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FORMULATION AND EVALUATION OF HERBAL SHAMPOO

Vandana M. V.*, Dr. Suja C., Farzana, Fathima Abdulla, Muhammed Jasim K.V. and Shaharba Mohammed Ashraf

Department of Pharmaceutics, Crescent College of Pharmaceutical Sciences, Payangadi P OKannur- 670358, Kerala, India.

***Corresponding Author: Vandana M. V.**

Department of Pharmaceutics, Crescent College of Pharmaceutical Sciences, Payangadi P OKannur- 670358, Kerala, India.

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ABSTRACT

Shampoo is a hair care product used to remove the sebum, skin particles, dandruff, environmental pollutants and other contaminant elements. The present study is aimed to formulate herbal shampoo containing extracts of natural products such as peel of pomegranate fruit (Punica *granatum*), henna leaves (Lawsonia *inermis*), curry leaves(Murraya *koenigii*), leaves of touch- me- not plant (Mimosa *pudica*) and to evaluate the formulated herbal shampoo,so as to improve its efficacy and reduce side effects. Qualitative phytochemical analysis were performed to find out the phyto-constituents present in the herbal extracts.All the formulations were then characterized for their physical appearance, pH, solid content percentage, wetting time, rheological evaluation, dirt dispersion, surface tension, foaming ability and foam stability, skin irritation test, microbial study and conditioning performance. Among all the formulations, F5 containing combination of herbal extracts was found to show better result. F5 showed the least percentage solid content and hence can be washed out easily. It also wets easily and has good rheological property. This formulation has reduced surface tension of water which shows that it has good detergent action. It shows greater foaming ability and good foam stability when compared to other formulations. Skin irritation tests revealed that the all the 5 formulation showsno harmful effect on the skin. The formulation F5 also showed good conditioning properties.

KEYWORDS: Herbal shampoo, *Punica granatum*, *Lawsonia inermis*, *Murraya koenigii*, *Mimosapudica*.

1. INTRODUCTION

Cosmetics can be defined as any article intended to be rubbed, poured, sprinkled or sprayed on, or introduced into, or otherwise applied to, the human body or any part thereof for cleansing, beautifying, promoting attractiveness, or altering the appearance, includes any article intended for use as a component of cosmetic.[1]

Shampoo is a hair care product used to remove the sebum, skin particles, dandruff, environmental pollutants and other contaminants. The shampoo sector is probably the largest market for sale amongst the hair care products since shampoos are one of the cosmetic products used in daily life. Many synthetic shampoos are present the current market both medicated and non-medicated; However, herbal shampoo are nowadays mostly popularized due to their natural origin, safety, increasing consumer demand, low cost & negligible side effects.[2]

The herbal shampoo is a cosmetic preparation in which herbs are collected from plants and is likely a regular shampoo that is usually for meant for washing the hair and scalp. Nowadays herbals help people in building their good health with the help of natural sources. This is because people found the benefits of herbs in cosmetic product which they used daily.

The aim of the present study is to formulate herbal shampoo containing extracts of natural products such as peel of pomegranate fruit (Punica *granatum*), henna leaves (Lawsonia *inermis*) , curry leaves(Murraya *koenigii*), leaves of touch- me- not plant (Mimosa *pudica*) and to evaluate the formulated herbal shampoo, so as to improve its efficacy and reduce side effects.

2. MATERIALS AND METHODS

1.1 Materials used

Pomegranate (Punica *granatum*), curry leaves (Murraya *koenigii)*, henna leaves (Lawsonia *inermis*), mimosa *pudica.*

1.2 Collection of plants

All plants were collected locally. It was identified and authenticated by the head of the Department of Pharmacognosy of our institution.[3]

1.3 Preparation of herbal extract

The collected plants were washed under running water to remove contaminant. They were dried in sunlight,

converted into coarse powder and sieved using 60 mesh.

1.3.1.Extract of pomegranate peel

5g of pomegranate peel powder was mixed with 100ml water in a stainless steel vessel. The mixture was kept for boiling until the water is reduced to one quarter. It was then filtered. The clear extract obtained was used as herbal extract.

1.3.2.Extract of henna leaves

10g of henna powder was mixed with 100ml water in a stainless steel vessel. The mixture was kept for boiling until the water is reduced to one quarter. It was then filtered. The clear extract obtained was used as herbal extract.

1.3.3.Extract of curry leaves

5g of curry leaves powder was mixed with 100ml water in a stainless steel vessel. The mixture was kept for boiling until the water is reduced to one quarter. It was then filtered. The clear extract obtained was used as herbal extract.

