

Formulation, Evaluation, and Comparison of Herbal Shampoo with Commercially Available Shampoos

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Abstract

Introduction: A shampoo is essentially a detergent solution with appropriate ingredients for additional advantages such as improved hair conditioning, lubrication, and medicine. There are many different types of shampoos on the market today; including synthetic, herbal, medicated, and non-medicated varieties, but herbal shampoo is becoming more and more popular among customers due to their perception that natural goods are risk-free and without adverse effects. **Aim:** The aim of the present study is to formulate herbal shampoo, and evaluate and compare its physicochemical properties with the commercially available shampoos. **Materials and Methods:** The herbal shampoo was formulated by adding the extracts of *Calendula officinalis*, *Lawsonia inermis*, *Citrus limonum*, *Citrus ulgaric*, and *Santolina trifoliatus* in different proportions to a 10% aqueous gelatin solution. Small amount of methylparaben was added as a preservative and pH was adjusted with citric acid. Several quality control tests such as physical appearance/visual inspection, pH, solid contents, foam test, viscosity test, dirt dispersion test, surface tension, wetting test, and conditioning performance tests were performed to determine the physicochemical properties of formulated herbal shampoo and commercial shampoos. The formulated herbal shampoo and commercial shampoo were also evaluated for conditioning performance by blind test on twenty volunteers. **Results and Discussion:** The results revealed that our formulated herbal shampoo was transparent. The results showed good cleansing and detergency, normal pH, low surface tension, small bubble size, good viscosity, and foam stability after 5 min. The formulated shampoo and commercial shampoos also showed comparable results for % solid contents. The score of the conditioning performance of the tress washed with herbal shampoo was found to be 3.2 out of 4, while the score of the commercial shampoo was 3.1 and 3.3, respectively. **Conclusion:** Our results revealed that the formulated herbal shampoo has excellent conditioning performance, at par with commercially available shampoo. However, further research and development is required to improve its quality and safety.

Key words: Commercial shampoos, cosmetics, herbal shampoo, methylparaben, physicochemical properties

INTRODUCTION

In our daily lives, shampoos are likely the most frequently used cosmetic products for cleaning our hair and scalp. A shampoo is essentially a detergent solution with appropriate additives for additional benefits such as improved hair conditioning, lubrication, medication.^[1] There are many different types of shampoos available today, including synthetic, herbal, medicated, and non-medicated varieties, but consumers are becoming more and more interested in herbal shampoo because they think that because these products come from natural

sources, they are risk-free and without side effects.^[2] Synthetic surfactants are included in synthetic shampoos mainly for their cleansing and foaming characteristics, but lengthy

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consumption of these surfactants can produce eye and scalp irritation, hair loss, and hair dryness. We have natural herbal shampoos as an alternative to synthetic shampoo. However, creating cosmetic products with entirely natural ingredients is exceedingly challenging.^[3]

Numerous medicinal plants with possible benefits on hair have been used for centuries in shampoo formulations allworldwide. These therapeutic herbs can be used as extracts, powders, crude forms, or derivatives. It is challenging to create a shampoo with only one natural ingredient that is safer and softer than synthetic shampoo. It must also include considerable foaming, detergency, and solid content, similar to synthetic shampoo. As a result, we gave careful thought to developing a pure natural cleanser employing a time-tested method and commonly used plant material for washing hair.^[4]

Herbs used in the formulation of shampoo

***Calendula officinalis* L. (Marigold)**

C. officinalis Linn's flower belongs to the *Asteraceae* family, made up of marigolds. Flavonoids, carotenes, xanthophyll, and essential oils can all be found in marigold flowers. Washing painful and irritated skin with floral water is used. It is also employed in relation to itch.^[5]

***Lawsonia inermis* (Henna)**

L. inermis belongs to the *Lythraceae* family is frequently used in cosmetology and is also referred to as henna or mehendi. The plant's potent ability to dye is widely employed in the beauty sector. A beloved hair color is henna. In addition, it exhibits antifungal and antibacterial properties. Studies show that laws one, the major chemical ingredient, is responsible for its potent killing ability. The keratin of hairs and the thiol group of lawsone are tightly linked.^[6]

***Citrus limonum* (Lemon)**

Lemon is a fruit of the *Rutaceae* species *C. limonum*. Hesperidin, limonene, pectin, terpineol, and citral are all found in juice. It acts as a stimulant, antibacterial agent, and anti-dandruff agent.^[7]

