flaxseed gel



A. Solid shampoo bar formulation:

1. Drug and excipient compatibility

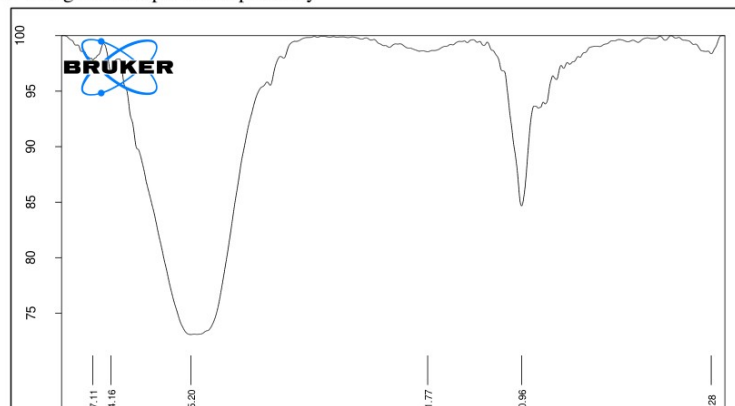


Figure 27: IR Spectroscopy of Flaxseed gel

Table 17: IR Spectroscopy of Flaxseed Gel

Functional group	Standard peak (cm-1)	Observed peak (cm-1)
Free O-H stretching	3800-3600	3744.16
Hydrogen-bonded O-H stretching	3600-3200	3335.20
Weak combination/overtone bond	2200-2000	2121.77
H-O-H bending/C=C vibration	1650-1600	1640.96
O-H out-of-plane/ skeletal vibration	700-600	669.28

IR Spectroscopy of Sodium cocyl isethionate

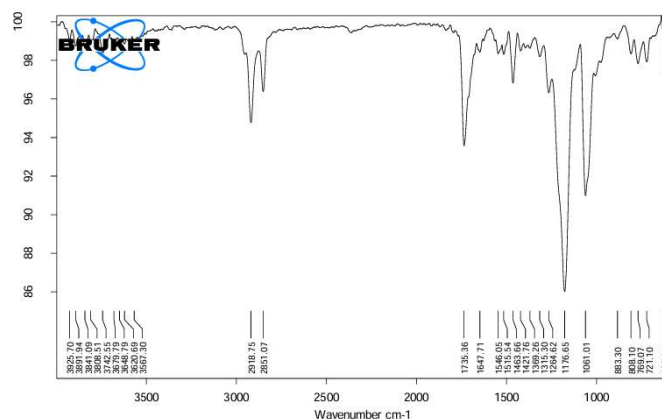


Figure 28: IR Spectroscopy of Sodium cocyl isethionate

Table 18: IR Spectroscopy of Sodium Cocoyl Isethionate

Functional group	Standard peak (cm-1)	Observed peak (cm-1)
C-H stretching	3000-2800	2918-2851
C=O stretching	1750-1700	1735
O-H bending / H-O-H bending	1680-1600	1648
C-H bending	1500-1400	1463
S-O / C-O stretching	1200-1100	1177
C-O stretching	1100-1000	1061

