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Poly Herbal Shampoo Formulation: Its Pharmacological Value And Characterization

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ABSTRACT

The growing need for natural and chemical free hair products has led to the formulation of poly herbal shampoos. Poly herbal shampoos are infused with extracts of herbal ingredients. They have positive and long lasting effects on hair. Poly herbal shampoos are safe, healthy and more economical for hair health and complications as compared to chemically synthesized commercial shampoos that have more side effects. The current research work was aimed to formulate the three different formulas of poly herbal shampoo by using different concentration of five selected plants such as Sapindus mukorossi (Sapindaceae), Salvadora persica (Salvadoraceae), Grewia tenax (Malvaceae), Berberis lycium (Berberidaceae), and Phyllanthus emblica (Phyllanthaceae) belonging to five different families. The chosen parts of selected plants for the synthesis of poly herbal shampoos were fruit (80%) and wood (20%). Out of five plants, fruits of four plants such as Sapindus mukorossi, Salvadora persica, Grewia tenax and Phyllanthus emblica were utilized to make the poly herbal shampoos. Wood of only one plant such as Berberis lycium was used. This study used a systematic methodology to measure the chosen plants' possible effects on hair health and hair disorders. Different laboratory evaluations including total phenolic contents, antioxidant activities, antimicrobial activity, organoleptic properties, skin irritation test, wet time test, evaluation of solid contents, foaming ability/ stability test, conditioning test, combing test, dirt dispersion test, pH test were performed and obtained positive results for its use in cosmetic industry.

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INTRODUCTION

Hair is a crucial and delicate part of the human body, serving various roles such as insulation, protection, and beautification. The concept of hair growth enhancing and conditioning shampoo can be traced back to ancient medicinal systems such as the Rig-Veda, Ayurveda, Unani and Homeopathic medicine. These products utilize herbs in their crude or extract form to promote healthy hair growth and improve hair condition. These herbs should possess a variety of properties such as tonic, laxative and relaxing action, antibacterial properties and hair growth (Evans & Trease, 1996).

Harry defined shampoo as "a preparation of a surfactant, or surface-active material, in a suitable form such as liquid, solid, or powder." The use of surface active materials can be very harmful to both the youth and the environment over time. Synthetic compounds, chemicals, dyes, and their derivatives have been proven to cause various skin diseases and have numerous side effects. In contrast, herbal products are seen as a safer alternative, with a growing popularity and a wide range of options now available to the public (Zhang & Demain, 2005).

The origin of cosmetic is from Greek language word kosmetics, that represents anything, that play role in beatification of human (Dubey*et al.*, 2023). In brand new times, there is a wide array of shampoos available, together with artificial, herbal, medicated and non-medicated alternatives. However, the preference for herbal shampoos is growing among consumers because they are considered safer as compared to synthetic traditional market shampoos which are dangerous comparatively. There are large numbers of medicinal flora which can be suggested to have useful results on hair and are usually used in shampoo (Gulwane *et al.*, 2024).

Nowadays, the use of herbs in cosmetic invention has significantly amplified in the personal care industry, leading to a high demand for herbal cosmetics. Shampoos are undoubtedly used as cosmetics. These are care product for hair and applied for clearing the scalp and hair. Shampoos are typically used as beauty products and are a sticky solution of detergents containing suitable additives, preservatives, and active ingredients. They are applied commonly on wet hair, massaged into the hair, and then rinsed with water. The purpose of using shampoo is to remove dirt that has built up on the hair without stripping out too much of the sebum. Many synthetic shampoos are present in the current market, both medicated and non-medicated; however, herbal shampoos have become prevalent due to their natural origin, safety, increased consumer demand, and lack of side effects (Mainkar & Jolly 2001; Aghel *et al.*, 2007; Potluri *et al.*,

2013).

Hair not only enhances the beauty of human but also serves as insulation layer on the cranium. From ancient times herbs have been reported to use for the diseases of skin and hair. World trend is shifting again towards herbal products. This practice provide a lot of benefits to people as these are economically suitable and also retain less side effects comparative to commercially manufactured shampoo.Different phytochemicals are present in different herbs that promote the health and shining of hair (Manisha *et al*., 2013).

In non-natural shampoos, surfactants are added mainly for their cleansing and foaming properties. However, the constant usage of these surfactants can lead to severe effects such as eye irritation, scalp irritation, dryness, and hair loss (Shinde *et al*., 2013). Various medicinal plants have been reported to have a positive influence on hair and have been used in the remote past and integrated into shampoo preparations (Pooja *et al*., 2011). The medicinal plants may be used in different forms such as powdered form, extract form, and in crude form (Kapoor 2005).

Synthetic ingredients are added in Shampoo formulation due to their cleaning and foaming property, but the nonstop practice of these ingredients cause severe effects on hair health such as irritation problem, hair loss and dryness. Best alternative to these synthetic shampoos is the use of natural herbs. Various medicinal plants with healthy effects on hair utilized conventionally from primitive times round the world and now are used in shampoo formulation (Bhagwat 2020).

The top sales product among hair care products is undoubtedly shampoo. Due to increasing awareness in people about the application of herbs for the manufacturing of effective cosmetics, there are seen growing trends regarding the use of plants for that purpose. Plants chemicals extracts can be used for the protection and beautification of human body especially skin and hair. Physicochemical methodology for the protection and evolving a self-protective poly herbal shampoo has escaped the threat impersonated by chemicals used in industrial additives (Gahlawat *et al*., 2019).

Presently, numerous artificial plant derived medicinal, non-medicinal shampoos are accessible in the market place. Acceptance of herbal shampoos among customers is increasing, because they consider herbal shampoo are safe for use without any side effects on hair (Ramadevi *et al*., 2019).