***Citrus vulgaris* (Orange)**

The dried or fresh epidermal component known as the orange peel is present in the pericarp of ripened or nearly ripe *C. vulgaris* fruits belonging to the *Rutaceae* family. It includes pectin, Vitamin C, volatile oil, hesperidin, iso-hesperidin, and neohesperidin. Peel infusion is applied as a hair rinse. In addition, it is employed as a carminative, flavoring, and stomatic agent.^[8]

***Santolina trifoliatus* (Reetha)**

These dried fruit species *S. trifoliatus* belongs to the *Sapindus* family are used to produce Reetha. Trifoliolate II, hederagenin,

saponin, sapindus acid, oleanolic, saponin A, and saponin B sesquiterpenes are all present. It can be utilized as a detergent, demulcent, and astringent.^[9]

MATERIALS AND METHODS

Plant material

All the required plant materials were collected from the local market of Chandrapur (M.S) India, and some were collected from the herbal garden of Hi-Tech College of Pharmacy, Chandrapur. The collected plant material was washed, dried, powdered, and stored in an airtight container for later research.

Extraction procedure

Powdered forms of *C. officinalis*, *L. inermis*, *C. limonum*, *C. vulgaris*, and *S. trifoliatus* (100 g) were extracted in a Soxhlet apparatus for 6 h each using distilled water and ethyl acetate. To determine the yield, the extract was concentrated and weighed at reduced pressure. Table 1 contains a list of the many extraction methods that were used to extract specific plants.

Formulation of herbal shampoo

The ratios of the plant extracts were blended to create the shampoo, whose composition is presented in Table 2. The 10% gelatin solution was combined with herbal extracts for 20 min by shaking. Furthermore, methylparaben was added while stirring. In the end, enough 1% citric acid solution was added to the solution to change the pH. Gelatin solution was used to adjust the final volume to 100 mL.^[10]

Evaluation of formulated herbal and commercial shampoo

To evaluate the quality of commercial and prepared formulations, several quality control tests such as physical appearance/visual inspection, pH, Solid contents, foam test, viscosity test, dirt dispersion test, surface tension, wetting test, and conditioning performance tests were performed.^[11]

Physical appearance/visual inspection

The preformed herbal shampoo was evaluated for clarity, color, odor, and foam-producing ability.^[12]

Determination of pH

The typical commercial goods were used to make a 1% solution of the formulation, and a digital pH meter was used to measure the pH 200 mL of distilled water and 2 mL of shampoo were combined in a beaker by swirling the beaker rather than shaking it to get a 1% solution of shampoo.^[13]

Table 1: Herbs and its extraction methods

S. No.	Herbs	Extraction
1.	<i>Calendula officinalis</i> L. (Marigold)	Distilled water was used to extract the marigold through infusion. 50 g of dried marigold flowers were blended with 287.5 mL of boiling water in a stainless-steel container, covered, and left for 12 h before being drained and filtered.
2.	<i>Lawsonia inermis</i> (Henna)	Decoction was used to extract the henna. 50 g of Reetha powder were added to 287.5 mL of water in a stainless steel container. The mixture was heated until the distilled water was reduced to one-fourth of the original volume, then strained and filtered.
3.	<i>Citrus limonum</i> Lemon)	The extraction of lemon juice using boiled ethyl acetate was done using a straightforward mechanical procedure.
4.	<i>Citrus ulgaric</i> (Orange)	Ethyl acetate was infused to extract orange peels. 287.5 mL of boiling ethyl acetate was added to 50 g of dried orange peel in a container, which was then covered for at least 12 h.
5.	<i>Santolina trifoliatus</i> (Reetha)	Decoction was used to extract Reetha. 287.5 mL of distilled water was added to 50 g of Reetha powder in a stainless-steel container before being covered. Combination was heated until the water had reduced to a fourth of its original volume, then strained and filtered.

Table 2: Herbal shampoo formula (for 100 mL)

S. No.	Extracts of different herbs	Quantity
1.	Marigold extract (<i>Calendula officinalis</i> Linn)	15 mL
2.	Henna extract (<i>Lawsonia inermis</i>)	15 mL
3.	Lemon juice (<i>Citrus limonum</i>)	15 mL
4.	Orange peel extract (<i>Citrus ulgaric</i>)	15 mL
5.	Reetha extract (<i>Santolina trifoliatus</i>)	15 mL
6.	Methylparaben	1 mL of 0.05%
7.	Gelatin solution	q.s.
8.	Citric acid	q.s.