IR Spectroscopy of Moringa powder



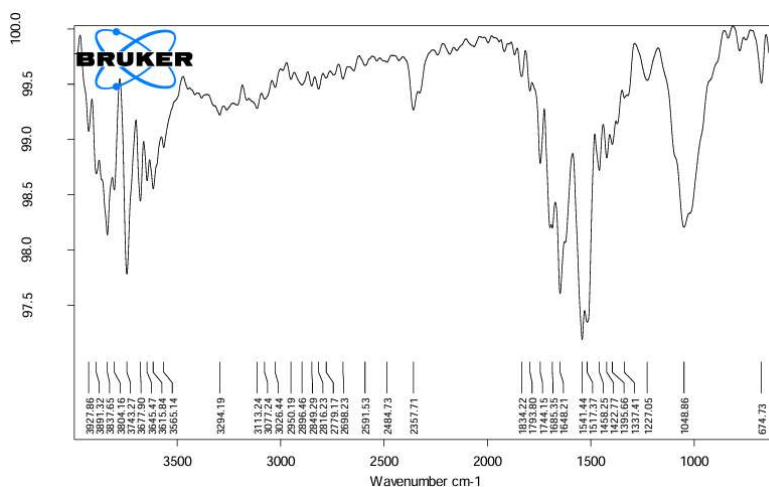


Figure 29: IR Spectroscopy of Moringa powder

Table 19: IR Spectroscopy of Moringa Powder

Functional group	Standard peak (cm-1)	Observed peak (cm-1)
O-H stretching	3600-3200	3294.19
Aliphatic C-H stretching	3000-2850	2950.60
C=O stretching	1750-1650	1744.15
C=C / amide I	1680-1600	1648.21
Amide II / N-H bending	1600-1500	1541.44
C-O stretching	1150-1000	1048.86

IR Spectroscopy of Sodium Lauryl Sulfoacetate

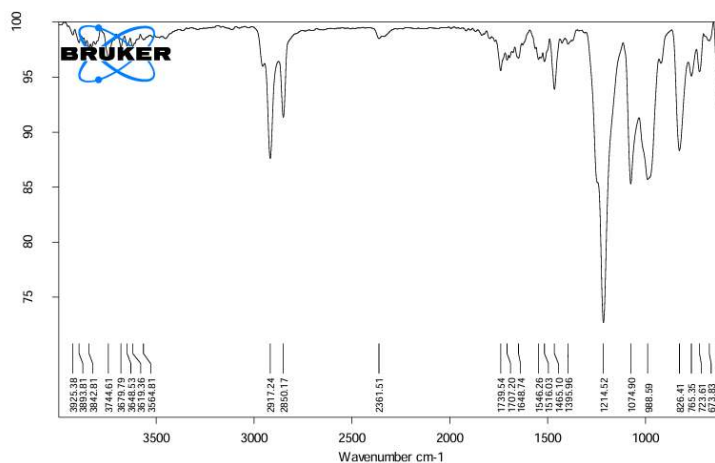


Figure 30: IR Spectroscopy of Sodium Lauryl Sulfoacetate

Table 20: IR Spectroscopy of Sodium Lauryl Sulfoacetate

Functional group	Standard peak (cm-1)	Observed peak (cm-1)
Aliphatic C-H stretching	3000-2850	2917.24
Aliphatic C-H stretching	2960-2850	2850.17
C=O stretching	1750-1700	1739.54
C=C stretching associated vibration	1680-1600	1648.77
S=O /SO3- asymmetric stretching	1250-1150	1214.52
S=O /SO3- symmetric stretching	1100-1000	1074.90

IR Spectroscopy of Excipient powder mix

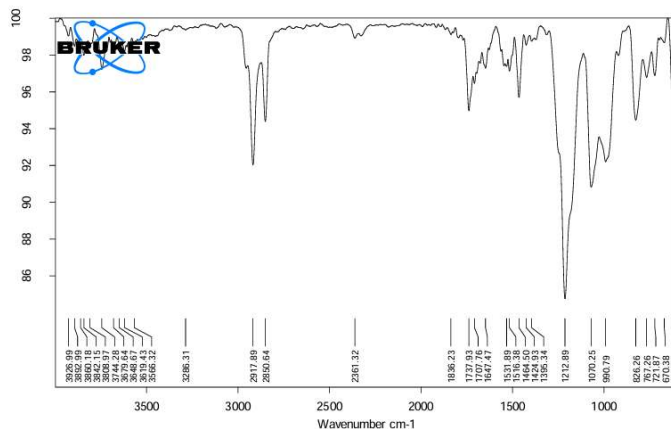


Figure 31: IR Spectroscopy of Excipient powder mix

Table 21: IR Spectroscopy of Excipient Powder Mix

Functional group	Standard peak (cm-1)	Observed peak (cm-1)
O-H / N-H stretching	3600-3200	3268.31
Aliphatic C-H stretching	3000-2850	2917.89
Aliphatic C-H stretching	2960-2850	2850.64
C=O stretching	1750-1650	1737.93
C=C / amide I	1680-1600	1647.17
C-O stretching	1150-1000	1070.25

