



Research Article

THE EFFECT OF SURFACTANT ON POLYHERBAL LIQUID SHAMPOO AND ITS COMPARATIVE ANALYSIS

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<p>Article info</p> <p>Article History: Received: 27-02-2022 Revised: 11-03-2022 Accepted: 19-03-2022</p> <p>KEYWORDS: Herbal shampoo, curry leaves, <i>Amla</i>, <i>Shikakai</i>, <i>Reetha</i>, <i>Methi</i>, Decyl glucoside.</p>	<p>ABSTRACT</p> <p>Objective: Herbal shampoo is gaining immense popularity among all consumer groups due to rising awareness about the side effects of chemical formulations. It was also observed that not many marketed shampoos incorporated excellent hair nurturing properties of curry leaves. The aim of the study was to formulate and evaluate herbal shampoo using <i>Murraya koenigii</i>, <i>Phyllanthus emblica</i>, <i>Acacia concinna</i> Linn., <i>Trigonella foenum-graecum</i>, <i>Sapindus mukorossi</i> and perform a comparative analysis with marketed formulation.</p> <p>Method: Three formulations were prepared using extracts of <i>Murraya koenigii</i>, <i>Phyllanthus emblica</i>, <i>Acacia concinna</i>, <i>Trigonella foenum-graecum</i> and <i>Sapindus mukorossi</i> in definite proportions. Decyl Glucoside and Sodium Lauryl Sulphate were added as surfactant in adequate amount. The formulated shampoo was evaluated for organoleptic properties (colour and odour), pH, surface tension, viscosity, dirt dispersion, cleansing action, foaming ability and stability studies. Results: The formulated shampoos were brown in colour with good acceptable fragrance. All the formulations showed good cleansing and detergency power with stable foam. F₁ showed comparatively better foaming ability. All the formulations had neutral pH and low surface tension (21-25 dyn/cm). The solid content was found to be in the range of 23-27% and viscosity 4885 cP- 4903 cP. The results of the prepared formulations were compared with a marketed formulation and were found that F₁ formulation was on par with marketed formulation. Conclusion: The prepared shampoo had good characteristics. It was further inferred that it is possible to develop safer and equally effective shampoo using ingredients of plant origin.</p>
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INTRODUCTION

A shampoo is a preparation of surfactant in a suitable form of liquid, solid or a powder which when used under a specified condition will remove surface grease, dirt, and skin debris from the hair shaft and scalp without adversely affecting the user.

Herbal formulations are considered as alternative to synthetic shampoo, however formulating cosmetics using completely natural raw material could be a difficult task.

There are large numbers of medicinal plants which are reported to possess beneficial effects on hair and are commonly employed in formulation of shampoo. A few are as listed below^[1,2].

Curry leaves, *Murraya koenigii*, belongs to the family Rutaceae (citrus family). This plant is known to be the richest source of carbazole alkaloids. Carbazole alkaloids, present in *M.koenigii* is responsible for its multiple biological properties like its anti-tumor, anti-mutagenic, anti-oxidative and anti-inflammatory activities^[3]. *Amla* fruits, *Phyllanthus emblica*, are rich in vitamin C (ascorbic acid). It nourishes hair and helps for the growth. It allows the shampoo to retain natural texture and delivers shine to the hair and also controls hair loss. *Amla* contains fatty acids which penetrate through the scalp to get rid of dandruff and dryness. It also possesses antioxidant properties^[4]. *Reetha*, *Sapindus mukorossi*, is a gentle cleansing agent which

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helps in preventing antimicrobial infection. It nourishes hair, keeps it healthy and smooth. It makes the hair lustrous and brings back the natural texture^[5]. *Shikakai*, *Acacia concinna* belongs to the family Leguminosae. It retains natural oil produced by hair and keeps the hair lustrous and healthy. In addition it conditions and strengthens the hair. It also adds volume to the hair and reduces hair loss. *Methi* or fenugreek seeds, *Trigonella foenum-graecum* belongs to the family Fabaceae, are rich source of iron and proteins. They contain unique composition of plant compounds, including flavonoids and saponins. It contains anti-inflammatory and antifungal activity. It provides shine to the hair and prevents hair loss^[6].