TABLE 1. SELECTED FIVE PLANTS USED FOR THE FORMULATION OF POLY HERBAL SHAMPOOS

S. No	Botanical Name	Common Name	Used Part of Plant	Used Form	Role for hair
1	*Berberis lycium*	Zirlargy	Wood	Powder	Yellow hair dye
2	*Grewia tenax*	Injare	Fruit	Powder	Anti-dandruff, Anti-lice action, Prevent hair fall, make hair silky and shining
3	*Phyllanthus emblica*	Amla	Fruit	Powder	Anti-dandruff agent and prevent hair loss
4	*Salvadora persica*	Jaal	Fruit	Powder	Anti-fungal and Anti-inflammatory
5	*Sapindus mukorossi*	Retha	Fruit	Powder	Detergent and antifungal

MATERIALS AND METHODS

Wood of*Berberis lycium* and fruits of two plants such as Grewia *tenax* and *Salvadora persica* were gained from the Surghar range area in district Karak. Fruits of *Phyllanthus emblica*, *Sapindus mukorossi* and a commercial shampoo Life Buoy (Unilliever, Pakistan Ltd.) were purchased from the local market of Kamar Mushani, District Mianwali, Punjab, Pakistan.

PREPARATION OF PLANT MATERIALS

Fruits of four plants such as*Grewia tenax*, *Phyllanthus emblica*, *Phyllanthus emblica*, *Salvadora persica* and *Sapindus mukorossi* as well as wood of *Berberis lycium* were grinded with the help of grinding machine in powder form. In addition to these plant materials, gelatin, distilled water, filter papers, weight balance, graduated cylinder, funnel, petri dishes, beaker, glass and plastic bottles, stop watch, china dishes were also utilized.

FORMULATION OF POLY HERBAL SHAMPOO

In this research, three formulas of poly herbal shampoo with different concentrations of five selected plants were prepared using a digital weight balance (Figures 1&2). The concentration of each formula was kept at 10.5 g (Table 2).

FORMULA 1

In formula 1, the concentration of *Sapindus mukorossi* seeds was 5g, *Salvadora persica* fruit was 2.5g, *Grewia tenax* fruit was 1.5 g, *Berberis lycium* wood powder was 1 g, and the concentration of *Phyllanthus emblica* fruit was 0.5 g.

FORMULA 2

In formula 2, the amount of *Sapindus mukorossi* seeds was 4 g, *Salvadora persica* fruit was 1.5g, *Grewia tenax* fruit was 2.5 g, *Berberis lycium* wood was 1 g, and the concentration of *Phyllanthus emblica* fruit was 1.5 g.

FORMULA 3

Similarly, formula 3 contained 3 g of *Sapindus mukorossi* seeds, 2 g of fruit of *Salvadora persica*, 2 g of *Grewia tenax* fruit, 1 g wood powder of *Berberis lycium*, and 2.5 g of *Phyllanthus emblica* fruit. The details of the different concentrations of the five plants in each of the three formulas are shown in Table 1.

FIGURE 1. THREE FORMULAS EACH WITH 10.5 G OF 5 SELECTED PLANTS FOR HERBAL SHAMPOO PREPARATION

FIGURE 2. PREPARED SHAMPOOS OF 3 DIFFERENT FORMULAS IN DIFFERENT GLASS BOTTLES

TABLE 2. THE THREE FORMULAS WITH DIFFERENT CONCENTRATIONS OF 5 SELECTED PLANTS FOR POLY- HERBAL SHAMPOO FORMULATIONS

S. No	Plant Name	Formula 1	Formula 2	Formula 3
1	*Sapindus mukorossi*	5g	4g	3g
2	*Salvadora persica*	2.5g	1.5g	2g
3	*Grewia tenax*	1.5g	2.5	2g
4	*Berberis lycium*	1g	1g	1g
5	*Phyllanthus emblica*	0.5g	1.5g	2.5g
Total amount of each formula		**10.5g**	**10.5g**	**10.5g**

After preparing three different formulas (10.5 g each) for poly herbal shampoo formulations, each formula was treated with 100 mL of distilled water. The solutions were shaken for 48 hours, and then filtrations were done to obtain the filtrate using Whatman filter paper.

In parallel to this process, we used 10 g of gelatin powder (Figure 3) in 100 mL of hot distilled water in different bottles for the three formulas separately.

FIGURE 3. TAKING 10 G OF GELATIN POWDER FOR POLY HERBAL SHAMPOO FORMULATION

In the next step, we mixed the gelatin solution (Figure 4) with each of the filtrates obtained from the three formulas (Figure 5). This was our target poly herbal shampoo (Figure 6). Furthermore, this poly herbal shampoo were also be evaluated for its antidandruff, antibacterial, antioxidant, total phenolic contents, phytochemical composition, and physiochemical analysis using standard scientific procedure.

