RESEARCH ARTICLE

Formulation and Characterization of Herbal Ingredients based Shampoo

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ABSTRACT

Shampoo is one of the cosmetic items that uses surfactants as its principal ingredient. When used as directed, the shampoo will clean the hair of surface grease, filth, and skin debris without having an unfavorable effect on the user. Shampoo is now used to promote hair growth and stop hair loss in addition to cleaning debris from the hair and scalp. The shampoo was prepared using amla extract, ritha extract, shikakai extract, bhringraja extract, henna extract, neem extract, and kalonji extract and evaluated for pH, wetting time, doaming properties, detergency ability, surface tension measurement, viscosity percent of solids, skin irritation test and stability test. It was concluded that sodium lauryl sulfate is very toxic to the hair. It damages the morphological integrity of the hair fiber, whereas natural conditioners protect hair morphological integrity and provides consistency and shine to hair.

Keywords: Amla extract, Hair shampoo, Herbal ingredients, Neem extract, Ritha extract, Shikakai extract.

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INTRODUCTION

The scalp is shielded by hair from high temperatures and UV light exposure. In addition, human hair serves as a crown.[1,2] Because of this, hair needs special care to be lustrous, silky, hard to break, and simple to comb.[3,4] One cosmetic item that is used to clean the filth that is adhered to the hair and scalp is shampoo.[5] To boost the effectiveness of shampoo, extra compounds are used in addition to the core ingredient, surfactant.[6,7] There are many different types of shampoos on the market that are made with synthetic components that are bad for your skin and overall health. However, most customers are unaware of these compounds' negative effects.[8,9] One surfactant that can be fairly harsh and cause irritation to the scalp and damage to hair follicles when used excessively is sodium lauryl sulphate[10]. Formaldehyde is routinely added to shampoo formulas as a preservative, increasing the risk of skin sensitization[11]. Consumers now prefer herbal-based cosmetics over synthetic cosmetics due to growing awareness of the harmful chemicals present in cosmetic goods.[12]

The potential for developing herbal shampoo formulas from a variety of plants has been examined. These plants contain vitamins, phenolics, amino acids, and essential oils.[13,14] Many plants are naturally available and have the potential to be employed in the manufacture of shampoos, including kalonji extract, henna extract, ritha extract, shikakai extract, and amla extract.[15-19] For shampoo products to be safe for hair and health, it is crucial to develop new cosmetic formulas and assess their quality.

MATERIAL AND METHODS

Raw materials of shampoo were collected from local traders of Jhunjhunu, Rajasthan, and from the medicinal garden of Krishnadevi Maheshwari Pharmacy College, Jhunjhunu Road, Bagar.

The marketed formulations of shampoo were also procured and labeled as MS1 and MS2.

Preparation of Plant Extract

After drying, powdered plant drugs were sieved from sieve no. 8. Preparation of extract was done by maceration method. This method involves soaking the dried uniform particles in the solvent. A 2 gm of the powdered plant materials were soaked in 20 mL of distilled water separately in tightly sealed test tubes labeled 3, 6, 9, and 12, respectively. They were stirred at regular time intervals. Samples were withdrawn to determine extractive value on 3rd, 6th, 9th, and 12th days, respectively. Samples were filtered through muslin cloth, and extract was used for extractive value determination.[20]

Preliminary Phytochemical Screening of Herbal Extracts

Preliminary tests were done for the existence or nonexistence of the phytoconstituents like alkaloids, glycosides, carbohydrates, flavonoids, saponins, sterols, terpenes, etc.[21]

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Table 1: Primary formula for shampoo formulation

S. No.	*Ingredients*	*Percentage (w/v)(%)*
1.	Sodium lauryl sulfate	0–24
2.	Amla extract	1–3
3.	Ritha extract	0.5–3
4.	Shikakai extract	0.5–3
5.	Bhringraja extract	1–2
6.	Henna extract	1–2
7.	Neem extract	1–2
8.	Kalonji Extract	1–2
9.	Sodium chloride	0.5–1.5
10.	Glycerin	5
11.	Methylcellulose	0.5–1.5
12.	Methyl paraben	0-0.25
13.	EDTA	0-0.15
14.	Deionized water	q .s. to 100 mL

It has been found that most extracts contain glycosides, saponins, and tannins.

Formulation of Shampoo

From the literature survey, a primary formula (Table 1) was chosen for formulating shampoos. Different shampoos were prepared as per primary formula and were evaluated.