Herbal shampoos are a type of cosmetic preparations that use Ayurvedic herbs for cleansing the hair and scalp. They are gentle and natural. They assist in maintaining scalp oils while promoting healthy and lustrous hair growth without harsh chemicals that strip hair of its natural oils^[7].

An ideal herbal shampoo should effectively remove dust and excessive sebum. It should clean hair with good amount of foam production and also should be easily removed by rinsing with water. It should not cause dry hair after wash, rather should make the hair soft and smooth^[8].

This study was designed to formulate herbal shampoo using aqueous extracts of *Murraya koenigii* (curry leaves), *Acacia concinna* (*Shikakai*), *Sapindus*

mukorossi (*Reetha*), *Phyllanthus emblica* (*Amla*) and *Trigonella foenum-graecum* (*Methi*) and simultaneously study the effect of surfactants and carry out a comparative analysis.

MATERIALS AND METHODS

Sample Collection

Murraya koenigii (Curry leaves) and *Phyllanthus emblica* (*Amla*) was obtained from medicinal garden of Rani Chennamma College of Pharmacy, Belagavi. *Acacia concinna* (*Shikakai*), *Sapindus mukorossi* (*Reetha*) and *Trigonella foenum-graecum* (*Methi*) was obtained from local market Belagavi. Decyl Glucoside was obtained from Purenso select global Ltd. Madhya Pradesh.

The leaves of the plant *Murraya koenigii* (Fig. 2), the fruits of the plant *Phyllanthus emblica* (Fig. 3), the fruits *Sapindus mukorossi* (Fig. 4) and seeds of *Trigonella foenum-graecum* (Fig. 5) were authenticated by Dr. Harsha Hegde, Taxonomist, Indian Council of Medical Research (ICMR) Belagavi, Karnataka, India. The herbarium specimens have been deposited with accession numbers RMRC-1652, RMRC-1653, RMRC-1654 and RMRC-1655 respectively. The pods of *Acacia concinna* (Fig. 6) was authenticated by Dr. Divya Khare (CRF no. 62/2021), at Central Research Facility of Shree B.M.K. Ayurveda Mahavidyalay, Belagavi, Karnataka, India. The uses of each ingredient are mentioned in Table 1.

Table 1: List of Ingredients and its Uses

Common name	Scientific name and family	Part used	Uses
Curry leaves	<i>Murraya koenigii</i> family Rutaceae	Dried leaves	It possesses anti-oxidative and anti-inflammatory activities ^[9] .
<i>Amla</i>	<i>Phyllanthus emblica</i> family Phyllanthaceae	Dried fruit	It nourishes hair and helps for the growth. Provides lustre, helps in treating dryness and dandruff ^[10] .
<i>Reetha</i> / soapnut	<i>Sapindus mukorossi</i> family Sapindaceae	Dried fruit	Gentle cleansing agent which helps in preventing antimicrobial infection ^[10] .
<i>Shikakai</i>	<i>Acacia concinna</i> family Leguminosae	Dried pods	Keeps the hair lustrous and healthy. It conditions and strengthens hair ^[10] .
<i>Methi</i>	<i>Trigonella foenum-graecum</i> family Fabaceae.	Dried seeds	It is an anti-inflammatory and antifungal agent. It gives shiny hair and prevents hair loss ^[11] .