1.3.4.Extract of Mimosa *pudica* leaves

10g of Mimosa pudica powder was mixed with 100ml water in a stainless steel vessel. The mixture was kept for boiling until the water is reduced to one quarter. It was then filtered. The clear extract obtained was used as herbal extract.

1.3.5.Extract containing combination of pomegranate peel, henna leaves, curry leaves and Mimosa *pudica* leaves.

5g of pomegranate peel powder, 10g henna powder, 5g curry leaves powder and 10g Mimosa *pudica* powder was mixed with 100ml water in a stainless steel vessel. The mixture was kept for boiling until the water is reduced to one quarter. It was then filtered. The clear extract obtained was used as herbal extract.[4]

2.4. Qualitative phytochemical analysis

a) The aqueous extract of pomegranate (Punica *granatum*) was subjected to the phytochemical analysis by using various chemical tests to identify the phytochemicals present in it.

i) Test for carbohydrates: Molisch's test
ii) Test for reducing sugars: Benedict's test
iii) Test for glycosides: Keller- Killiani's test
iv) Test for protiens: Xanthoproteic test
v) Test for amino acids: Ninhydrin's test
vi) Test for phenolic compounds: Ferric chloride test
vii) Test for tannins: Ferric chloride test
viii) Test for alkaloids: Wagner's test
ix) Test for flavonoids: Lead acetate test
x) Test for saponins: Froth's test
xi) Test for sterols: Salkowski's test
xii) Test for fixed oils: Saponification test
xiii) Test for cardiac glycosides: Kedde test
xiv) Test for anthraquinones: Borntranger's test
xv) Test for terpenoids: Salkowski's test
xvi) Test for steroids: Sulphuric acid test
xii) Test for quinones: Sulphuric acid test

b) The aqueous extract of henna leaves (Lawsonia *inermis*) was subjected to the phytochemical analysis by using various chemical tests to identify the phytochemicals present in it:

i) Test for tannins: Ferric chloride test
ii) Test for flavonoids: Lead acetate test
iii) Test for alkaloids: Wagner's test
iv) Test for terpenoids: Salkowski's test
v) Test for saponins: Froth's test
vi) Test for cardiac glycosides: Kedde test
vii) Test for glycosides: Keller- Killiani's test
viii) Test for reducing sugars: Benedict's test
ix) Test for steroids: Sulphuric acid test
x) Test for phenolic compounds: Ferric chloride test
xi) Test for amino acids: Ninhydrin's test
xii) Test for proteins: Xanthoproteic test
xiii) Test for quinones: Sulphuric acid test
xiv) Test for carbohydrates: Molisch's test
xv) Test for sterols: Salkowski's test
xvi) Test for fixed oils: Saponification test
xvii) Test for anthraquinones: Borntranger's test

c) The aqueous extract of curry leaves (Murraya *koenigii)* was subjected to the phytochemical analysis by using various chemical tests to identify the phytochemicals present in it.

i) Test for alkaloids: Wagner's test
ii) Test for flavonoids: Lead acetate test
iii) Test for glycosides: Keller- Killiani's test
iv) Test for steroids: Sulphuric acid test
v) Test for cardiac glycosides: Kedde test
vi) Test for saponins: Froth's test
vii) Test for phenols: Litmus test
viii) Test for tannins: Ferric chloride test
ix) Test for terpenoids: Salkowski's test
x) Test for quinones: Sulphuric acid test
xi) Test for amino acids: Ninhydrin's test
xii) Test for carbohydrates: Molisch's test
xiii) Test for reducing sugars: Benedict's test
xiv) Test for anthraquinones: orntranger's test
xv) Test for sterols: Salkowski's test
xvi) Test for proteins: Xanthoproteic test
xvii) Test for fixed oils: Saponification test

d) The aqueous extract of Mimosa *pudica* was subjected to the phytochemical analysis byusing various chemical tests to identify the phytochemicals present in it.

i) Test for tannins: Ferric chloride test
ii) Test for saponins: Froth's test
iii) Test for alkaloids: Wagner's test
iv) Test for flavonoids: Lead acetate test
v) Test for proteins: Xanthoproteic test
vi) Test for steroids: Sulphuric acid test
vii) Test for anthraquinones: Borntranger's test
viii) Test for amino acids: Ninhydrin's test
ix) Test for cardiac glycosides: Kedde test

x) Test for quinones: Sulphuric acid test
xi) Test for terpenoids: Salkowski's test
xii) Test for fixed oils: Saponification test
xiii) Test for sterols: Salkowski's test
xiv) Test for carbohydrates: Molisch's test
xv) Test for reducing sugars: Benedict's test
xvi) Test for glycosides: Keller- Killiani's test
xvii) Test for phenols: Litmus test