Determination of % of solid contents

In this experiment, we first determined and recorded the weight of an empty, dry, clean evaporating dish. The exact starting weight of shampoo was determined by weighing the dish after adding a sample of prepared herbal shampoo weighing about 4 g to it. The dried weight of the shampoo was determined by placing the evaporating shampooing dish on a hot plate and permitting it to entirely evaporate. The percentage of solids was calculated using the formula shown below:

$$\text{Percentage of the solids} = \frac{\text{Dried weight of shampoo}}{\text{Initial weight of shampoo}} \times 100$$

Determination of foam formation

By pouring 20 mL of shampoo into a clean, dry measuring cylinder, the initial amount of foam created by the herbal shampoo formulation was measured. The measuring cylinder was shaken ten times to capture the final volume, and the following calculations were made to determine the foam formulation.^[14]

$$\text{Foam formation} = \text{Final volume of shampoo} - \text{Initial volume}$$

Determination of foam quality and retention

Test for quality and retention of foam was initiated as soon as the foam formulation test result was known. Every 1 min time interval, the foam volume retention was measured.

Determination of viscosity

The viscosity of the shampoo formulation was determined using a Brookfield viscometer (Model DV-1 Plus, LV, USA) set at various spindle speeds ranging from 0.3 to 10 rpm. All shampoos' viscosities were determined using the Spindle T95 scale. Throughout the investigation, the temperature and the size of the sample container were held unchanged.

Dirt dispersion test

Add two droplets of shampoo in a test tube to create a volume of 10 mL. The test tube is then filled with water, one drop of India ink, and 10 shakes. The amount of ink in the foam was meticulously measured.^[15]

Determination of surface tension

Both surface tension for pure water and a 10% shampoo solution were calculated. Since the presence of grease or other lubricants significantly influenced the surface tension, the stalagmometer was cleaned using chromic acid and filtered water.^[16]

The following equation was used to calculate the data:

$$R2 = (W3 - W1) N1 \times R1 (W2 - W1) N2$$

where,

W1: Beaker's empty weight.

W2: Distilled water in a beaker.

W3: Weight of beaker containing shampoo solution.

N1: Number of distilled water droplets.

N2: Number of shampoo solution drops.

R1: Distilled water's surface tension at ambient temperature.

R2: Shampoo solution's surface tension.

Wetting time test

A canvas paper was cut into 1-inch diameter discs having an average weight of 0.44 g. The 1% v/v shampoo solution was placed on the smooth surface of the disc and a stopwatch was started. The time required for the disc to begin to sink was noted as wetting time.^[17]

Evaluation of conditioning performance

The hair tress of an Indian woman was obtained from a local salon in Chandrapur, Maharashtra. The hair tress was cut into four swatches approximately 10 cm long and around weighing 5 g. One swatch without washing served as the control. The other three tresses were washed with the commercial and formulated herbal shampoos in an identical manner. For each cycle, each tress was shaken with the mixture of 10 g of a sample and 15 g of water in a conical flask for 2 min and then rinsed with 50 mL water. After that, each tress was left for air drying at room temperature. The tresses were washed for a maximum of ten cycles. The conditioning performance of herbal-formulated and commercial shampoos was evaluated by a blind touch test, administered to twenty randomly selected volunteers.^[18]

All twenty volunteers were blindfolded and asked to touch and rate the four tresses for conditioning performance from scores 1 to 4 (1 = poor; 2 = satisfactory; 3 = good; 4 = excellent).

Statistical analysis

The data were analyzed using analysis of variance (ANOVA). All tests were performed in triplicate and the data were expressed as Mean \pm standard deviation. ANOVA single factor was used for determining significance. $P < 0.05$ were considered significant.