Preparation of Plant Extracts

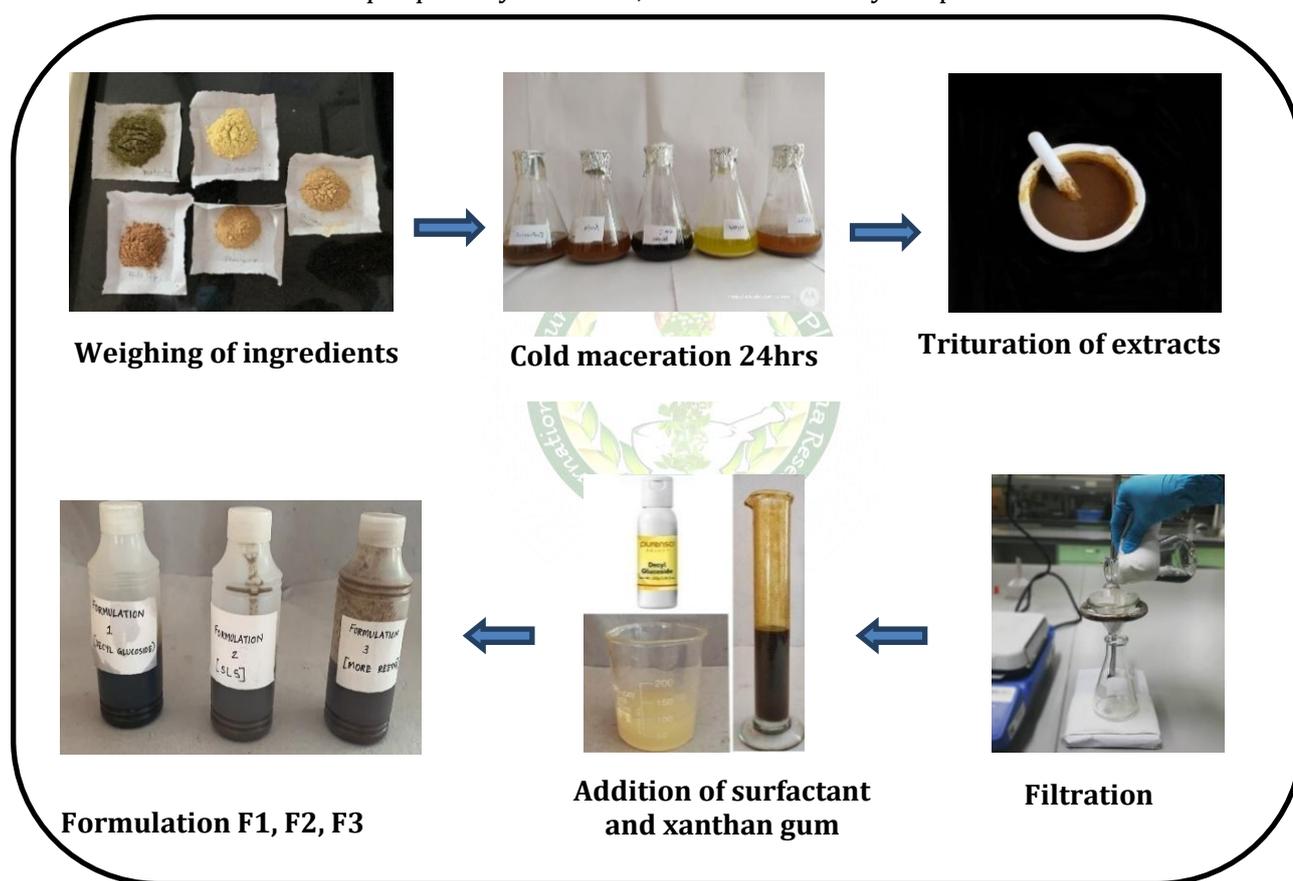
All the plant material collected was washed under running water to remove foreign substances, later thoroughly dried and finely powdered and further used for preparing the herb extract.

Aqueous extracts of curry leaves, *Amla*, *Shikakai* and *Methi* were prepared whereas *Reetha* was prepared as alcoholic extract. The extracts were then subjected to phytochemical screening.