FIGURE 4. THREE GELATINS AND POLY HERBAL SOLUTIONS IN SIX BOTTLES

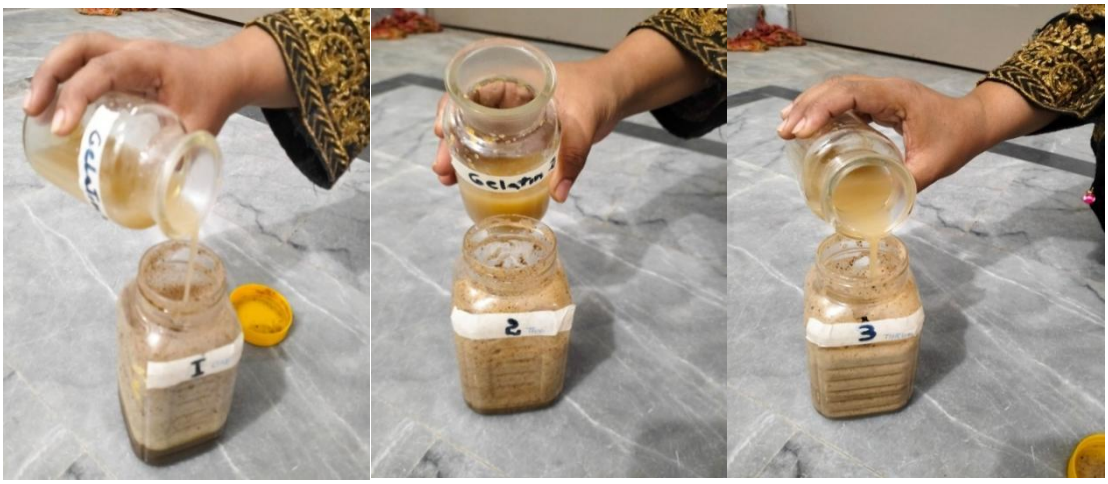

FIGURE 5. MIXING GELATIN WITH THREE HERBAL FORMULAS SOLUTIONS

FIGURE 6. FINAL FORMULATED THREE POLY HERBAL SHAMPOOS

EVALUATION PARAMETERS OF POLY HERBAL SHAMPOO

We evaluated different features of our 3 formulas of poly herbal shampoo.

ORGANOLEPTIC PROPERTIES OF POLY HERBAL SHAMPOO

Organoleptic Properties such as color, odor, texture and taste of 3 different formula of poly herbal shampoo were evaluated (Saripalla *et al.*, 2022).

SKIN IRRITATION TEST

Skin irritation test was done by applying the prepared poly herbal shampoo on arm skin of volunteers and exposed them for 5 minutes under sun light (Figure 7) and observed any irritation such as swelling, itchiness and redness on skin (Kose *et al.*, 2018).

FIGURE 7. SKIN IRRITATION TEST OF THREE FORMULA OF POLY HERBAL SHAMPOOS ON SKIN OF 6 VOLUNTEERS

WET TIME TEST

Canvas papers were cut into 2 different sizes such as 2 and 4 sq.cm. They were used to determine the wet time of 3 poly herbal shampoos respectively. In petri dishes, shampoo was applied and canvas papers were placed on it (Figure 8). Wet time for both sizes of canvas papers was determined with the help of stop watch (Al Badi and Khan, 2014).

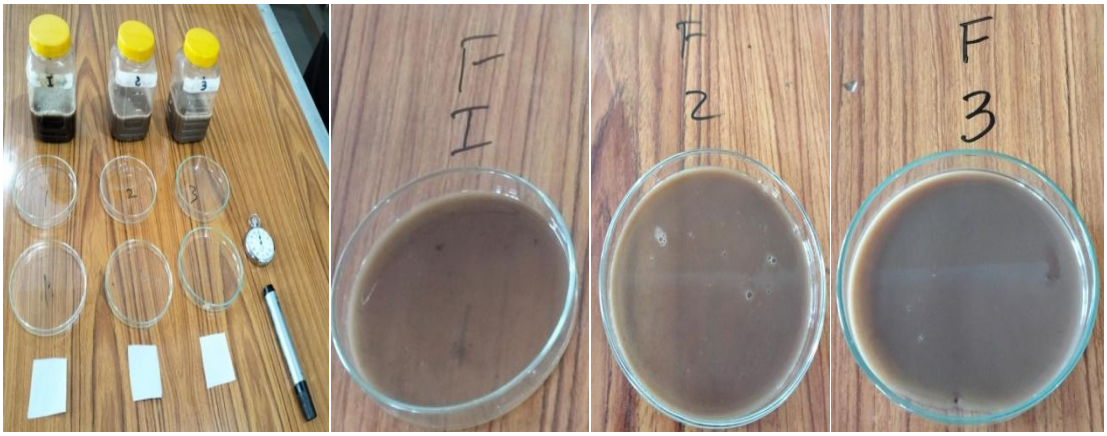

FIGURE 8. APPARATUS FOR WET TIME TEST OF POLY HERBAL SHAMPOOS

EVALUATION OF SOLID CONTENTS

Firstly tyred the weight balance then checked the weight of china dish. After it, put the 5g of poly herbal shampoo in china dish. China dish along with applied shampoo checked for combined weight. These dishes were kept at hot site for evaporation. After evaporation, solid content weight was determined. These steps were performed for 3 samples separately (Kumar and Mali, 2010).

FOAMING ABILITY/ STABILITY TEST

Cylinder shake method was applied to determine the foam ability and stability of poly herbal shampoos (Figure 9). Put the 50 mL poly herbal shampoo in a 100 mL graduated cylinder and

then shake it for ten times by covering it with hand. After shaking, noted the foam ability of shampoo in graduated cylinder. Shampoo foam stability was observed after zero, one and four minutes with the help of stop watch respectively for each prepared poly herbal shampoo (Fazlolahzadeh and Masoudi, 2015).

FIGURE 9. APPARATUS FOR CYLINDER SHAKE METHOD FOR FORMULATED POLY HERBAL SHAMPOOS

COMBING TEST

This method used to determine the easiness of combing after using poly herbal shampoo. 10 mL of poly herbal shampoo was used for washing the hair. After washing, dried the hair and evaluated the easiness of combing. This practice was evaluated for all the three prepared poly herbal shampoo (Kengar *et al*., 2018).