IR Spectroscopy of Final Formulation (Solid shampoo bar)

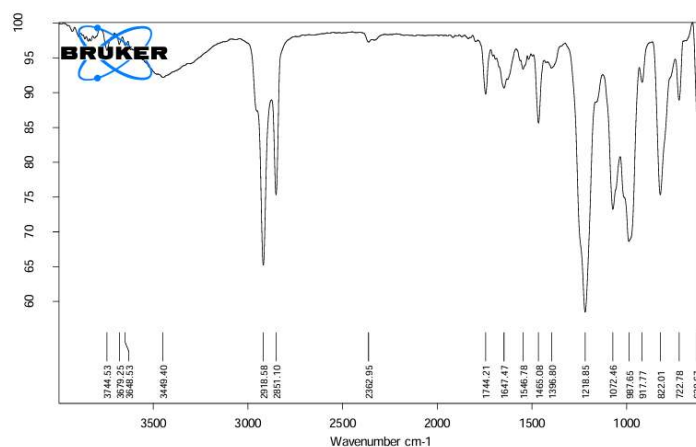


Figure 32: IR Spectroscopy of Final Formulation (Solid shampoo bar)

Table 22: IR Spectroscopy of Final Formulation (Solid Shampoo bar)

Functional group	Standard peak (cm-1)	Observed peak (cm-1)
O-H stretching	3600-3200	3449.40
Aliphatic C-H Stretching	3000-2850	2918.58
Aliphatic C-H Stretching	2960-2850	2851.10

Functional group	Standard peak (cm-1)	Observed peak (cm-1)
C=O stretching	1750-1650	1744.21
C=C stretching / amide I	1680-1600	1647.47
C-O / C-N stretching	1300-1000	1218.85

FTIR analysis of flaxseed gel, Moringa powder, SCI, SLISA and the final shampoo bar formulation confirmed the presence of characteristic functional groups such as O-H, C-H, C=O, amide, C-O/C-N and sulfonate groups.

The characteristic absorption bands observed in the individual ingredients were retained in the final shampoo bar formulation, indicating preservation of the principal functional groups during formulation.

No major new or unexpected peaks were observed in the FTIR spectrum of the final shampoo bar, suggesting the absence of any apparent major chemical interaction or incompatibility among the formulation components.

Overall, the FTIR findings support the chemical compatibility and integrity of the ingredients incorporated into the final shampoo bar formulation.

RESULTS AND DISCUSSION

The obtained flaxseed mucilage is pale yellow in colour, and having mild, slightly nutty odour, mild and neutral nutty in taste which was physically examined.

Test for Flaxseed Gel



Figure 14: Flaxseed Gel



Fig.15: Decolourization of brown colour

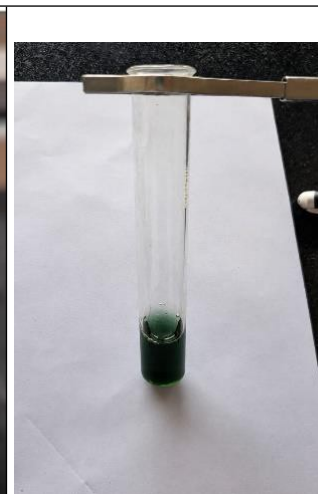


Fig.16: Green colour



Figure 17: Pink color

Test	Observation	Inference
1ml Bromine water + 2ml of flaxseed gel	Decolorization of brown colour	Presence of omega-3-fatty acid
1ml 1 %FeCl ₃ solution and 2ml flaxseed gel	Dark green colour	Presence of phenolic compounds

Test	Observation	Inference
Take 2 ml of non-hydrolysed sample solution in a test tube add a few drops of ruthenium red solution and heat on flame until the color changes	Pink color is observed	Flaxseed gel is confirmed

The moringa powder was found to have a characteristic green colour, mild herbal odour, and slightly bitter taste, indicating its typical organoleptic properties.