2.5. Formulation of Herbal Shampoo

Triethanolamine lauryl sulphate sodium was diluted with half the quantity of water by slow stirring. Carbopol was triturated with propylene glycol and EDTA was mixed and dissolved in the remaining quantity of water and this solution was added to the carbogel mixture. Then it was mixed well by slow stirring. This mixture was then added to the detergent solution in small proportions, stirred it slowly and thoroughly. Perfume was dissolved in alcohol and the solution was added to the shampoo mixture. Stirred slowly until uniform. Then the corresponding herbal extracts were incorporated to obtain the desired herbal shampoo.[4]

Table 1: Formulation design of Herbal Shampoo.

Sl. no	Ingredients (in g/ ml)	F1	F2	F3	F4	F5
1	Pomegranate extract	20	-	-	-	-
2	Henna extract	-	20	-	-	-
3	Curry leaves extract	-	-	20	-	-
4	Mimosa *pudica* extract	-	-	-	20	-
5	Combination	-	-	-	-	20
6	Tri ethanolamine lauryl sulphate solution	45	45	45	45	45
7	Propylene glycol	5	5	5	5	5
8	Carbapol	15	15	15	15	15
9	EDTA	0.5	0.5	0.5	0.5	0.5
10	Ethyl alcohol	5	5	5	5	5
11	Propyl paraben	q. s	q. s	q. s	q. s	q. s
12	Perfume	q. s	q. s	q. s	q. s	q. s
13	Water	q. s	q. s	q. s	q. s	q. s

2.6. Evaluation of Herbal Shampoo

To evaluate the prepared formulations, various evaluation test were performed to determine the physicochemical parameters.

2.6.1.Physical appearance/visual inspection: The formulation prepared wasevaluated for the clarity, color and odour.[5]

2.6.2.Determination of pH: A 10% v/v shampoo solution was constituted in distilled water and the pH of the solution was measured by using a calibrated p^H meter.[6]

2.6.3.Determination of solid content percentage: A clean dry evaporating dish was weighed and 4 grams of shampoo was added to the evaporating dish. The evaporating dish with shampoo was placed on the hot plate until the liquid portion was evaporated. The weight of the solid contents present in the shampoo was calculated after drying.

% Solids = (Net weight of the dry specimen / Net weight of the original specimen) X100

2.6.4.Wetting time: Wetting time was determined by noting the time required by the canvas paper to sink completely. A canvas paper weighing 0.44 g was cut into a disc of diameter measuring 1-inch. Over the shampoo (1% v/v) surface, the canvas paper disc was kept and the time taken for the paper to sink was measured using thestopwatch.[7]

2.6.5.Rheological evaluation: The viscosity of herbal shampoo was determined by using Ostwald's viscometer. The viscosity of the herbal shampoo was measured by counting drops of herbal shampoo from point A to point B.[8]

$$ny = nw\frac{dyty}{dwtw}$$

nw: viscosity of water
ny: viscosity of tested liquid
dw: density of water
dy: density of tested liquid
tw: time taken by water to flow from point A to B in Ostwald's viscometer.
ty: time taken by test liquid to flow from point A to B in Ostwald's viscometer.

2.6.6.Dirt dispersion: Two drops of herbal shampoo was added to the test tube containing 10ml 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.[9]

2.6.7.Surface tension measurement: Stalagmometer was used to determine surface tension. The principle is to measure the weight of the drops of herbal shampoo falling from a capillary glasstube, and thereby calculate the surface tension of the fluid. Surface tension can be determined by using the formula.[10]

$$ST = \frac{nl}{nw} \times \frac{dl}{dw} \times tw \mid$$

nl: no. of drops of liquid
nw: no. of drops of waterdl: density of liquid
dw: density of watertw: 71.2 dyne/cm

2.6.8.Foaming ability & Foam stability: Cylinder shake method was used for determining foaming ability. 50ml of the 1% herbal shampoo solution was put into a 250ml graduated cylinder& the cylinder was covered with hands and shaken for 10 minutes. The total volume of the foam content after 1 minute shaking was recorded. Immediately after shaking the volume of foam at 1 minute intervals for 10 minutes were recorded. The time taken by the foam to remain as such was recorded for determining the foam stability.[11]