CONDITIONING TEST

Human hairs were cut into 6 rolls each with 5 cm length and 2 g weight. One pack was remained unwashed used as control sample. Out of 5, one pack was washed with 15 mL of water in petri dish for approximately 2 minutes. Remaining three packs were treated individually with 15 mL of commercial shampoo Life Buoy, 15 mL Formula 1, 15 mL Formula 2 and 15 mL Formula 3 separate petri dishes respectively. After washing, each washed pack was kept for drying in room temperature (Figure 10). Blind touch test was conducted to determine the softness and smooth characteristics of poly herbal shampoo as compared to unwashed sample, water washed and Life Buoy treated hair packs. Blind touch test was arranged by using 12 volunteers' students. Students were advised to touch the all washed 6 packs of hair and told us about the conditioning performance of these samples in categories such as poor, satisfactory, good and excellence

(Boonme *et al.*, 2011).

FIGURE 10. CONDITIONING TEST APPARATUS FOR THE DETERMINATION OF POLY HERBAL SHAMPOOS

DIRT DISPERSION TEST

5 mL of poly herbal shampoo was taken in test tube along with distilled water (10 mL). After it, 1 drop of Indian ink was poured in that test tube. Shacked the test tube for for 10 minutes (Figure 11). Four different indicators such as none, light, moderate and heavy were used for identification of ink in the solution (Al Badi and Khan, 2014).

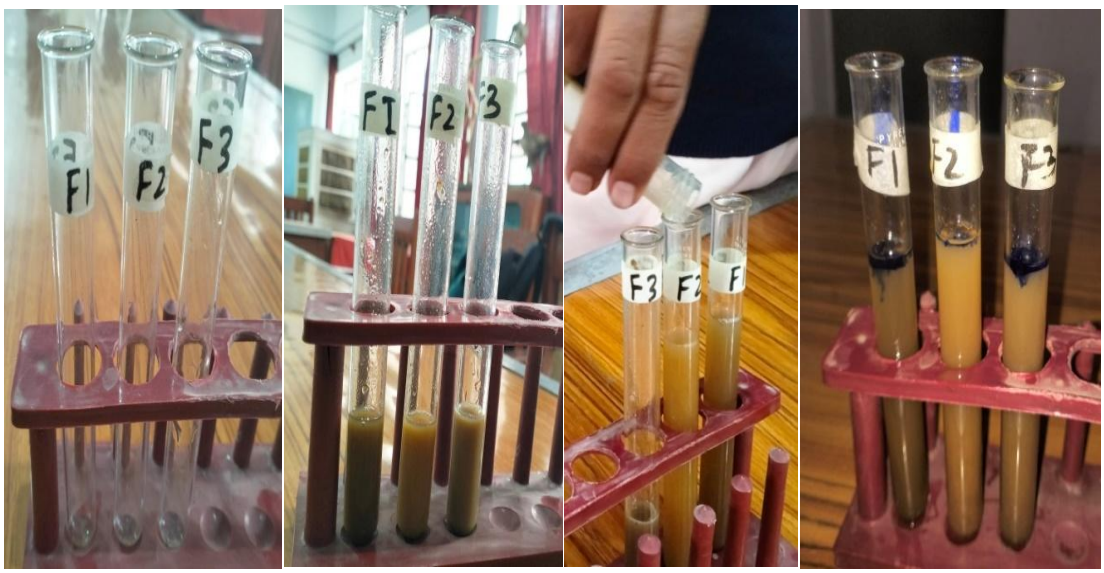

FIGURE 11. DIRT DISPERSION TEST FOR THREE FORMULATED POLY HERBAL SHAMPOOS

PH TEST

Poly herbal shampoos pH was evaluated by using pH meter. We took I g of each our formulated poly herbal shampoo in 10 ml of water and checked pH with the help of pH meter (Tarun *et al.*, 2014).

PHARMACOLOGICAL EVALUATION OF POLY HERBAL SHAMPOO

Three pharmacological activities such as antimicrobial, phenol and antioxidants were performed for all the three prepared poly herbal shampoos.

PHENOLICS CONTENT

One mL of methanol extract was poured in one mL of Folin-Ciocalteu phenol reagent. After 3 minutes, sample was mixed with 10 mL sodium carbonate solution. After that, (13 mL of distilled water was added in it. Prepared mixtures were kept for 1 hour and 30 minutes minutes in room temperature. All samples absorbance values were measured at 750 nm by using spectrophotometer (Kim *et al.*, 2003).

ANTIOXIDANTS CONTENT

Antioxidant potential of prepared shampoos was assessed by 2, 2-diphenyl-1 picrylhydrazyl (DPPH) assay (Brand-Williams *et al.*, 1995). All the three mixtures were placed in dark for 15 minutes. Absorbance of all the three samples was measured at 517 nm with the help of spectrophotometer.

ANTIMICROBIAL ACTIVITY

Antifungal activity of prepared shampoos was evaluated by using 10% KOH preparation and 10% Dimethyl Sulphoxide 40% in equal amount (Shalaby *et al.*, (2016), Yadav *et al.*, (2024), Singh *et al.*, (2009).

RESULTS AND DISCUSSION

The trend of world cosmetic market is now shifting towards plant based hair preparations. There is a very wide variety of synthetic shampoos available in the market, but these commercial shampoos demonstrate damaging influence on the hair health (Dubey *et al.*, 2004).

A recent study found that the three formulas of poly herbal shampoos prepared by using varying concentration of five important plants such as *Sapindus mukorossi*, *Salvadora persica*, *Grewia tenax*, *Berberis lycium*, and *Phyllanthus emblica* put very positive effects on hair growth and disorders parallel to the commercially used Life Buoy shampoo.