Formulation of Herbal Shampoo**Table 2: Formulation Table for Herbal Shampoo**

Ingredients	F1	F2
Curry leaves	10 g	10 g
<i>Amla</i>	10 g	10 g
<i>Reetha</i>	10 g	10 g
<i>Shikakai</i>	10 g	10 g
<i>Methi</i>	10 g	10 g
Xanthan gum	0.1 %	0.1 %
Distilled water	q.s	q.s
SLS (7.5%)	-	10 ml
Decylglucoside	27 ml	-
Methyl Paraben	0.025g	0.025 g
Rose oil	0.1 ml	0.1 ml

q.s: quantity sufficient; SLS: Sodium Lauryl Sulphate

**Fig. 1: Formulation of Shampoo****Method of Preparation of Shampoo**

The shampoo was formulated as shown in Fig. 1. 10gm powder each of *Shikakai*, *Amla*, curry leaves and *Methi* were added to 50ml distilled water. 10gm of *Reetha* powder was added to 30ml of ethanol and kept for cold maceration for one day. 0.5% solution of Xanthan gum was prepared by dissolving 0.5gm of powder in 100ml of boiling water. The aqueous extracts of powders were boiled and transferred to a mortar and pestle. The alcoholic extract of *Reetha* was then added to the mortar and pestle and triturated to

mix well. Trituration was followed by the process of filtration using filter paper. After filtration, surfactant was added according to the formulation and 0.5% xanthan solution was added to make up the volume. The shampoo was then labeled and stored in a bottle for further evaluation studies.

Evaluation of Formulated Shampoo**Phytochemical Screening**

The aqueous extract was screened for qualitative chemical tests in order to detect various phytoconstituents^[12,13].

Physical Appearance and Content Analysis

Physical Appearance: Various physical parameters like colour and odour were observed for the prepared formulation^[14].

Determination of pH: The pH of the scalp is close to the pH of skin which is in the range of 5-7. Hence the desired pH range of the shampoo should be between 5 and 7. The pH of the formulation was determined by using pH meter^[14].

Determination of Percentage Solid Contents: The percentage of solid contents present in the formulation was carried out by evaporating the shampoo. The weight of empty china dish was recorded as W_0 . 4gm of shampoo was weighed and added to the empty china dish. This weight was recorded as W_1 . The china dish was then placed on a hot plate and the shampoo was allowed to evaporate until all the liquid part was lost. The dish was allowed to cool down and the weight of the china dish with solid content was recorded as W_2 . The percentage solid content was calculated by the following formula:^[13]

$$\% \text{ solid content} = \frac{W_1 - W_2}{W_1} \times 100$$

Physiochemical Analysis

Determination of Surface Tension: The surface tension was determined using stalagmometer by drop count method. A 10% solution of the shampoo was prepared and used for this test. Using electric weighing balance, weight of empty specific gravity bottle was recorded as W_1 . The bottle was then filled with distilled water and the weight was recorded again as W_2 . The same bottle was then filled with shampoo solution and the weight was recorded as W_3 . A clean stalagmometer was then filled with distilled water and number of drops from upper mark to lower mark was counted and was indicated by N_1 . Same procedure was followed for the shampoo solution and was indicated by N_2 . R_1 stands for surface tension of water^[15].

The surface tension was calculated using the following formula:

$$R_2 = \frac{(W_3 - W_1) \times N_1}{(W_2 - W_1) \times N_2} \times R_1$$

Determination of Viscosity: The viscosity of herbal shampoo was determined by using Brookfield viscometer. The viscosity of shampoo was measured at room temperature with varying rpm and torque^[15].

Dirt Dispersion Test: Two drops of herbal shampoo were added in a wide mouthed falcon tube containing 10 ml of distilled water. 1 drop of India ink was added, the falcon tube was covered and shaken for ten times. The amount of ink in the foam was estimated as none, light, moderate or heavy^[15].