To formulate a clear shampoo base, sodium lauryl sulfate (0–24%), herbal extracts of different concentrations as per the formula, and sodium chloride (0.5–1.5%) were added to an aqueous solution containing glycerin (5%), Methylcellulose (0.5–1.5%), methylparaben (0–0.25%), and edetic acid (EDTA) (0–0.15%). If necessary, triethanolamine solution or citric acid was added to bring the pH between 5.5–6.0.

Evaluation of Shampoo

pH

Using a pH metre, the pH of a 10% shampoo solution in distilled water was calculated (Systronics-361). It has been demonstrated that shampoo pH plays a significant role in increasing and enhancing hair characteristics, reducing eye discomfort, and maintaining the ecological balance of the scalp. One method to reduce hair damage is the current tendency to push shampoos with a lower pH. Mild acidity reduces edema and encourages scaling, which results in shine.[22]

Wetting Ability

The wetting phenomenon has generated a great deal of economic attention and is essential for wiping away dirt, dye, lubricant, and printing. Comparative detergent efficacies of surface-active agents are frequently assessed based on their wetting capacity. Draves invented the technique for calculating wetting ability. A 5 gm skein of grey cotton yarn is immersed in the test solution during the experiment. The amount of time it took for the solution to replace the air in the yarn completely. The skein sinks at the endpoint, which is where it is observed. Wetting capacity is measured in minute units.[23]

Foaming Properties

Foam generation is a significant factor in evaluating shampoos, even though it has little to do with how well they clean hair. This is because it is so important to consumers. Ross and Miles created the technique for measuring foaming power. A portion of the test solution was poured into a cylinder for measurement. When a stream of a second portion of the 100 mL test solution was added to the first portion through a standard orifice from a height of 90 cm, foam formed. Turbulence and foam were produced as a result. Immediately after the foam was created, its height was measured. The first foam height shows the surfactant solution's foam power.[23,24]

Detergency Ability

The main goal of shampoo is cleaning or the elimination of soil or sebum. The effectiveness of the samples' detergency was assessed using the Thompson method. A handful of hair washed in a 5% sodium lauryl sulfate (SLS) solution, dried, and then separated into 3 g weight groups. The samples were shaken for 15 minutes at room temperature while being suspended in a 10% fake sebum solution in hexane. Following sample removal, the solvent was at room temperature evaporated, and the sebum content was calculated. The following procedure involved splitting each sample into two equal halves, one of which rinsed with 0.1 mL of the 10% test shampoo and was used as the negative control. Following drying, the samples' remaining sebum was removed with 20 mL of hexane before being reweighed. Finally, the following equation was used to get the detergency power percentage.

$$DP = 100 (1-T/C)$$

Here,
DP= % of detergency power
C= weight of sebum in a control sample
T= weight of sebum in the test sample.[23-25]

Surface Tension Measurement

One of the mechanisms allegedly involved in detergency is the lowering of surface tension. The surface tension of pure water should be reduced by a good shampoo to around 40 dynes/cm. The surface tension of samples was determined using dynamic contact angle tensiometer (Data physics, Germany) at room temperature.[23,24]

Viscosity

Apparent viscosities of the 1% shampoo solution were determined at room temperature using an Ostwald Viscometer.

Table 2: Composition of artificial sebum[25]

S. No.	*Ingredients*	*Percentage (w/v)*
01	Olive oil	20
02	Coconut oil	15
03	Stearic acid	15
04	Oleic acid	15
05	Liquid paraffin	15
06	Cholesterol	20

Viscosity has an impact on both how well a product cleans and how well customers receive it. The rheology has an impact on the product's foaming characteristics, production filling, packing, stability, and storage. The final product's required rheological qualities and the compatibility of the thickener with the other compositional elements both influence the choice of viscosity builder. The viscosity of the shampoos is virtually always increased by the use of electrolytes. They work well and are affordable.[24,25]

Percent of Solids

After weighing an evaporating dish that was clean and dry, 4 grams of shampoo were added. The shampoo and dish were weighed. The shampoo's precise weight was determined. The dish with shampoo in it was placed on the hot plate and left there until the liquid part evaporated. After drying, the weight of the shampoo (solids) alone was calculated. The percentage of solids in the shampoo should be less than 30%; if there are too many particles, the shampoo will be difficult to work into the hair or difficult to remove.[26]