2.6.9.Skin Irritation Test: Prepared herbal shampoo was applied on skin for 5 minutes after that was washed and tested for irritation or inflammation to the skin.[12]

2.6.10. Microbial study

a. Preparation of media: Modified agar well diffusion method was used for preparation of media and to determine the antimicrobial activity of formulation, where nutrient agar plates were seeded with 0.2ml of 24 hour broth culture. After solidifying the agar plates, wells are cut at equal distance in each plate by using a sterile 8mm borer.

b. Test: The wells of plates were filled with near about 0.5ml of formulation. The plates were then incubated at 37°C for 24hr.The antibacterial activity was evaluated by measuring zones of inhibition (in cm).[13]

2.6.11. Evaluation of conditioning performance

Hair tress of a woman was obtained voluntarily. It was cut into two swatches with approximately the length of 12cm and the weight of 2.2g. A swatch without washing served as the control. Another swatch was washed with the formulated shampoo. For each cycle, the swatch was shaken with the mixture of 10g of a sample and 15ml of water in a conical flask for 2min and then rinse4d with 50ml water. Afterward, the tress was left for air drying at room temperature. The tress was washed for maximum ten cycles. The conditioning performance of the shampoos ie., smoothness and softness was evaluated by a blind touch test, administered to 10 randomly selected student volunteers. The consent form with test procedure was given to the student volunteers to get their permission. The students voluntarily participated in the study. All the students were blindfolded and asked to touch and rate the tress for conditioning performance from score 1 to 4 (1= poor; 2= satisfactory; 3= good; 4= excellent).[13]

2. RESULT AND DISCUSSION

The different formulation of herbal shampoos was prepared and evaluated.

The photographs of prepared shampoos are shown below.

Fig 1: F1

Fig 2: F2

Fig 3: F3

Fig 4: F4

Fig 5: F5

The following evaluation test were performed on formulated shampoo.

3.1. Phytochemical analysis on leaf extracts

The aqueous extract of leaves were subjected to the phytochemical analysis by using various chemical tests to identify the phytochemicals present in it as shown in the table.

Table 2: Phytochemical analysis on aqueous extract of pomegranate (Punica *granatum*).

Phytochemical test	Compound detected	Inference
Molisch's test	Carbohydrates	+
Benedict's test	Reducing sugars	+
Keller- Killiani's test	Glycosides	+
Xanthoproteic test	Protiens	+
Ninhydrin's test	Amino acids	+
Ferric chloride test	Phenolic compounds	+
Ferric chloride test	Tannins	+
Wagner's test	Alkaloids	+
Lead acetate test	Flavonoids	+
Froth's test	Saponins	+
Salkowski's test	Sterols	+

Saponification test	Fixed oils	-
Kedde test	Cardiac glycosides	-
Borntranger's test	Anthraquinones	-
Salkowski's test	Terpenoids	-
Sulphuric acid test	Steroids	-
Sulphuric acid test	Quinones	-

+: presence; -: absence

Table 3: Phytochemical analysis on aqueous extract of henna leaves (Lawsonia *inermis)*.

Phytochemical test	Compound detected	Inference
Ferric chloride test	Tannins	+
Lead acetate test	Flavonoids	+
Wagner's test	Alkaloids	+
Salkowski's test	Terpenoids	+
Froth's test	Saponins	+
Kedde test	Cardiac glycosides	+
Keller- Killiani's test	Glycosides	+
Benedict's test	Reducing sugars	+
Sulphuric acid test	Steroids	+
Ferric chloride test	Phenolic compounds	+
Ninhydrin's test	Amino acids	+
Xanthoproteic test	Proteins	+
Sulphuric acid test	Quinones	+
Molisch's test	Carbohydrates	-
Salkowski's test	Sterols	-
Saponification test	Fixed oils	-
Borntranger's test	Anthraquinones	-

+: presence; -: absence

Table 4: Phytochemical analysis on aqueous extract of curry leaves (Murraya *koenigii)*

Phytochemical test	Compound detected	Inference
Wagner's test	Alkaloids	+
Lead acetate test	Flavonoids	-
Keller- Killiani's test	Glycosides	+
Sulphuric acid test	Steroids	+
Kedde test	Cardiac glycosides	-
Froth's test	Saponins	-
Litmus test	Phenols	+
Ferric chloride test	Tannins	+
Salkowski's test	Terpenoids	+
Sulphuric acid test	Quinone	+
Ninhydrin's test	Amino acids	-
Xanthoproteic test	Proteins	-
Molisch's test	Carbohydrates	-
Benedict's test	Reducing sugars	-
Borntranger's test	Anthraquinones	-
Salkowski's test	Sterols	-
Saponification test	Fixed oils	-