Determination of Cleansing Action: 5 grams of wool yarn was added in grease and it was placed in flask containing 200ml of water with 1gm of shampoo.

Temperature of content in the flask was maintained at $30 \pm 2^\circ\text{C}$. The flask was shaken for 4 minutes at the rate of 50 shakes per minute. The solution was removed and sample was taken out, dried and weighed^[15]. The amount of grease removed was calculated by using the following equation:

$$DP = 100 \left(1 - \frac{T}{C}\right)$$

In which,

DP = percentage of detergency power

C = weight of sebum in the control sample

T = weight of sebum in the test sample

Foaming Ability and Stability

Cylinder shake method with slight modification was used for determining foaming ability. 50ml of 1% shampoo solution was put into a 250ml graduated measuring cylinder and covered with hand. Measuring cylinder was shaken for 1 min. The total volume of the foam contents after 1 min shaking was recorded. The procedure was continued for 5 minutes^[15].

Short Term Stability Study: The stability of the formulation was studied for a period of one month by keeping at temperature of $25-30^\circ\text{C}$ ^[15].

RESULTS AND DISCUSSION

Formulation of Herbal Shampoo

The shampoo was formulated using the ingredients as specified in Table 2. The plant material used in the formulation is rich in various phytochemicals. These phytochemicals consist of beta carotene, proteins and amino acids along with antioxidants which enhance hair growth and provide lustre to the hair and moisture to the scalp.

A good shampoo must have ideal viscosity to facilitate the flow of formulation from the bottle. Xanthan gum was added as thickening as well as suspending agent. Two different surfactants, decyl glucoside and sodium lauryl sulphate were added to the formulation.

Evaluation of Shampoos

Comparative effectiveness of the formulated herbal and commercial shampoo were evaluated by performing some simple physicochemical tests, results of which are discussed and tabulated below.

Phytochemical Screening

In plants, the naturally occurring chemical compounds are phytochemicals. Some phytochemicals are known to reveal medicinal and physiological activities which are phenols, tannins, flavonoids, saponins, carbohydrates, alkaloids, and phytosterols etc.

Tests were carried out to detect the presence of secondary metabolites such as alkaloids, glycosides, flavonoids, terpenoids, proteins, steroids, saponins, carbohydrates, tannins and phenolic compounds. The results of the same are mentioned in Table 3.

Table 3: Phytochemical Screening of Aqueous Extracts of Plant

	<i>Murraya koenigii</i> (Curry Leaves)	<i>Phyllanthus emblica</i> (Amla)	<i>Sapindus mukorossi</i> (Reetha)	<i>Acacia concinna</i> Linn. (Shikakai)	<i>Trigonella foenum-graecum</i> (Methi)
Alkaloids	+	+	+	+	+
Glycosides	-	+	+	-	-
Flavonoids	-	+	+	+	+
Terpenoids	+	+	+	-	+
Proteins	-	-	-	-	
Steroids	+	+	+	-	-
Saponins	+	+	+	-	-
Phenolic compounds	+	+	+	+	+
Carbohydrates	+	+	+	-	+
Tannins	+	+	+	+	+

(+) indicates presence whereas (-) indicates absence of the phytochemical

Physical Appearance and Content Analysis

Appearance

The prepared formulation is examined visually. The formulation must be visually appealing for greater customer satisfaction. The prepared formulation must be free from any agglomerates and must be uniform in nature. Proper care was taken while preparing the formulation to ensure that there was no formation of lumps. The formulation was also inspected for other physical attributes such as colour and odour which also play an important role while usage of any cosmetic product. It was observed that the formulation exhibits brown colour as shown in Fig. 7 and has a good odour due to addition of fragrance.

pH

The hair is extremely sensitive to the pH variation. The pH of the shampoo is important for improving the quality of the hair, minimizing irritation to the eye and to maintain balance of the scalp. Mild acidity promotes tightening of scalp thereby inducing shine to the hair. Balanced pH is one of the ways to minimize damage to the hair. Most shampoos are neutral or slightly acidic. Acidic solutions cause the cuticle (outer layer) of the hair to shrink and lie flatter on the hair shaft. Basic solutions cause the cuticle to swell and open up. Acidic solutions make the hair smoother, while basic solutions make the hair frizzier. The pH of formulated shampoos was determined using pH meter. The results of all the formulation from F1 to F3 were within the standard limit range that is pH 6-7 as shown in Table No: 5.