Skin Irritation Test

The open patch method is used to test for skin irritation. After applying the specially formulated shampoo for 5 minutes, the skin was cleansed, and during the following 15–20 minutes, any indicators of irritation, such as itching, pain, breakouts on the skin, redness, or rashes, were monitored.[27]

Stability Test

Shampoo formulations were divided into two parts to check physical stability. For a month, the first portion was held at 45°C and the second portion at 5°C. Phase separation and any changes to the formulation's appearance, colour, or odour were assessed after one month. Additionally, the pH, foam volume, detergency power, and stability of the formulations were assessed.[27]

Analysis of Hair

Tensile Strength Determination

The effectiveness of hair treatments like permanent waves, permanent hair colors, bleaches, and permanent hair strengtheners is significantly influenced by the tensile property of the hair fiber. The hair fibers of a single person were taken from the barbershop. These hair fibers were treated with different formulations like shampoo containing 24% SLS, shampoo containing 3% SLS, 24% SLS solution, and mixtures of extracts. The diameter of these hair fibers was determined by using digital thickness gauze (PK-1012SU Mitutoyo corporation, Japan), and the influence of various shampoo formulation on the tensile strength of the hair fibres was determined by using an instron tensile testing machine (Instron-3366, UK).[28,29]

Scanning Electron Microscope Analysis

The SEM-based analysis enables assessing subtle changes in the surface structure of human hair. The effects of shampooing on the microstructure of hair were investigated using SEM.

Table 3: pH of different formulations

S.no.	*Samples*	*pH*
01	Shampoo with 0.5% Shikakai	6.2
02	Shampoo with 1.0% Shikakai	6.1
03	Shampoo with 1.5% Shikakai	6.0
04	Marketed Shampoo	7.06
05	Mixture of Extracts	3.75
06	24% SLS solution	9.20
07	Shampoo without Ext.	7.2
08	Shampoo with Ext.	6.13
09	Shampoo without SLS	5.6

The hair fibers of a single person were taken from barber shop. These hair fibers were treated with different formulations like shampoo containing 24% SLS, shampoo containing 3% SLS, 24% SLS solution, artificial sebum, and mixtures of extracts. Samples were coated with a thin coating of gold-palladium using a sputter coater (VG-Microtech, UK) before examining their surface topography using SEM. Digital pictures of hair fiber were obtained by Scanning electron microscope (Jeol, JSM-6390LV, Japan) at a magnification of 1000x. The SEM photographs of hair fiber of untreated hair were compared with the hair treated with formulated shampoo as well as marketed shampoos. SEM analysis describes the cleansing and condensing effects of shampoos.[30,31]

RESULTS AND DISCUSSION

Evaluation of Shampoos

pH

Shampoo's pH is crucial for increasing and enhancing hair's attributes, reducing eye discomfort, and sustaining the ecological balance of the scalp. As shown in Table 3, herbal

Table 4: The wetting ability of different formulations

S.no.	*Samples*	*Wetting time (minutes)*
1	Shampoo with 0.5% Shikakai	2.21
2	Shampoo with 1.0% Shikakai	2.12
3	Shampoo with 1.5% Shikakai	2.04
4	Shampoo with 0.5% Ritha	2.53
5	Shampoo with 1.0% Ritha	2.47
6	Shampoo with 1.5% Ritha	2.38
7	Shampoo with 0.5% Kalonji	2.34
8.	Shampoo with 1.0% Kalonji	2.12
9.	Shampoo with 1.5% Kalonji	2.49
10.	Shampoo with 0.45% EDTA	2.30
11.	Shampoo with 0.1% EDTA	2.10
12.	Shampoo with 0.15% EDTA	2.13
13.	Shampoo with 0.5% Nacl	2.58
14.	Shampoo with 1.0% Nacl	2.95
15.	Shampoo with 1.5% Nacl	3.05
16.	Shampoo without herbal extract	1.41