Test for Moringa Powder



Figure 18: Moringa powder



Fig.19: Dark green colour



Fig.20: Red colour



Fig.21: Foam Persists



Fig.22: Reddish-brown precipitation



Fig.23: Violet ring at junction



Fig.24: Violet colour



Fig.25: Blue color



Fig.26: Yellow precipitate

Test	Observation	Inference
Add a few drops of 5% ferric chloride to the extract	Dark Green color	Phenolic compounds and tannins present
Add magnesium turnings and a few drops of concentrated HCL to the extract	Red colour	Flavonoids are present
Shake the extract vigorously with water	Stable foam persist for 10-15 minutes	Saponins are present
Add dragendorff's reagent to extract	Orange or reddish-brown precipitation	Alkaloids are present
Add molish's reagent, then carefully add concentration H ₂ SO ₄	Violet ring at junction	Carbohydrates are present
Add NaoH followed by a few drops of Cuso ₄ solution	Violet color	Protiens are present
Heat the extract with Ninhydrin solution	Purple or blue color	Amino acids are present
Add 10 % lead acetate solution	White or yellow precipitate	Tannis are present

FTIR analysis of flaxseed gel, Moringa powder, SCI, SLISA and the final shampoo bar formulation confirmed the presence of characteristic functional groups such as O–H, C–H, C=O, amide, C–O/C–N and sulfonate groups. The characteristic absorption bands observed in the individual ingredients were retained in the final shampoo bar formulation, indicating preservation of the principal functional groups during

formulation. No major new or unexpected peaks were observed in the FTIR spectrum of the final shampoo bar, suggesting the absence of any apparent major chemical interaction or incompatibility among the formulation components. Overall, the FTIR findings support the chemical compatibility and integrity of the ingredients incorporated into the final shampoo bar formulation.

Functional group	Standard peak (cm ⁻¹)	Observed peak (cm ⁻¹)
O-H stretching	3600-3200	3449.40
Aliphatic C-H Stretching	3000-2850	2918.58
Aliphatic C-H Stretching	2960-2850	2851.10
C=O stretching	1750-1650	1744.21

Functional group	Standard peak (cm-1)	Observed peak (cm-1)
C=C stretching / amide I	1680-1600	1647.47
C-O / C-N stretching	1300-1000	1218.85

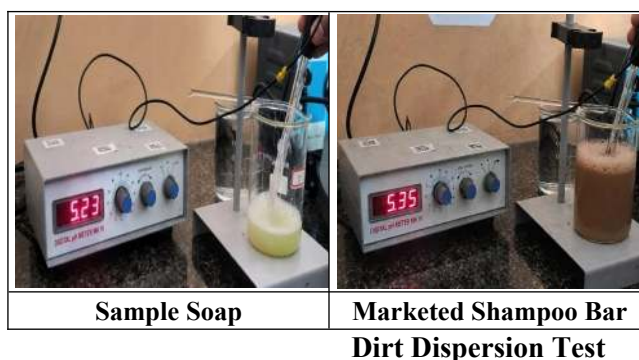
Formulation	Colour	Odour	Shape
F1	Dark olive green	Characteristic herbal odour	Oval shaped, hard, compact bar with a smooth surface.
F2	Dark olive green	Characteristic herbal odour	Oval shaped, firm solid bar, slightly softer texture.
F3	Dark olive green	Characteristic herbal odour	Oval shaped, very hard, highly compact solid bar.

pH Test

Formulation	pH
F1	5.23
F2	4.85
F3	5.63
Marketed Shampoo Bar	5.35

The pH values of F1 (5.23), F2 (4.85), and F3 (5.63) were found to be within a suitable range for shampoo formulations, with F1 showing a pH closest to the marketed product (5.35). All three formulations showed a mildly acidic pH, which is suitable for hair and scalp application.