Determination of Percentage Solid Contents

If a shampoo has too many solids, it will be difficult to work in hair as well as to wash out with water. The amount of solids in a liquid formulation can be minimized by using filtration method. If it is too watery it will wash away quickly and would not give desired results. A good viscous shampoo possesses 20-25% solid content. All 3 formulations prepared had a

percentage solid content between 23-27% as shown in Fig. 8, 9 and Table No: 5.

Physiochemical Analysis

Determination of Surface Tension

A shampoo is considered to be of good quality if it decreases the surface tension of pure water from 72.28 dyn/cm to about 40 dyn/cm. Generally, herbal shampoo possesses surface tension of 25 - 35 dyn/cm. The surface tension of the prepared herbal shampoo was found to be in the range of 21-25 dyn/cm. This implies that the shampoo exhibits a good detergent activity.

A graph was plotted to compare the surface tension of all the formulations as shown in Fig. 10. It was found that marketed formulation possesses maximum surface tension followed by F1, F2 and F3.

Determination of Viscosity

Measuring the viscosity of the formulation is an essential part of quality control of the product. Product viscosity plays an important role in defining and controlling many attributes such as shelf life, stability and product aesthetics such as clarity, ease of flow on removal from packing and spreading on application to hair and product consistency in the package. The viscosity of the prepared formulations was found to be in the range of 4885 cP- 4903 cP as shown in Table 5.

Dirt Dispersion Test

Shampoo that causes the ink to concentrate in the foam is considered poor quality. The amount of ink in the foam is estimated as none, light, moderate or heavy. The dirt should stay in water. Dirt that stays in the foam will be difficult to rinse away as it will redeposit on the hair.

The amount of ink in foam for all 3 formulations was observed to be moderate, implying that the formulations were satisfactory as shown in Fig. 11.

Determination of Cleansing Action

The cleansing action of a shampoo is the ability of the shampoo to remove dirt from the scalp and hair. Cleansing action of the shampoos is due to presence of surfactants in the formulations. Surfactants dissolve the impurities and sebum produced by the scalp, preventing them from binding to the shaft or the scalp. The hydrophobic part of the surfactant binds with the dirt and sebum. The hydrophilic end binds with water. Hence during rinsing of hair, the surfactant or detergent is swept off with water.

The detergency power of the prepared formulations was determined as shown in Fig. 12 and it was found to be in the range of 35-50%. The detergency power of all 3 formulations was compared with the marketed formulation. It was observed that the detergency power of F₁ formulation was on a par with marketed formulation.

Foaming Ability and Foaming Stability

Foaming or lathering is an important characteristic for any formulated shampoo. It is considered to be an important parameter during commercialization of shampoos. Foaming ability is not

directly related to the cleansing ability of a shampoo. Hence the shampoo that foams well need not necessarily cleanse well. Formation of foam plays an important part in consumer satisfaction and hence foaming agents are added to the formulation. The tests conducted for foaming are as depicted in Fig. 13 and Fig.14.

A graph was plotted between foam volume and time (Fig. 15) to compare the stability of the foam produced by all the 3 formulations as well as the marketed formulation. F1 formulation and marketed formulation almost showed same volume of foam and it was found that both the formulations produce stable foam. When F1 formulation was compared with F2 and F3, the graph showed a decrease in the foam volume. It was also observed that F3 formulation produced the least amount of foam and the produced foam was not stable. This confirms that the formulations F1 and F2 were much stable with respect to foam ability and foam stability than F3. It can be also said that the foaming ability and stability of the shampoo was identical. The results are recorded in Table 5.