Different parameters that considered as standard for determining the quality of shampoo such as, organoleptic properties, skin irritation test, wet time test, evaluation of solid contents, foaming ability/ stability test, conditioning test, combing test, dirt dispersion test, pH test, total phenolic contents, antioxidant activities, anti-microbial activity(anti-fungal activity) were evaluated and obtained good results.

Wongrakpanich *et al.*, (2022), Wu *et al.*, (2021), Patel *et al.*, (2015), Goel *et al.*,(2022), Mulani *et al.*, (2021), Jaiswal *et al.*, (2024), Nooreen *et al.*, (2024), Shaheen *et al.*, (2014), Al-Fatimi (2024), Ghazanfar and Shahina, (1998), Bakr *et al.*, (2019), Gawshinde *et al.*, (2021) also worked on poly herbal shampoo formulation and gave parallel findings.

ORGANOLEPTIC PROPERTIES

Organoleptic properties were evaluated by using two senses such as vision and touch. Four parameters such as color, odor, texture and taste of the three prepared poly herbal shampoos. Results revealed that color of Formula 1 were dark brown (Patel *et al.*, 2022) while formula 2 retained medium brown color. Formula 3 was found to have light brown color (Figure 12). Odor of all the three prepared shampoo was tamarind like. Similarly texture was observed liquid in all the 3 samples. And taste was found bitter in all the three formulated shampoos (Table 3). There were not any major differences among the all formulated shampoos. Dubey *et al.*, (2023) and Namita (2013) also worked on organoleptic properties of poly herbal shampoo and gave similar findings about the color of poly herbal shampoo.

TABLE 3. ORGANOLEPTIC PROPERTIES OF THREE FORMULATED SHAMPOOS

Sr. No	Formula	Color	Odor	Texture	Taste
1	1	Dark Brown	Tamarind like	Smooth Liquid	Bitter
2	2	Medium Brown	Tamarind like	Smooth Liquid	More Bitter
3	3	Medium Brown	Tamarind like	Smooth Liquid	More Bitter

FIGURE 12. COLORS OF THREE FORMULATED POLY HERBAL SHAMPOOS

SKIN IRRITATION TEST

Poly herbal shampoos were applied on the skin of 9 volunteers for five minutes under sun light. All the 3 formulas were found safe because no any shampoo caused any irritation like swelling, redness and itching on volunteers' skin (Table 4). Mushtaq and Zaman (2022) also gave similar findings about skin irritation test in their poly herbal shampoo formulation.

TABLE 4. SKIN IRRITATION TEST OF THREE POLY HERBAL SHAMPOOS

Sr. No	Formula	Time	Irritation
1	1	5 minutes	No any irritation was observed
2	2	5 minutes	No any irritation was observed
3	3	5 minutes	No any irritation was observed

EVALUATION OF SOLID CONTENT

Firstly measured the weight of china dish then put the 5g shampoo in it again measured the weight of china dish and shampoo. After it, placed the china dish at hot place for the process of evaporation. Results revealed that value of solid content in our formulated three formulas were 4.25 g, 4.32 g and 4.29 g respectively. Maximum value of solid content was found in formula 2 (4.32 g), secondly in formula 3 (4.29 g) and thirdly in formula 1 (4.25 g) (Table 5 & Figures 13, 14, 15, 16). Vidhate and Pallavi (2023) formulated poly herbal shampoo and worked on solid content evaluation. Thy also supported our results about the evaluation of solid content.

TABLE 5. EVALUATION OF SOLID CONTENT OF FORMULATED THREE SHAMPOOS

Sr. No	Formula	China Dish Weight	Shampoo Weight	Total Weight	After Evaporation Weight	Total solid Content
1	1	39.25 g	5 g	44.25 g	40 g	4.25 g
2	2	31.78 g	5 g	36.78 g	32.46 g	4.32 g
3	3	33.85 g	5 g	38.85 g	34.56 g	4.29 g

FIGURE 13. DETERMINATION OF SOLID CONTENTS IN FORMULA 1

FIGURE 14. DETERMINATION OF SOLID CONTENTS IN FORMULA 2

FIGURE 15. DETERMINATION OF SOLID CONTENTS IN FORMULA 3

FIGURE 16. AFTER EVAPORATION, TOTAL SOLID CONTENTS OF ALL THREE FORMULATED SHAMPOOS

WET TEST

Wet time of two different sizes of canvas papers was determined for the three prepared poly herbal shampoos. Wet time of 4 sq. cm papers was 50 second and for 2 sq.cm was 20 seconds. For formula 2, wet time was 54 and 24 seconds for 4 and 2 sq.cm canvas papers respectively. Fifty seven seconds and twenty six seconds were recorded for canvas papers in formula 3. So, according to the results, formula 1 was found more effective with less wet time. Secondly, Poly herbal shampoo 2 and thirdly F3 was with less wet time (Table 6 & 7) (Figure 17). Hanwate *et al*., (2023) findings about wet time was also identical to our evaluation results.