Table 5: Detergency ability of different formulations

S. No.	*Samples*	*D.A.*
01	Marketed Shampoo (MS1)	72.35%
02	Marketed Shampoo (MS2)	77.64%
03	24% SLS solution	68.23%
04	Shampoo without extract	62.80%
05	Shampoo with extract	77.50%
06	Shikakai extract	48.65%
07	Ritha extract	43.53%
08	Shampoo with 0.5% Shikakai	62%
09	Shampoo with 1.0% Shikakai	65%
10	Shampoo with 1.5% Shikakai	69%
11	Shampoo with 0.5% Ritha	58.30%
12	Shampoo with 1.0% Ritha	63.52%
13	Shampoo with 1.5% Ritha	65.11%
14	Shampoo with 0.5% Kalonji	62%
15	Shampoo with 1.0% Kalonji	58%
16	Shampoo with 1.5% Kalonji	55%
17	Shampoo with 24% SLS	78.52%
18	Shampoo with 12% SLS	77.50%
19	Shampoo with 06% SLS	74.43%
20	Shampoo with 03% SLS	65.23%
21	Shampoo without SLS	63.88%

extract is acidic in nature, and SLS is basic in nature. Shampoo formulated without any natural extracts shows higher pH, whereas the shampoos formulated with natural extracts are acid balanced and range from 5.5 to 6.0, which is near skin pH.

Wetting Ability

The concentration of a material affects its ability to wet. By relating outcomes in Table 4 it appears fair to conclude that shampoo formulated without herbal extracts comprises max concentration of detergents, therefore, displays minimum wetting time, and shampoos formulated with herbal extracts show intermediate detergency and wetting time. These data point out that the wetting ability of herbal extracts is weaker than general detergent (SLS).

Detergency Ability

Something that makes it easier to remove air from a liquid or solid surface is a detergent. The amounts of sebum eliminated by the various shampoos varied significantly, as can be observed from the findings. The sebum removed from 24% SLS solution, shikakai extract and ritha extract were 68.23, 48.65 and 43.53%, respectively. These results indicate excellent detergency of SLS and moderate detergency of shikakai and ritha extract. The studies indicated that by varying the concentration of the selected herbal extracts, the sodium lauryl sulfate can be completely eliminated from the shampoo without losing the properties of the ideal shampoo (Table 5).

Table 6: Foaming ability of different formulations

S. No.	*Samples*	*Foam height (ml)*
01	Marketed shampoo (MS1)	20
02	Marketed shampoo (MS2)	15
03	24 % SLS solution	23
04	Shampoo with extracts	14
05	Shampoo without extracts	19
06	Shampoo with 1.0 % Shikakai	13
07	Shampoo with 1.0 % Ritha	15
08	Mixture of extracts	15
09	Shampoo without SLS	14

Table 7: Surface tension of different formulations

S. No.	*Samples*	*Surface tension (dynes cm^{-1})*
01	Marketed shampoo (MS2)	35.53
02	Marketed shampoo (MS1)	36.42
03	Mixture of extracts	45.67
04	24% SLS solution	24.85
05	Shampoo without extract	38.91
06	Shampoo with extract	31.77
07	Shikakai extract	45.51
08	Ritha extract	43.03
09	Kalonji extract	47.52
10	Shampoo with 0.5% Shikakai	30.92
11	Shampoo with 1.0% Shikakai	30.31
12	Shampoo with 1.5% Shikakai	30.07
13	Shampoo with 03% SLS	46.54
14	Shampoo with 06% SLS	42.17
15	Shampoo with 12% SLS	37.01
16	Shampoo with 24% SLS	31.77
17	Shampoo with 0.5% Ritha	36.5
18	Shampoo with 1.0% Ritha	35.15
19	Shampoo with 1.5% Ritha	34.96
20	Shampoo with 3% Ritha	44.35
21	Shampoo with 3% Amla	45.72
22	Shampoo with 2% Neem	45.55
23	Shampoo with 3% Bhringraja	44.38
24	Shampoo without SLS	43.44

Foaming Ability

Even while foam creation has little to do with a shampoo's ability to clean, it is of utmost importance to consumers and is, therefore a crucial factor to consider when comparing shampoos. Compared with marketed formulation (MS2), a mixture of extracts has good foaming properties, whereas SLS has more foaming ability. The foaming ability of the formulated natural shampoo (without SLS) is slightly lesser than the marketed formulation. Detergency and foaming do