+: presence; -: absence

Table 5: Phytochemical analysis on aqueous extract of Mimosa *pudica.*

Phytochemical test	Compound detected	Inference
Ferric chloride test	Tannins	+
Froth's test	Saponins	-
Wagner's test	Alkaloids	-
Lead acetate test	Flavonoids	-
Xanthoproteic test	Proteins	+
Sulphuric acid test	Steroids	+

Borntranger's test	Anthraquinones	-
Ninhydrin's test	Amino acids	-
Kedde test	Cardiac glycosides	-
Sulphuric acid test	Quinones	-
Salkowski's test	Terpenoids	-
Saponification test	Fixed oils	-
Salkowski's test	Sterols	-
Molisch's test	Carbohydrates	-
Benedict's test	Reducing sugars	-
Keller- Killiani's test	Glycosides	-
Litmus test	Phenols	-

+: presence; -: absence

3.2. Physical appearance

The formulated shampoos were visually inspected for their colour, clarity and its odour wasdetermined.

Table 6: Physical properties of formulated herbal shampoos.

Formulation	Colour	Odour
F1	Deep gold	Pleasant
F2	Light brown	Pleasant
F3	Pale straw	Pleasant
F4	Lemon green	Pleasant
F5	Deep amber	Pleasant

The formulated shampoos were visually inspected and the colour of each formulation wasnoted and recorded in table 2.

3.2. Determination of P^H

The pH of prepared formulations was determined using digital pH meter and the pH values are shown in table 3.

Table 7: pH of formulated herbal shampoos.

Formulation	pH
F1	6 ± 0.96
F2	6 ± 0.43
F3	6 ± 0.23
F4	6 ± 0.25
F5	6 ± 0.58

All values are expressed as a mean of ±SD, n = 3

The pH of all formulated shampoo was found to be 6, which is within the ideal pH range for shampoo that is between 5 and 7.8.

3.3 Determination of percentage solid content:

The percentage solid content of all formulated herbal shampoos was determined and valuesare shown in table no.4.

Table 8: Percentage solid content of formulated herbal shampoos.

Formulation	Percentage solid content (5%)
F1	9.65 ± 0.03
F2	7.38 ± 0.21
F3	8.6 ± 0.65
F4	7.27 ± 0.95
F5	7.02 ± 0.87

All values are expressed as a mean of ± SD, n = 3

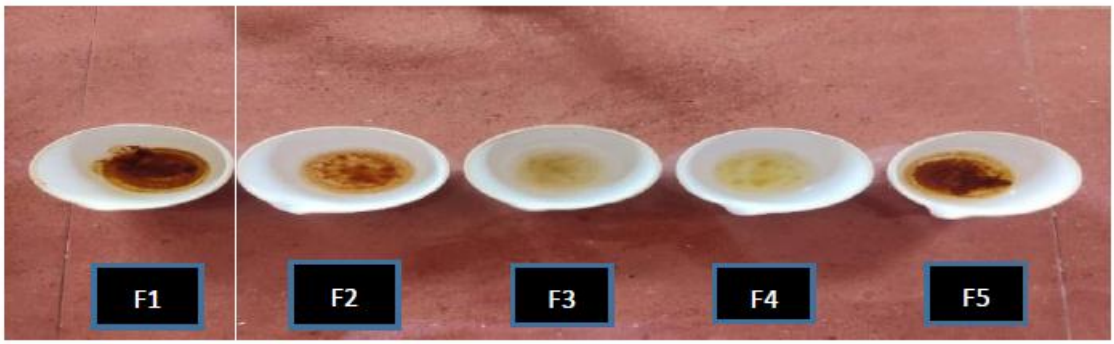

Fig 6: Percentage Solid Contents Of Formulated Shampoos.