Figure 33: pH determination for solid shampoo bar

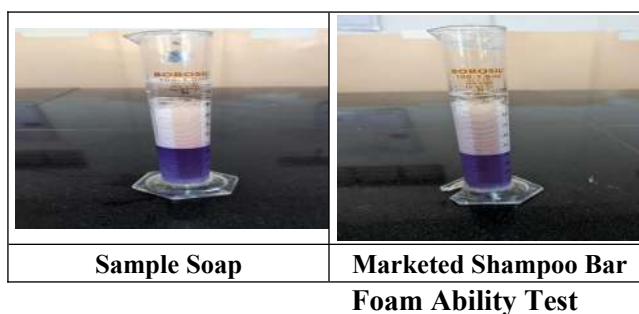


Dirt Dispersion Test

Dirt Dispersion Test	Shampoo Soln. Conc.	No. of Ink Drops	Observation	Grade
F1	1%	2	No ink	Excellent
F2	1%	2	Very little	Good
F3	1%	2	No ink	Excellent
Marketed shampoo bar	1%	2	No ink	Excellent

Dirt Dispersion Test

Figure 34: Dirt dispersion test for solid shampoo bar



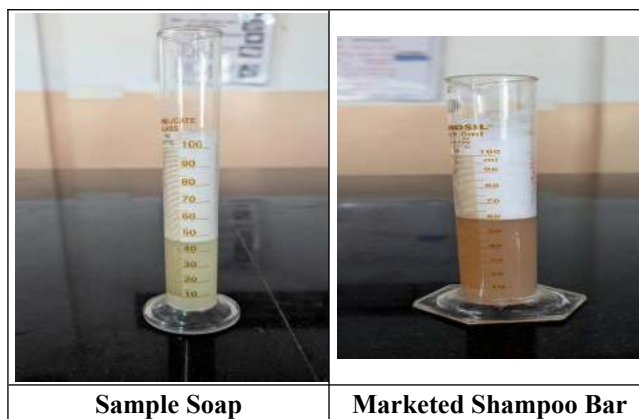
Foam Ability Test

Formulation	Trial 1 (cm)	Trial 2 (cm)	Trial 3 (cm)	Average
F1	9	10	9.5	9.5
F2	8.5	8.7	8.3	8.5
F3	9.8	10	10.1	9.9
Marketed shampoo bar	9	9.5	10.5	9.6

F1, F2, and F3 showed good foam ability, with average foam heights of 9.5, 8.5, and 9.9 cm, respectively. F3 produced the highest foam among the solid shampoo

bar formulations. Overall, all formulations showed acceptable foam-producing ability, indicating good cleansing performance.

Figure 35: Foam ability test for solid shampoo bar



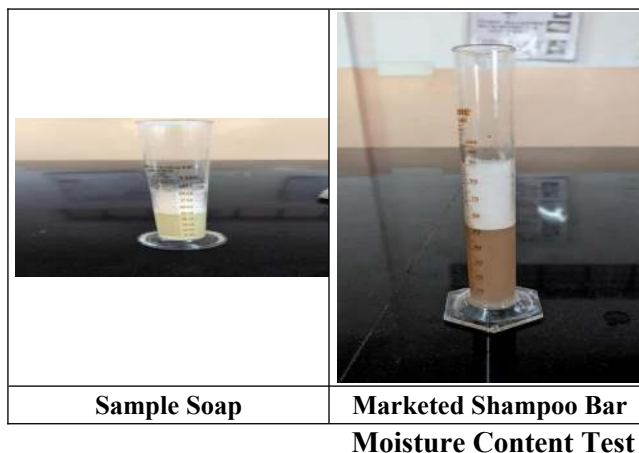
Foam Stability Test

Formulation	Initial foam volume (cm)	Final foam volume after 10mins (cm)	Foam stability (%)
F1	9.5	8.7	90.6
F2	8.5	7.5	89.5
F3	9.9	9.1	91.9
Marketed shampoo bar	9.6	8.8	91.7

F1, F2, and F3 showed good foam stability, with retention above 89%. F3 showed the highest foam stability (91.9%), slightly higher than the marketed soap

(91.7%). Overall, the solid shampoo bars demonstrated excellent foam retention and comparable performance to the marketed product.