Table 4: Foaming Ability and Stability

Formulation	Foam Volume in Time				Foaming Ability
	1 min	2min	3 min	4min	
F1	112±0.57	110±1	107±1	104±0.58	Moderate
F2	100±0.58	97±0.58	94±1	91±0.58	Moderate
F3	80±1	76±1	74±0.53	69±0.58	Low
Marketed	113±0.58	110±0.58	108±0.58	105±0.58	Moderate

Results are mean ± SD (n = 3)

Stability Testing: Stability testing was carried out to check the quality of the product at room temperature which was kept for the period of one month. The samples were later tested to determine the change. Data obtained is as shown in the below Table: 5.

Table 5: Stability Testing

Formulation	F1	F2	F3
Colour	Brown	Brown	Brown
Odour	Characteristic	Characteristic	Characteristic
pH	6.8±0.06	6.4±0.06	6.5±0.15
Solid content	24%	24%	27%
Viscosity (cP)	4908	4895	4885
Foaming ability and stability	Moderate	Moderate	Low
Dirt dispersion	Moderate	Moderate	Moderate
Cleansing action	50%	40%	35%

Results are mean ± SD (n = 3)

Table 6: Results of Evaluation Tests for Different Formulations

Formulation	pH	% Solid contents	Surface tension (dyn/cm)	Viscosity (cP)	Dirt dispersion	Cleansing action
F1	6.8±0.06	24	25±1	4903	moderate	50%
F2	6.4±0.06	24	24±0.58	4895	moderate	40%
F3	6.5±0.06	27	21±1	4888	moderate	35%

Results are mean ± SD (n = 3)

CONCLUSION

The herbal shampoo was successfully formulated which was at par with the synthetic shampoo available in the market. All the ingredients used to formulate shampoo were commonly used across Asia and were safe and effective. Several tests were performed to evaluate and compare the physicochemical properties of both prepared and marketed shampoos. Our F1 formulation showed comparable result with that of marketed shampoo for quality control tests but further research and development is required to improve its overall quality.

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Authors Contributions: Mrs Rashmi Surve designed the experiment and is involved in the interpretation of data. All other authors equally contributed by carrying out the experimental work, analysis of data, and draft manuscript preparation.