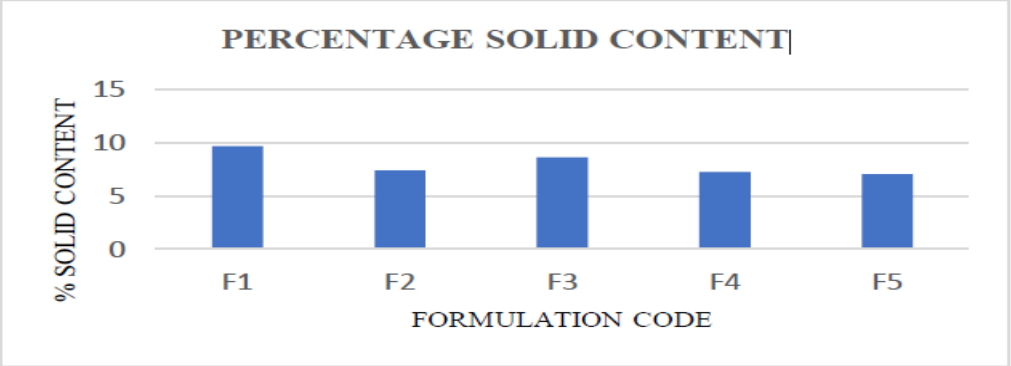

Fig 7: Plot showing percentage solid contents of formulated shampoos.

Determination of percentage solid content in shampoo is important since, if the shampoo has too many solid it will be hard to work in to the hair or too hard to wash out. The percentage solid content of formulations was found to be in range of 7 to 10 %. The F5 formulation has the least percentage solid content (7.02) and it suggests that it can be washed out easily.

3.4 Wetting time

The wetting time of all formulated herbal shampoo was determined and values are shown in table 5**.**

Table 9: Wetting time of formulated herbal shampoos

Formulation	Wetting time (sec)
F1	11 ± 0.36
F2	10 ± 0.24
F3	11 ± 0.89
F4	11 ± 0.45
F5	11 ± 0.96

All values are expressed as a mean of ± SD, n = 3

The wetting ability of surfactant is dependent on its concentration in the formulation and is commonly used to test its efficacy. The canvas disc method is quick, efficient and reliable testto evaluate the wetting ability of shampoo.

Wetting efficiency was considered to be higher if the disc takes less time for sinking.

The wetting time of all formulated herbal shampoo was found to be within 11 seconds which suggests that it wets easily.

Fig 8: Wetting time of F5 formulation.

3.5 Rheological evaluation

Viscosity of all formulated herbal shampoos was determined using Ostwald's viscometer and values were shown in table 6.

Table 10: Rheological evaluation of formulated herbal shampoos.

Formulation	Viscosity (mp)
F1	30.4 ± 0.68
F2	40.1 ± 0.42
F3	45.62 ± 0.54
F4	46.42 ± 0.78
F5	50.54 ± 0.15

All values are expressed as a mean of ± SD, n = 3

The viscosity of the shampoo plays an important role in determining its shelf life stability, the ease of flow on removal from packing and spreading on application to hair and product consistency in the package. It is found that formulation F5 has viscosity 50.5mp, which ensures that it has good rheological property.

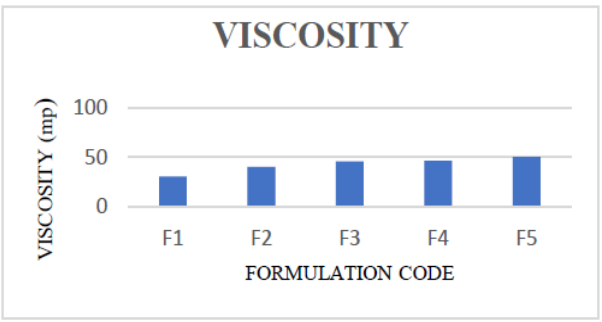

Fig 9: Plot showing rheological evaluation of formulated herbal shampoos.

3.6. Dirt dispersion

Dirt dispersion of all formulated herbal shampoos was determined and values were shown in table 7.

Table 11: Dirt dispersion of formulated herbal shampoos.

Formulation	Amount of ink in foam
F1	Light
F2	Moderate
F3	Moderate
F4	Moderate
F5	Light

Fig 10: Dirt dispersion of formulated herbal shampoos.

Shampoo that causes the ink to concentrate in the foam is considered poor quality. The dirt should stay in water. Dirt that stays in the foam will be difficult to rinse away, it will redepositon the hair. T was found from study that the amount of ink in foam was moderate for F2, F3 and F4 formulation and light for F1 and F5 formulations. So result indicated that formulation F1 and F5 have satisfactory dirt dispersion properties.

3.7. Surface tension measurement

Surface tension of all formulated herbal shampoos was determined and values were shown in table 8.

Table 12: Surface tension of formulated herbal shampoos.