RESULTS AND DISCUSSION

Formulation of herbal shampoo

Herbal shampoo was formulated by mixing extracts of *C. officinalis*, *L. inermis*, *C. limonum*, *C. ulgaric*, and *S. trifoliatius* in definite amounts [Table 2]. These plants contain a variety of phytochemicals like saponins, which have surfactants property; it also have good detergency and foaming properties. *S. trifoliatius* extracts were added

as a conditioning agent. A good shampoo should not flow off the hair while being used but should have enough viscosity to make removal from the container easy. There are several natural substances that may be used to increase viscosity. For this, we selected a 10% gelatin solution since it creates transparent solutions and exhibits pseudoplastic activity. Citric acid was added to adjust the pH to the desired level. Our formulated herbal shampoo contains Lemon juice, which has natural antioxidant, chelating, and anti-dandruff properties, which also maintain the acidic pH of formulation. Shampoo was preserved by adding a small amount of methylparaben. The final formula of the prepared shampoo is presented in Table 2.

Evaluation of formulated herbal and commercial shampoo

The comparative effectiveness of the formulated herbal and commercial shampoo was evaluated, the results of which are discussed below.

Physical appearance/visual inspection

A shampoo should seem attractive and appealing on the outside, just like any other cosmetic product. The physical qualities of the formulated herbal and commercial shampoos, such as color, odor, and clarity, were assessed [Table 3]. Our freshly prepared herbal shampoo was clear, pale green, and smelled great. With the exception of color, there was no discernible difference in odor, transparency, or foaming properties between commercial and designed shampoo.

pH

Because pH might irritate the eyes and skin while also being required for healthy, luscious hair and scalp tightness, it is an essential issue in shampoo analysis.^[19] Alkaline shampoos typically allow the scalp to expand and open up, which is why cosmetic manufacturers sell shampoos with a broad pH range as opposed to a fixed pH value.^[13]

However, new trends indicate that mildly acidic pH shampoos are becoming more and more well-liked by consumers. The pH value for the prepared herbal shampoos was 5.91 ± 0.26 as shown in Table 3 and Figure 1a, which is near to the skin pH and its other commercially available counterparts.

% of solids content

According to studies, shampoos with larger percentages of solids are harder to remove from hair, whereas shampoos with lower percentages of solids will remain fluid and be removed more rapidly after use. For a balanced cleaning action, an optimal shampoo should also include 20–30% solids, according to Table 3.

Table 3: Physicochemical evaluation of formulated herbal and commercial shampoo

Specification	Patanjali's Reetha shampoo	Dabur Vatika shampoo	Prepared Herbal shampoo	P-value
Color	Black	Greenish black	Pale green	
Transparency	Transparent	Transparent	Transparent	
Odor	Pleasant	Pleasant	Pleasant	
pH (1% solution)	6.50±0.07	7.10±0.18	5.91±0.26	<0.05*
% Solid Content	25	27	29	
Foam volume	102±2.15	98±3.33	110±1.25	<0.001*
Foam type	Small bubble size	Small bubble size	Small bubble size	
Viscosity	15623	11139	10265	
Dirt dispersion	None	Light	Moderate	
Surface tension (dynes/cm)	30.88	31.23	43.15	<0.05*
Wetting time (sec)	146±4.14	155±2.26	161±2.48	<0.001*

Results are mean±standard deviation (n=3); *significant difference $P<0.05$ by ANOVA single factor

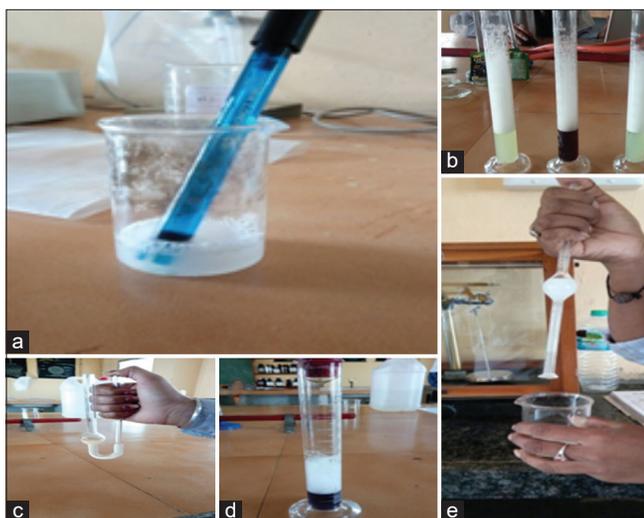


Figure 1: Various evaluation parameters of formulated herbal shampoo. (a) pH determination; (b) Foam quality and retention; (c) Viscosity measurement; (d) Dirt dispersion test; (e) Surface tension measurement

Foam formation

Although a shampoo's capacity to produce foam has nothing to do with how well it cleans, it does represent the product's esthetic look, making it an important evaluation factor. As shown in Table 3, during the test, a good shampoo should produce at least 100 cc of foam, the smaller the bubbles, the longer the foam will last.