Figure 36: Foam stability test for solid shampoo bar



Moisture Content	Initial Wt. (g)	Final Wt. After Drying (g)	Weight Loss (g)	Moisture Content (%)
F1	5	4.98	0.02	0.4
F2	5	4.98	0.02	0.4
F3	5	4.99	0.01	0.2
Marketed shampoo bar	5	4.97	0.03	0.6

The moisture content of F1, F2, and F3 was found to be 0.4%, 0.4%, and 0.2%, respectively. The low moisture values indicate proper drying and good physical stability of the solid shampoo bars.

Figure 37: Moisture content test for solid shampoo bar



Formulation	Trial 1 (sec)	Trial 2 (sec)	Trial 3 (sec)	Average (sec)
F1	124	128	119	123.6
F2	168	175	164	169
F3	74	79	71	74.6
Marketed shampoo bar	118	112	115	115

F3 showed the fastest wetting time (74.6 sec) among the formulations. F1 showed moderate wetting ability (123.6 sec) compared with the marketed product (115 sec). F2 showed the longest wetting time (169 sec), indicating slower wetting. F3 showed better wetting

performance than the marketed product. Overall, the formulations demonstrated acceptable wetting ability for effective shampooing.

Conditioning Test

Formulation	Allocated score	Grade
F1	4	Good
F2	5	Excellent
F3	3	Moderate
Marketed shampoo bar	4.5	Excellent

Conditioning Test

Figure 38: Conditioning test for solid shampoo bar



Surface Tension Test (Drop Count Method)

Formulation	Average no. of drops (n)	Density (ρ)	Surface Tension (dyn/cm)
Water	60.0	0.997	72.0
F1	129.6	1.046	34.9
F2	114.0	0.991	36.61
F3	139.3	1.046	32.47
Marketed shampoo bar	128.0	0.988	33.4

F1: Surface tension was 34.90 dyne/cm, indicating satisfactory wetting and cleansing ability. F2: Surface tension was 36.61 dyne/cm, showing good surface activity. F3: Surface tension was 32.47 dyne/cm, indicating better wetting and cleansing action. Marketed

product: Showed 33.4 dyne/cm, which was comparable with the formulated batches. Overall, the solid shampoo bar formulations showed satisfactory surface-tension properties and were comparable with the marketed product.

Figure 39: Drop count test for water and solid shampoo bar



CONCLUSION

The solid shampoo bar enriched with moringa powder and flaxseed gel was successfully formulated and evaluated. The prepared formulations showed satisfactory physicochemical and functional characteristics, demonstrating effective cleansing and conditioning

performance. Among the three prepared formulations, Formulation F1 was selected as the optimized formulation because it achieved a superior balance between physical hardness and conditioning performance. While other formulations achieved higher individual readings, they compromised hair softness. Formulation F1 safely satisfied our target acceptance criteria,



providing excellent structural stability, proper moisture control (0.4%), and performance results directly comparable to the premium marketed benchmark product. Thus, the study successfully confirms the feasibility of incorporating moringa powder and flaxseed gel into a solid shampoo bar and demonstrates their potential for use in sustainable, zero-plastic hair-care cosmetics.

Conflict of Interest

The authors declare that there is no conflict of interest associated with the present study.

Further Studies / Scope of the Study

- **Stability Studies:** The stability of the optimized solid shampoo bar can be further studied for an extended period under different storage conditions.
- **Safety Evaluation:** Further studies can be carried out to establish the safety and scalp compatibility of the optimized formulation.
- **Performance Evaluation:** The cleansing and conditioning performance of the optimized formulation can be further investigated through detailed hair-care studies.
- **Comparative Studies:** Further comparative studies can be conducted with different commercially available shampoo bars and conventional shampoos.
- **Formulation Optimization:** Further work can be carried out to optimize the formulation and explore its potential for large-scale preparation.