TABLE 6. WET TIME FOR CANVAS PAPERS (4 SQ. CM) THREE PREPARED POLY HERBAL SHAMPOO

Sr. No	Formula	Canvas Paper Size	Wet Time (second)
1	1	4 square.cm	50±1.67 c
2	2	4 square.cm	54± 2.58 b
3	3	4 square.cm	57±1.63 a

TABLE 7. WET TIME FOR CANVAS PAPERS (2SQ.CM) THREE PREPARED POLY HERBAL SHAMPOO

Sr. No	Formula	Canvas Paper Size	Wet Time (second)
1	1	2 square.cm	20±0.94 c
2	2	2 square.cm	24±0.38 b
3	3	2 square.cm	26±1.08 a

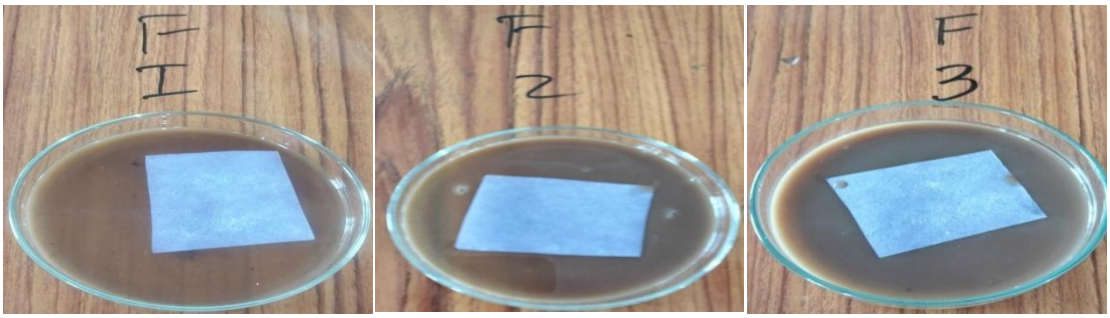

FIGURE 17. WET TIME TEST FOR THE THREE FORMULATED SHAMPOOS

FOAM ABILITY/ STABILITY

Foaming is a very important feature and considered as an important parameters for the

evaluation of a shampoo. Cylinder shake method was used for the determination of foam ability and stability of our formulated three poly herbal shampoos. Poured the 50 mL of poly herbal shampoo in a 100 mL graduated cylinder and then shake it for ten times by covering it with hand. After shaking, noted the foam ability of shampoo. Results demonstrated that maximum foam ability was found in F1 (70 mL), secondly in F2 (68 mL) and thirdly in F3 (65mL). Foam stability was observed after zero, one and four minutes with the help of stop. Foam stability was found maximum in F3 with 63 mL (1 minute) and 61mL (4 minutes). F1 was observed on second number regarding the foam stability. After 1 and 4 minutes its volume was 67 mL and 65 mL respectively (Table 8). Pant *et al.*, (2023) formulated poly herbal shampoo and evaluated foam ability and stability and gave similar observation.

TABLE 8. FOAM ABILITY AND STABILITY OF THREE FOR FORMULATED SHAMPOOS

Sr. No	Formula	Volume taken in graduated cylinder (before shaken)	Volume after 10 times shaken in graduated cylinder (mL)	Volume after zero minute (mL)	Volume after 1 minute (mL)	Volume after 4 minutes (mL)
1	1	50 mL	70±0.34 a	70±0.67 a	67±0.45a	65±0.24a
2	2	50 mL	68± 0.53 ab	68±0.46 ab	64±1.36a	62±0.19b
3	3	50 mL	65±0.36 b	65±0.45 b	63±0.56a	61±0.15b

COMBING TEST

During combing test 10 mL of each formulated poly herbal shampoo was applied for washing the hair. After it, dried the hair and evaluated the easiness of combing. Results showed that combing was easy in all the hair that were washed with three different poly herbal shampoo, but observation indicated that combing was very easy for those hair that were washed with F1 shampoo as compared to F2 and F3 (Table 9). Vidhate and Pallavi (2023) synthesized poly herbal shampoo and evaluated different features. Their results were also parallel to our findings.

TABLE 9. COMBING TEST BY USING THREE DIFFERENT POLY HERBAL SHAMPOOS

Sr. No	Formula	Volume of shampoo applied on hair	Combing
1	1	10 mL	Very easy
2	2	10 mL	Easy
3	3	10 mL	Easy

DIRT DISPERSION TEST

Dirt dispersion is also an important parameter for the determination of cleaning ability of shampoo. The shampoo that concentrate the ink in foam is considered poor in quality and that disperse the ink in water part is considered effective. Findings of this activity demonstrated that F1 and F2 were with light rubric while F3 was with darker color (Table 10 & Figure 18). Patel *et al.*, (2022) worked on the formulation and evaluation of poly herbal anti-dandruff shampoo and its marketed comparison and supported our finding regarding dirt dispersion analysis.

TABLE 10. DIRT DISPERSION TEST OF THREE FORMULATED POLY HERBAL SHAMPOOS

Sr. No	Formula	Drops of shampoo used	Drops of ink used	Amount of distilled water	Rubric
1	1	2	1	10 mL	Light
2	2	2	1	10 mL	Light
3	3	2	1	10 mL	Dark

FIGURE 18. FINAL RUBRICS OF DIRT DISPERSION TEST FOR THE THREE FORMULATED SHAMPOOS

CONDITIONING TEST

A blind touch test of 12 volunteers' was conducted to determine the softness and fairness power

of the poly herbal shampoos as compared to unwashed, water and Life Buoy treated hair packs. According to volunteer's findings, formula 1 was parallel to commercially used shampoo Life Buoy and both of these were categorized as excellent. F2 and F3 were classified in good category. Hair pack that was washed with water was given the poor status (Table 11). Zambare *et al.*, (2019) and Tegeli *et al.*, (2022) results also supported our conclusions regarding the conditioning analysis of our formulated poly herbal shampoos.