Foam quality and retention

Shampoo should produce a consistent amount of foam that lasts for at least 5 min; anything less could lead to unhappy customers. In our analysis, every sample displays a high retention rate [Table 3 and Figure 1b].

Viscosity

The viscosity of a liquid can be thought of as its thickness. The viscosity of a shampoo is determined by the proportion of particles present. Our findings suggest that the viscosities of the samples vary progressively as the rpm increases, exhibiting pseudo plastic activity and that all of the samples had pseudo plastic rheograms, which is excellent for shampoo [Table 3 and Figure 1c].

Dirt dispersion

The quantity of dirt dispersed with shampoo is an essential factor in determining how thoroughly it cleans. Shampoos that cause ink or dirt to concentrate in the foam are considered low quality because they are difficult to clean and frequently redeposited on hair.

To get better washing action, the dirt should remain in the water component. The ink was concentrated in the water portion of every shampoo, ensuring their adequate cleansing capacity and practical usefulness.^[15]

A low-quality shampoo is one that promotes the accumulation of ink in the foam. While dirt should stay in the water, it will be difficult to remove any that remains in the foam. If it remains in the foam, it will redeposit on the hair. According to Table 3 and Figure 1d, every shampoo sample we tested yielded favorable outcomes.

Surface tension

According to past studies, a perfect shampoo should be able to reduce the surface tension of distant water from 72 dynes/cm to around 40 dynes/cm.^[20] As indicated in Table 3 and Figure 1e, formulated herbal shampoo enhanced cleaning and detergent qualities by lowering water's surface tension up to 43.15 dynes/cm with $P < 0.05$.

Table 4: The mean score of the volunteers opinion on the conditioning performance of the tresses after treatment with shampoos ($n=20$)

Score	Patanjali's Reetha shampoo	Dabur Vatika shampoo	Formulated herbal shampoo	No washing
1	0	0	1	18
2	2	1	2	2
3	9	10	12	0
4	9	9	5	0
Average	3.1	3.3	3.2	1.1

Wetting time

The wetting ability of a surfactant is dependent on its concentration. Wetting ability of surfactant is commonly used to test its efficacy. The canvas disc method is a quick, efficient, and reliable test to evaluate the wetting ability of a shampoo.^[17] The wetting time of three shampoos was found in the order $146 \pm 4.14 < 155 \pm 2.26 < 161 \pm 2.48$ for Patanjali's Reetha shampoo, Dabur Vatika shampoo, and formulated herbal shampoo, respectively. From the result, it was concluded that Patanjali Reetha shampoo contains the maximum concentration of detergents because it had the least wetting time as compared to our formulated herbal shampoo which shows maximum wetting time [Table 3] so, it means that our formulated herbal shampoo contains minimum concentration of detergents.

Condition performance

The conditioning performance of all three shampoos based on the mean scores of volunteers was tabulated in Table 4. Majority of the volunteers rated Dabur Vatika shampoo's best conditioning performance and as expected the control tress (without washing) got the minimum score of 1.1. The score of the conditioning performance of the tresses washed with formulated herbal shampoo was found to be 3.2 out of 4 and was comparable with the scores of commercial shampoos. The results indicated that the formulated herbal shampoo has having good conditioning performance level.

CONCLUSION

According to research, 5% of the population suffers from dandruff, which primarily appears between 20 and 30 years after puberty and more frequently affects men than women. Any cosmetic product must be carefully formulated using only natural ingredients and raw materials. The most challenging thing is choosing a natural material that can be rationally justified and is equivalent to synthetic materials. Our goal in the current study is to create an herbal shampoo that is entirely natural.

Although the shampoo's detergent and cleansing qualities were found to be somewhat less than those of commercially available shampoos, it nevertheless exhibits good rheological

properties and is quite equivalent to those of its marketed counterparts. It can be justified by the fact that commercial shampoo includes artificial additives including thickening agents and surfactants, which assist in cleaning. Herbal shampoo that has been specially formulated exhibits favorable physical characteristics, such as physical appearance/visual inspection, pH, solid contents, foam test, viscosity test, dirt dispersion test, surface tension, wetting test, and conditioning performance. However, further research and development is required to improve its quality and safety.

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