REFERENCES

1. Buffoli B, Rinaldi F, Labanca M, Sorbellini E, Trink A, Guanzioli E, Rezzani R, Rodella LF. The human hair: from anatomy to physiology. *International journal of dermatology*. 2014 Mar;53 (3):331-41.
2. Sperling LC: Hair anatomy for the clinician. *J Am AcadDermatol* 1991;25:1–17.
3. Wortsman X, Carreño L, Ferreira-Wortsman C, Poniachik R, Pizarro K, Morales C, Calderon P, Castro A. Ultrasound characteristics of the hair follicles and tracts, sebaceous glands, Montgomery glands, apocrine glands, and arrector pili muscles. *Journal of Ultrasound in Medicine*. 2019 Aug;38 (8):1995-2004.
4. Peña-Jimenez D, Fontenete S, Megias D, Fustero -Torre C, Graña-Castro O, Castellana D, Loewe R, Perez-Moreno M. Lymphatic vessels interact dynamically with the hair follicle stem cell niche during skin regeneration in vivo. *The EMBO Journal*. 2019 Oct 1;38 (19):EMBJ2019101688.
5. Rahmani W, Abbasi S, Hagner A, Raharjo E, Kumar R, Hotta A, Magness S, Metzger D, Bier-naskie J. Hair follicle dermal stem cells regenerate the dermal sheath, repopulate the dermal papilla, and modulate hair type. *Developmental cell*. 2014 Dec 8;31 (5):543-58.
6. De La Mettrie R, Saint-Léger D, Loussouarn G, Garcel AL, Porter C, Langaney A. Shape variability and classification of human hair: a world-wide approach. *Human biology*. 2007;79 (3):265-81.
7. Cotsarelis G, Sun TT, Lavker RM. Label-retaining cells reside in the bulge area of pilosebaceous unit: implications for follicular stem cells, hair cycle, and skin carcinogenesis. *Cell*. 1990 Jun 29;61 (7):1329-37.
8. Messenger AG, De Berker DA, Sinclair RD. Disorders of hair. *Rook's textbook of Dermatology*. 2010 Mar 22;1:1-00.
9. de Lima LS, Illiceto GC, Velasco MV, Dario MF. Desenvolvimento e avaliação de eficácia de xampu sólido em barra: Desenvolvimento de xampu sólido. *BBR-Biomedical and Biopharmaceutical Research*. 2023;20 (2).
10. Patel H, Patel H, Zangariya S, Patel S, Patel S, Vasava D. Formulation and evaluation of herbal solid shampoo. *J Emerg Technol Innov Res*. 2023;10 (5):289-294.
11. Bawanthade SR, Hemne DY, Bhelawe SF, Banerjee DA, Rahangdale RP. Formulation and evaluation of polyherbal shampoo bar. *Int J Creative Res Thoughts*. 2025;13 (4):e407-e430.
12. Nandhini J, Arulmani M, Deepa Priya K, Naveen Kumar M. Formulation and evaluation of naturally derived shampoo bar. *Int J Innov Sci Res*