Formulation	Surface tension (dyne/cm)
F1	64.48 ± 0.63
F2	40.48 ± 0.52
F3	49.2 ± 0.89
F4	54.54 ± 0.45
F5	31.14 ± 0.95

All values are expressed as a mean of ± SD, n = 3

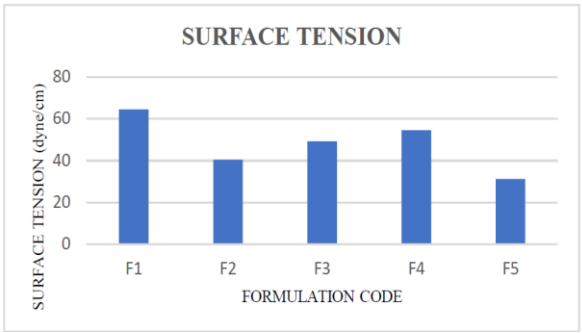

Fig 11: Plot showing surface tension of formulated herbal shampoos.

Foaming ability
Foam stability

Shampoo should be able to decrease the surface tension of pure water to about 40 dynes/cm. Surface tension reduction is one of the mechanism implicated in the detergency.

It is seen that formulation F5 has reduced surface tension of water from 72.8 dyne/cm to 31.14 dyne/cm , which shows that it has good detergent action.

3.8. Foaming ability and Foam stability

Formulated herbal shampoos were tested for the ability to form foam and stability of formed foam. The results were shown in table 9.

Table 13: Foaming ability and Foam stability of formulated herbal shampoos.

Formulation	Foaming ability and Foam stability (ml)
F1	40 ml after 1min and 32 ml after 10 min
F2	35 ml after 1min and 32 ml after 10 min
F3	35 ml after 1 min and 30 ml after 10 min
F4	39 ml after 1 min and 36 ml after 10 min
F5	48 ml after 1 min and 46 ml after 10min

Fig 12: Foaming ability and Foam stability of F5 formulation.

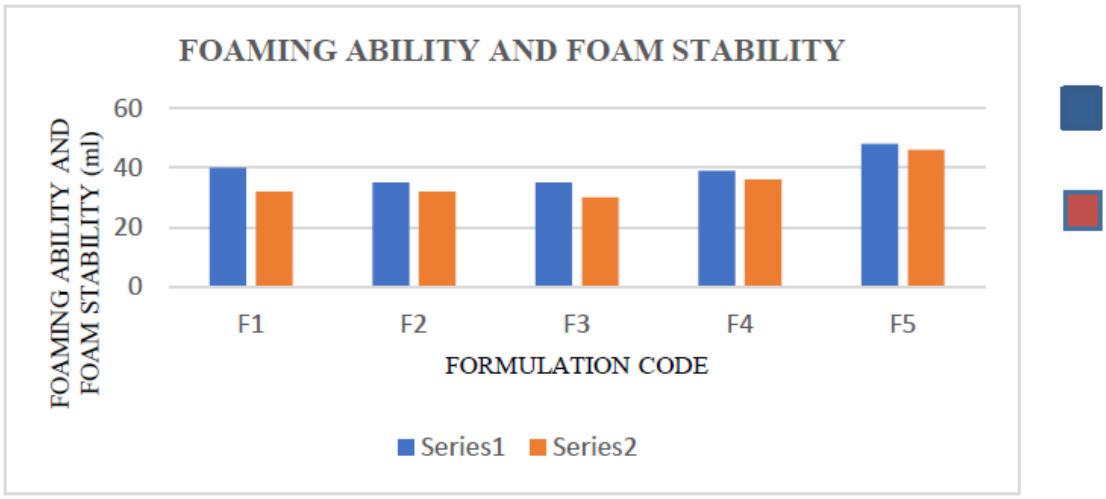

Fig 13: Plot showing foaming ability and foam stability of formulations.

Ideally, a good shampoo produces sufficient foam when shaken with water and therefore is an important parameter in the evaluation process. All formulated shampoo produced enough foam when shaken with sufficient water. The F5 formulation shows greater foaming ability and also exhibit good foam stability (the foam was 46ml after 10 minutes) when compared to other formulations.

3.9. Skin irritation test

Skin irritation test was performed on all formulated herbal shampoos and results were shown in table 10.

Table 14: Skin irritation of all formulated herbal shampoos.

Formulation	Skin irritation
F1	Nil
F2	Nil
F3	Nil
F4	Nil
F5	Nil

The skin irritation tests revealed that the all 5 formulation shows no harmful effect on theskin.

3.10. Microbial study

All formulated herbal shampoos was subjected to microbiological study and zone of inhibition was determined.

Table 15: Microbial study of formulated herbal shampoos.