Table 8: Viscosity of different formulations

S.no.	*Samples*	*Viscosity (centipoise)*
01	Marketed Shampoo (MS2)	1.116
0	Marketed Shampoo (MS1)	1.096
03	Mixture of extract	1.007
04	24% SLS solution	1.279
05	Shampoo without extract	1.046
06	Shampoo with NaCl	1.065
07	Shikakai extract	1.04
08	Ritha extract	1.176
09	Shampoo with 0.5% methylcellulose.	1.019
10	Shampoo with 1.0% methylcellulose	1.03
11	Shampoo with 1.5% methylcellulose	1.045
12	Shampoo with 0.5% Ritha	1.031
13	Shampoo with 1.0% Ritha	1.149
14	Shampoo with 1.5% Ritha	1.17
15	Shampoo with 0.5% Shikakai	1.002
16	Shampoo with 1.0% Shikakai	1.066
17	Shampoo with 1.5% Shikakai	1.132
18	Shampoo without NaCl	1.019
19	Shampoo with 0.5% NaCl	1.025
20	Shampoo with 1.0% NaCl	1.042
21	Shampoo with 1.5% NaCl	1.065
22	Shampoo without SLS	1.08

not appear to be directly correlated, as shown in the results that shampoo formulated with 1% Ritha has more foaming power and less cleansing ability in comparison with a shampoo formulated with 1% shikakai (Table 6).

Surface Tension

One of the mechanisms involved in detergency is the reduction of surface tension, and the shampoo's ability to lower water's surface tension from 72.8 to 32–37 dynes cm^{-1} is a sign of effective detergency. The surface tension of 24% aqueous solution fallen from 72.0 to 24.85 dynes cm^{-1} by SLS, to 43.03 by ritha extract, to 45.51 dynes cm^{-1} by shikakai extract and to 47.52 dynes cm^{-1} by kalonji extract, respectively. The data indicated that ritha, shikakai, and kalonji extracts have the potential to be an effective aid in improving the detergency of the shampoo (Table 7).

Viscosity

The viscosity of the shampoo formulation is very important for the fulfillment of psychological and practical advantages. For application to the hair, high-viscosity liquid shampoos can be poured into the palm, preventing pouring through the fingers or down the face and neck.

From Table 8 it could be seen that even with a quite small difference in surfactant quantity, viscosity was also affected. Data indicates that as we increase the concentration of surfactant, viscosity also increases. The viscosity of the shampoo formulated without sodium chloride, with 0.5% sodium chloride, with 1.0% sodium chloride, and with 1.5% sodium chloride were 1.019, 1.025, 1.042, and 1.065 centipoises, respectively. These data indicate that as we increase the concentration of sodium chloride, viscosity also increases.

Table 9: Solid content of different formulations

S.no.	*Samples*	*Percent of Solids (%)*
01	Marketed Shampoo (MS1)	25.60
02	Shampoo with 1.0% Shikakai	29.20
03	Shampoo with 1.0% Ritha	29
04	Shampoo with 1.0% Kalonji	27.27
05	Shampoo without extract	29
06	Shampoo with extract	29
07	Shampoo with 1.0% NaCl	26.47
08	Shampoo with 1.0 % methylcellulose	24

Determination of Solid Content

If the shampoo has an excessive amount of solids, it will be difficult to wash out or work into the hair. The percentage of solids contents, which is given in Table 9, ranged between 24 and 29%, indicating that they are simple to wash off.

Skin Irritation Test

The open patch method is used to test for skin irritation. After applying the specially formulated shampoo for 5 minutes, the skin was cleansed, and during the following 15–20 minutes, any indicators of irritation, such as itching, pain, breakouts on the skin, redness, or rashes, were monitored. Due to the absence of potentially dangerous synthetic components, shampoo that has been specifically formulated has no negative effects on the skin. Most synthetic chemicals cause skin inflammation and irritation, however, practically all of the substances in this formulation are derived from natural sources.

Stability Test

Shampoo formulations were divided into two parts to check physical stability. For a month, the first portion was held at 45°C and the second portion at 5°C. Phase separation and any changes to the formulation's appearance, color, or odor were assessed after one month. Additionally, the pH, foam volume, detergency power, and stability of the formulations were assessed. The formulation's stability over the course of storage demonstrated its physical and chemical stability. Herbal shampoo that has been developed is stable at room temperature. The findings show that it has good stability.