TABLE 11. CONDITIONING TEST OF POLY HERBAL SHAMPOOS

Sr. No	Sample	Poor	Satisfactory	Good	Excellent
1	Unwashed	✓			
2	Washed with water		✓		
3	Washed with life Buoy shampoo				✓
4	Washed with F-1				✓
5	Washed with F-2			✓	
6	Washed with F-3			✓	

PH TEST

Shampoos with neutral or alkaline pH are considered safer for the health and growth of hair. pH meter was used to check the pH of our three formulated poly herbal shampoo. 1g of our each sample was taken in 100 mL of distilled water and pH was recorded. pH ranged from 4.02 to 4.11 in our formulated shampoos.pH of Formula 1 was recorded as 4.04±0.06 a, pH of F2 was 4.11±0.09 a and F3 was4.02±0.08 a (Table 12 & Figure 19). Shampoos with acidic pH make the hair smoother. Madhusudhan *et al.*, (2021) formulated poly herbal shampoos and recorded pH ranged from 3.04 to 4.29 and supported our results of pH. Al Badi and Khan (2014) also evaluated pH test of their formulated shampoo and showed identical conclusions.

TABLE 12: PH TEST RESULTS OF DIFFERENT POLY HERBAL SHAMPOO

Poly herbal shampoo	pH value
F1	4.04±0.06 a
F2	4.11±0.09 a
F3	4.02±0.08 a

FIGURE 19. PH RESULTS OF THREE FORMULATED POLY HERBAL SHAMPOO

TOTAL PHENOLIC CONTENTS IN FORMULATED SHAMPOOS

Phenolics are natural plentiful antioxidants present in plants. Phenolics compounds are basically secondary metabolites and control the defense process of flora(Pratyusha, 2022). Phenolic analysis of formulated shampoos revealed that F1 was with greater phenolic contents (142 mg GAE eq. /mL shampoo), secondly high value was found in F2 (137 mg GAE eq. /mL shampoo). Phenolics content was lower in F3 shampoo (130 mg GAE eq. /mL shampoo) (Figure 20). Bakr *et al.*, (2019) also evaluated phenolic contents of their formulated shampoo and gave similar conclusions.

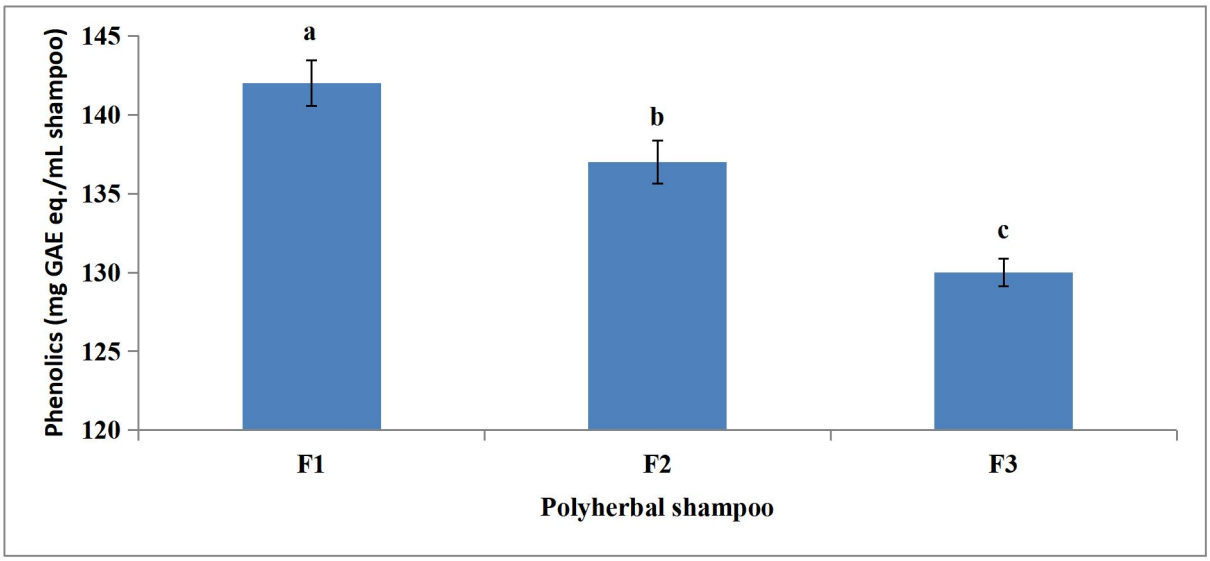

FIGURE 20. PHENOLICS CONTENT IN FORMULATED SHAMPOOS

ANTIOXIDANT CONTENTS IN FORMULATED SHAMPOOS

Antioxidants play very important part in healthy life of human by avoiding it from the prolonged disorders (Li *et al.*, 2016). The antioxidants content of our formulated three formulas of poly herbal shampoos were determined. Antioxidant analysis was performed by DPPH free radical scavenging activity. Results demonstrated that antioxidant contents were greater in FI (75%). F2 was reported with 59% and F3 was with 55% (Figure 21). Madhavan *et al.*, (2024) worked on shampoo formulation with antioxidant analysis and supported our findings about anti-oxidant content of formulated three poly herbal shampoos.