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Figures



Fig. 2: Leaves of *Murraya koenigii*



Fig. 3: Fruits of *Phyllanthus emblica*



Fig. 4: Fruits of *Sapindus mukorossi*



Fig. 5: Seeds of *Trigonella foenum-graecum*



Fig. 6: Pods of *Acacia concinna*



Fig. 7: Appearance of the shampoo



Fig. 8: Evaporation of shampoo

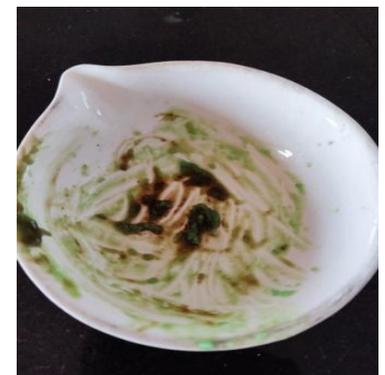


Fig. 9: After drying

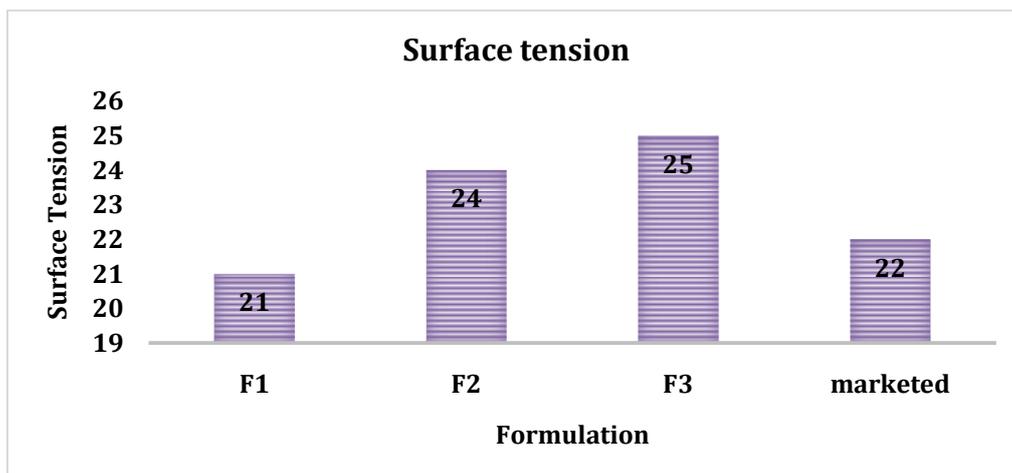


Fig. 10: Comparison of Reduction in Surface Tension by Formulations

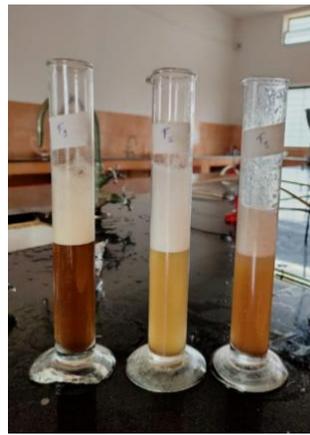


Fig. 11: Dirt dispersion test

Fig. 12: Cleansing action

Fig. 13: Foaming ability

Fig. 14: Comparison with marketed formulation

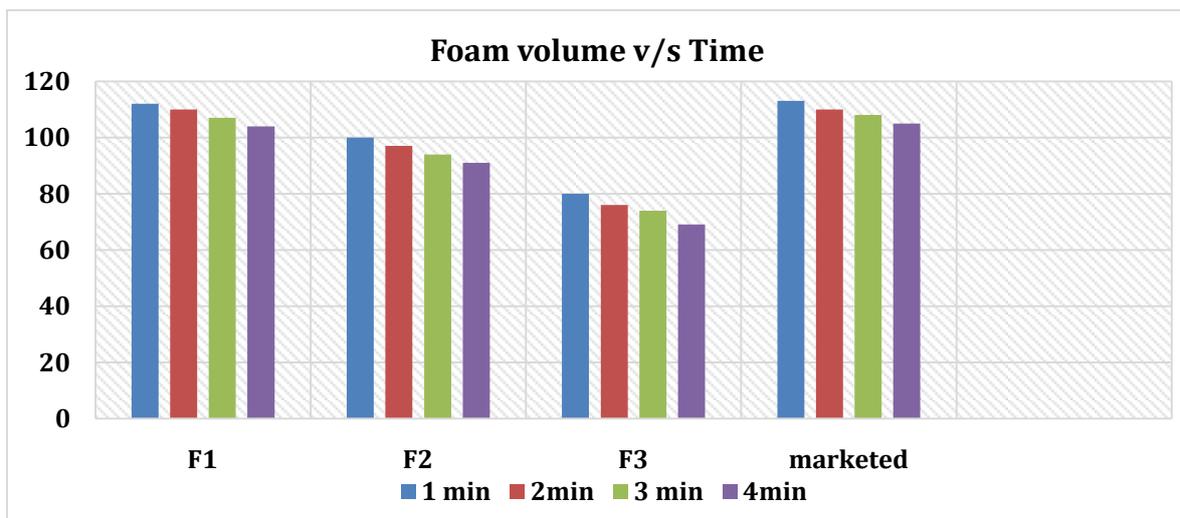


Fig. 15: Retention in Foam Volume with Time