Formulation	Zone of inhibition (cm)
F1	1.2±0.02
F2	1.1±0.04
F3	1.1±0.16
F4	1.1±0.09
F5	1.4±0.17

All values are expressed as a mean of ± SD, n = 3

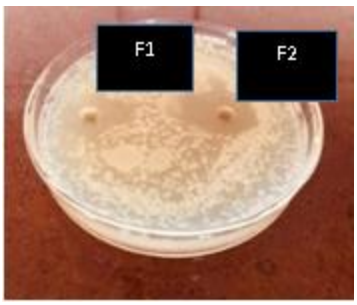

Fig 14: Zone of inhibition of formulations F1and F2.

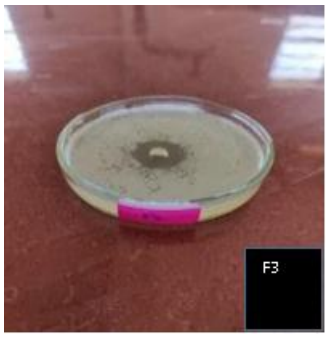

Fig 15: Zone of inhibition of formulation F3.

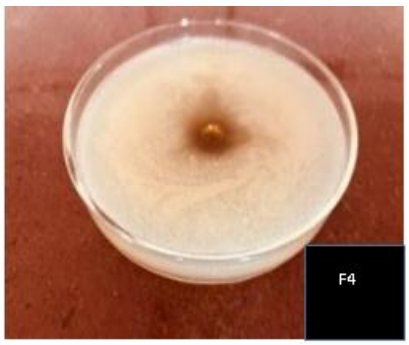

Fig 16: Zone of inhibition of formulation F4.

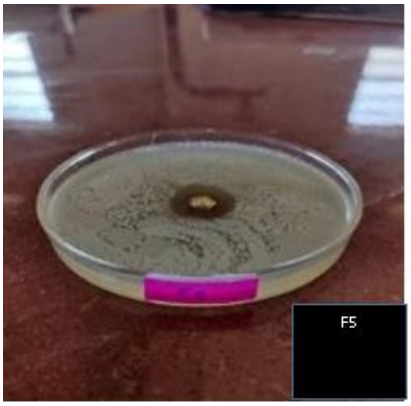

Fig 17: Zone of inhibition of formulation F5.

The zone of inhibition of formulation F5 was found to be 1.4 cm which is more than the zone of inhibition of other formulations which shows that formulation F5 has more anti-microbial activity.

3.11. Conditioning Performance

Formulation F5 was subjected to evaluation of conditioning performance and the score of student volunteers opinion on conditioning performance of the tresses after the treatment with shampoo was determined. The students rated the unwashed tresses higher and it was noted that they preferred the feel of unwashed tresses than the tresses washed with formulated shampoo. The results indicated that the formulated shampoo has satisfactory conditioning performance.

Table 16: Score of student volunteers opinion on conditioning performance of the tresses after the treatment with shampoo (n= 10)

Score	Formulated herbal shampoo	No washing
1	0	0
2	9	0
3	1	7
4	0	3

(1= poor, 2= satisfactory, 3= good, 4= excellent)

3. CONCLUSIONS

Herbal shampoo were successfully developed using aqueous herbal extracts of pomegranate *(Punica granatum)*, henna leaves *(Lawsonia inermis)*, curry tree *(Murraya koenigii)*, *Mimosa pudica* and combination of pomegranate peel, henna leaves, curry leaves and Mimosa pudica leaves. Qualitative phytochemical analysis were done to find out the phytoconstituents present inthe extracts. The developed formulations were then characterized for their physical appearance, pH, solid content percentage, wetting time, rheological evaluation, dirt dispersion, surface tension, foaming ability and foam stability, skin irritation test, microbial study and conditioning performance. Amoung all the formulations, F5 containing combination of herbal extracts was found to show better result. The F5 formulation has the least percentage solid content (7.02) and it suggests that it can be washed out easily. The wetting time was found to be within 11 seconds which suggests that it wets easily. It was found that formulation F5 has viscosity 50.5mp, which ensures that it has good rheological property. It was found that F5 have satisfactory dirt dispersion properties. The formulation F5 has reduced surface tension of water from 72.8 dyne/cm to 31.14 dyne/cm , which shows that it has good detergent action. The F5 formulation shows greater foaming ability and also exhibit good foam stability when compared to other formulations. The skin irritation tests revealed that the all 5 formulation shows no harmful effect on the skin. The results of conditioning performance evaluation of F5 formulation indicated that the it has satisfactory hair conditioning effect.

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