Analysis of Hair

Tensile Strength of Hair Fibre

The influence of SLS and extract on the tensile strength of the hair fiber is summarised in Table 10. The result shows that tensile strength of hair fiber before treatment is 319.5 MPa and after treatment with 24% SLS solution, with shampoo containing 24% SLS, with shampoo containing 3% SLS and with mixture of extracts is 243.91, 226.29, 302.15 and 322.52 MPa, respectively. These data indicate that SLS damage the hair and herbal extract provide strength to the hair fiber

Table 10: Effect of SLS and extract on tensile strength of hair fiber

S.no	*Samples*	*Diameter (mm)*	*Tensile strength (MPa)*
1	Untreated hair	0.07	319.5
2	Hair treated with mixture of extracts	0.07	322.52
3	Hair treated with 24% SLS solution	0.06	226.29
4	Hair treated with shampoo containing 3% SLS	0.08	302.15
5	Hair treated with shampoo containing 24% SLS	0.08	243.91

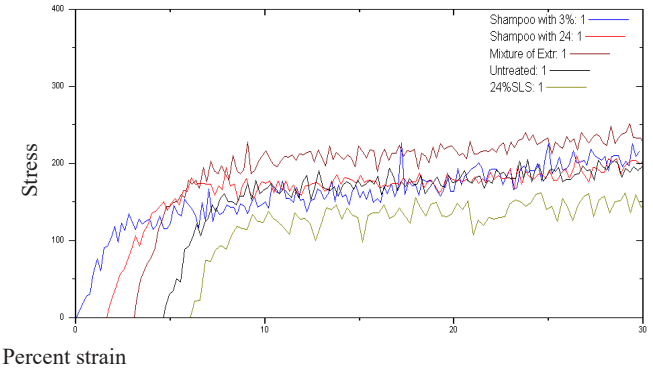

Figure 1: Effect of SLS and extract on tensile strength of hair fiber

(Figure 1).

SEM Analysis

SEM analysis displayed clear variances amid treated as well as untreated hairs. SEM observation provided evidence for the cleansing action of the formulations. As shown in Figure 2 SLS is very toxic to the hair. It damages the morphological integrity of the hair fiber, whereas natural conditioners defend hair morphological integrity and provides consistency as well as shine to hair.

Based on all the observations final formula for shampoo formulation was developed**.** The final formula of the shampoo is-

The final formula of the shampoo indicates that by optimizing the concentrations of herbal extracts in a mixture, we can completely eliminate SLS from the shampoo without losing the properties of ideal shampoo (Table 11).

CONCLUSION

Preliminary phytochemical screening shows that the majority of herbal extracts contain glycosides, tannins, and saponins except *for Emblica officinalis*. As shown in results, herbal extract is acidic in nature, and SLS is basic. Shampoo formulated without any natural extracts shows higher pH, whereas the shampoos formulated with natural extracts are acid balanced as well as are ranged 5.5 to 6.0, which is close to pH of the skin. A substance's concentration determines how well it will wet a surface. By relating results of wetting ability, it appears reasonable to conclude that the shampoo formulated

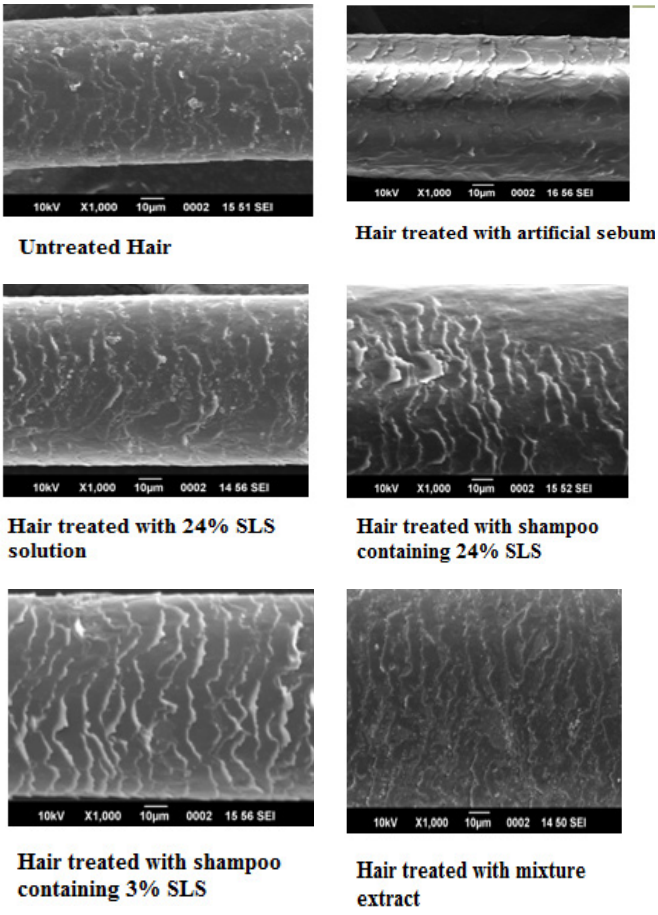

Figure 2: SEM photograph of hair fiber before and after treatment with different formulations