- Technol. 2025;10 (4):481-487. doi:10.38124/ijisrt/25apr346.
13. Pal AK, Thakur DS, Pathan S, Kusgwaha R. Formulation and evaluation of herbal shampoo. *Int J Res Technol*. 2026;14 (2):592-598.
14. Thakare NH, Shirole SS, Patil UR, Deo SD, Yeole RR. Review on hair care cosmetic-formulation and evaluation of shampoo bar [solid shampoo]. *Int J Progress Res Eng Manag Sci*. 2024;4 (1):519-526.
15. Patil SP. Formulation and evaluation of multipurpose herbals solid shampoo and conditioner soap. *Int J Chem Eng Process*. 2024;10 (1):12-19
16. Saini RK, Sivanesan I, Keum YS. Phytochemicals of *Moringa oleifera*: a review of their nutritional, therapeutic and industrial significance. *3 Biotech*. 2016;6 (2):203. doi:10.1007/s13205-016-0526-3.
17. Klimek-Szczykutowicz M, Gawel-Bęben K, Rutka A, Blicharska E, Tatarczak-Michalewska M, Kulik-Siarek K, et al. *Moringa oleifera* (drumstick tree)—nutraceutical, cosmetological and medicinal importance: a review. *Front Pharmacol*. 2024;15:1288382. doi:10.3389/fphar.2024.1288382.
18. Kajla P, Sharma A, Sood DR. Flaxseed—a potential functional food source. *J Food Sci Technol*. 2015;52 (4):1857-1871. doi:10.1007/s13197-014-1293-y.
19. Goyal A, Sharma V, Upadhyay N, Gill S, Sihag M. Flax and flaxseed oil: an ancient medicine and modern functional food. *J Food Sci Technol*. 2014;51 (9):1633-1653. doi:10.1007/s13197-013-1247-9.
20. Kaur M, Kaur R, Punia S. Characterization of mucilages extracted from different flaxseed (*Linum usitatissimum* L.) cultivars: a heteropolysaccharide with desirable functional and rheological properties. *Int J Biol Macromol*. 2018;117:919-927. doi:10.1016/j.ijbiomac.2018.06.010.
21. PubChem. Sodium cocoyl isethionate [Internet]. Bethesda (MD): National Library of Medicine.
22. PubChem. Sodium lauryl sulfoacetate [Internet]. Bethesda (MD): National Center for Biotechnology Information, National Library of Medicine.
23. PubChem. Cocamidopropyl betaine [Internet]. Bethesda (MD): National Center for Biotechnology Information, National Library of Medicine.
24. PubChem. Behentrimonium methosulfate [Internet]. Bethesda (MD): National Center for Biotechnology Information, National Library of Medicine.
25. PubChem. Cetearyl alcohol [Internet]. Bethesda (MD): National Center for Biotechnology Information, National Library of Medicine.
26. PubChem. Cocoa butter [Internet]. Bethesda (MD): National Center for Biotechnology Information, National Library of Medicine.
27. Burnett C, Bergfeld WF, Belsito DV, Hill RA, Klaassen CD, Liebler DC, et al. Safety assessment of hydrolyzed wheat protein and hydrolyzed wheat gluten as used in cosmetics. *Int J Toxicol*. 2018;37 (1 Suppl):55S-66S. doi:10.1177/1091581818776013.
28. PubChem. Panthenol [Internet]. Bethesda (MD): National Library of Medicine.
29. Cosmetic Ingredient Review Expert Panel. Safety assessment of panthenol, pantothenic acid, and derivatives as used in cosmetics. *Int J Toxicol*. 2017;36 (3 Suppl):5S-18S.
30. PubChem. Glycerin [Internet]. Bethesda (MD): National Center for Biotechnology Information, National Library of Medicine.
31. Becker LC, Bergfeld WF, Belsito DV, Hill RA, Klaassen CD, Liebler DC, et al. Safety assessment of glycerin as used in cosmetics. *Int J Toxicol*. 2019;38 (3 Suppl):6S-22S. doi:10.1177/1091581819883820.
32. Thakare NH, Shirole SS, Patil UR, Deo SD, Yeole RR. Review on hair care cosmetic – formulation and evaluation of shampoo bar [solid shampoo]. *Int J Prog Res Eng Manag Sci*. 2024;4 (1):519-526.
33. Pal AK, Thakur DS, Pathan S, Kusgwaha R. Formulation and evaluation of herbal shampoo.



34. Sakshi S. Raut, Sumit Neukar, and Bhavana P. Raut the Science of Flaxseed in Skincare: A Review on Its Moisturizing and Hydrating Benefits: 10 (3) May–June 2025, 01-08 www.ijprajournal.com ISSN: 2456-4494
35. Khalid S, Arshad M, Mahmood S, Ahmed W, Siddique F, Khalid W, et al. Nutritional and phytochemical screening of Moringa oleifera leaf powder in aqueous and ethanol extract. *Int J Food Prop.* 2023;26 (1):2338-2348. doi:10.1080/10942912.2023.2246685.
36. Cossio L, Torres A, Roeckel M, Neubert RH. Characterisation of surfactant activity and solid bar performance. *Int J Cosmet Sci.* 2021;43:72-81.

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