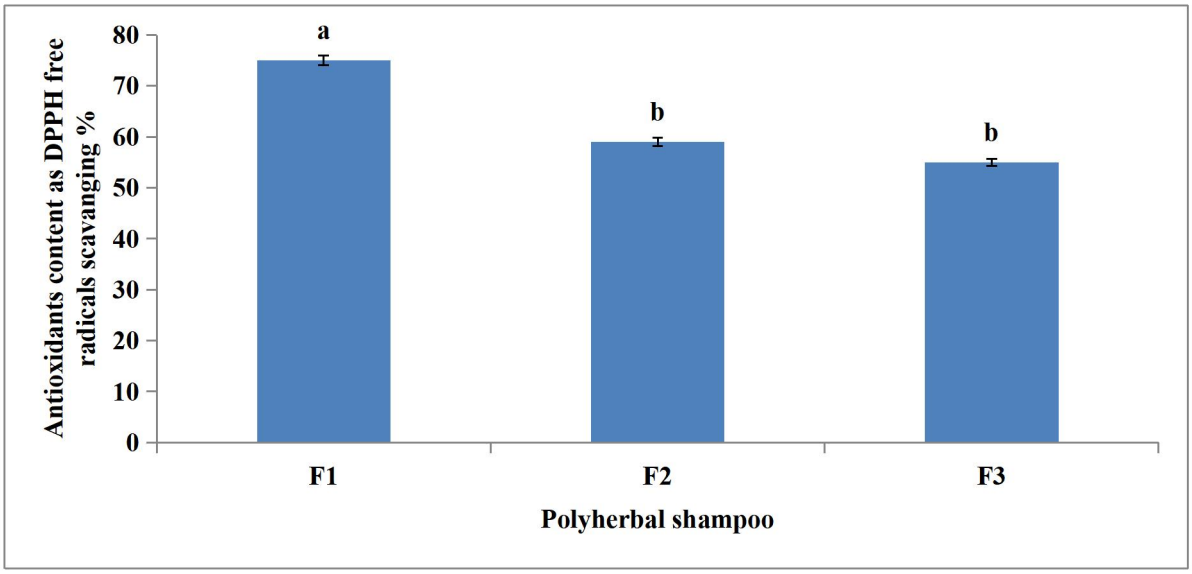

FIGURE 21. ANTIOXIDANT CONTENTS IN FORMULATED SHAMPOOS

ANTIFUNGAL ACTIVITY

Highest amount of Phenolics present in plants enables them to exhibit antimicrobial activity. Maximum anti-dandruff activity (68% inhibition of fungal growth) was shown by poly herbal shampoo formulation F1 which was followed by F3 showing 59% inhibition of fungal growth and then F2 showing 55% growth inhibition of fungi (Figure 22). (Shalaby *et al.*, (2016), Sharma *et al.*, (2023), Yadav *et al.*, (2024), Singh *et al.*, (2009), Al-Bayati and Sulaiman, (2008), Paliwal *et al.*, (2007) also worked on the antimicrobial potential of these plants and supported our investigations.

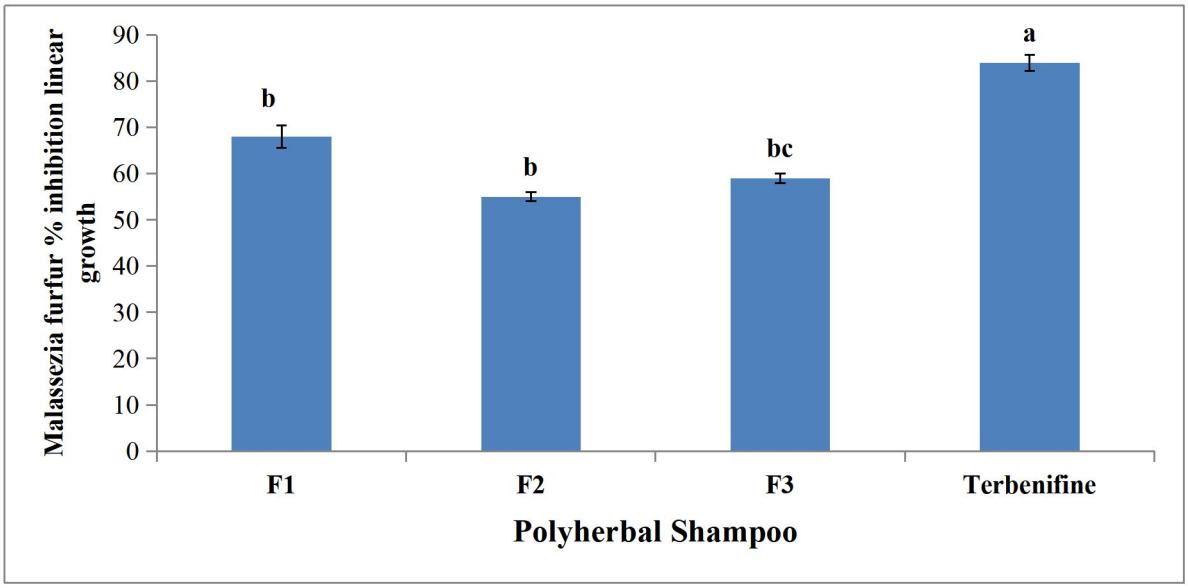

FIGURE 22. ANTI-DANDRUFF ACTIVITY OF POLY HERBAL SHAMPOO

CONCLUSIONS

This work revealed that the combination of five selected plants such as *Sapindus mukorossi*, *Salvadora persica*, *Grewia tenax*, *Berberis lycium* and *Phyllanthus emblica* for the formulation of natural poly herbal shampoo proved very effective and natural alternatives to synthetic hair care products that have many side effects.

Among the three prepared formulas of poly herbal shampoo, F1 was graded at first rank because it was nearly parallel to the commercially used Life Buoy shampoo in its performance. The results of Formula 2 and 3 were also found as satisfactory.

We evaluated the potential of selected plants phytochemicals for the preparation of effective and more economical poly herbal shampoo as compared to the synthetic shampoo.In addition, we also assessed the antioxidant, total phenolic contents and antimicrobial potential (antifungal potential) of these selected plants that were used for the formulations of three formulas of poly herbal shampoos.

CONFLICT OF INTEREST

No potential conflicts of interest are stated by the authors.

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