Table 11: Final formula for shampoo formulation

S.no.	*Ingredients*	*Percentage (w/v)*
1.	Amla extract	2 %
2.	Ritha extract	2%
3.	Shikakai extract	2 %
4.	Bhringraja extract	1%
5.	Henna extract	1%
6	Kalonji extract	1%
7.	Neem extract	1%
8.	Sodium chloride	1 %
9.	Glycerin	5 %
10.	EDTA	0.15%
11.	Deionized water	q.s. to 100 mL

without herbal extracts comprises the max concentration of detergents and therefore displays min wetting time (1.4 minutes), and shampoos formulated with herbal extracts show intermediate detergency and wetting time (2.3 minutes).

Although foam generation has nothing to do with how well shampoos clean hair, it is nonetheless a crucial factor in judging shampoos since it is so essential to customers. In comparison with the marketed formulation MS2 (15 mL),

mixture of extracts has good foaming properties (15 mL), whereas SLS has more foaming ability (23 mL). The foaming ability of the formulated shampoo without SLS (14 mL) is slightly lesser than the marketed formulation. It should be noted that detergency and foaming do not appear to be directly correlated, as shown in results that shampoo formulated with 1% ritha has more foaming power (15 mL) and less cleansing ability (63.5%) in comparison with shampoo formulated with 1% shikakai (13 mL, 65%).

One of the mechanisms involved in detergency is the reduction of surface tension, and the shampoo's ability to lower water's surface tension from 72.8 dynes cm^{-1} to 32–37 dynes cm^{-1} is a sign of effective detergency. A 24% aqueous solution's surface tension decreased from 72.0 to 24.85 dynes cm^{-1} by SLS, to 43.03 dynes cm^{-1} by ritha extract, and to 45.51 dynes cm^{-1} by shikakai extract, respectively. The data indicated that ritha and shikakai extracts have the potential to be an effective aid in improving the detergency of the shampoo.

Viscosity of the shampoo formulation is very important for fulfillment of psychological and practical advantages. For application to the hair, high-viscosity liquid shampoos can be poured into the palm, preventing pouring through the fingers or down the face and neck. From the results, it could be seen that even with a quite small difference in surfactant quantity, viscosity also affected. Data indicates that as we increase the concentration of surfactant, viscosity also increases. The viscosity of the shampoo formulated without sodium chloride, with 0.5% sodium chloride, with 1.0% sodium chloride, and with 1.5% sodium chloride were 1.019, 1.025, 1.042, and 1.065 centipoises, respectively. These data indicate that as we increase the concentration of sodium chloride, viscosity also increases.

Something that makes it easier to remove air from a liquid or solid surface is a detergent. The amounts of sebum eliminated by the various shampoos varied significantly, as can be observed from the findings. The sebum removed from 24% SLS solution, shikakai extract, and ritha extract were 68.23, 48.65, and 43.53%, respectively. These findings demonstrate the superior detergency of SLS. ritha and shikakai extract both exhibit moderate detergency. The studies indicated that by varying the concentration of the selected herbal extracts, the SLS could be completely eliminated from the shampoo without losing the properties of the ideal shampoo.

If the shampoo has an excessive amount of solids, it will be difficult to wash out or work into the hair. The percentage of solid contents was determined to be between 24 and 29%, proving that they are simple to wash off.

The tensile strength of hair fiber before treatment is 319.5 MPa and after treatment with 24% SLS solution, with shampoo containing 24% SLS, with shampoo containing 3% SLS, and with mixture of extracts is 243.91, 226.29, 302.15, and 322.52 MPa, respectively. These data indicate that SLS damage the hair and herbal extract provide strength to the hair fiber.

SEM analysis displayed clear variances amid treated as well as untreated hair. SEM observation provided evidence for the cleansing action of the formulations. SLS is very toxic to the hair; it damages the hair fiber's morphological integrity, whereas natural conditioners defend hair morphological integrity, providing consistency and shine to hair.

The final formula of shampoo indicates that by optimizing the concentrations of herbal extracts in a mixture we can completely eliminate SLS from the shampoo without losing the properties of ideal shampoo.

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