

Research Article

Formulation and Assessment of Effective Polyherbal Powder Shampoo in Comparison with Marketed Shampoos

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ABSTRACT

The present study was aimed toward formulation and assessment of polyherbal shampoo contains conventionally used plants in comparison with marketed shampoos. This powder shampoo was developed using regular ingredient which are conventionally used with well-trying effectuality of hair care. The physicochemical parameters include colour, clarity, pH, the percentage of solid contents, dirt dispersion, foaming ability & stability, wetting time, surface characterization analysis using scanning electron microscopy (SEM) were studied using standard protocols. The combination of outmoded ingredients has created it doable to secure extremely effective powder shampoo. The developed herbal shampoo was found to produce higher effectuality than available synthetic shampoos. Current scenario of life style and stress, wide gamut of skin and hair disorders are encountered. The present results which is able to positively provide better insight within the standardization and development of polyherbal powder shampoo with virtuous quality and purity.

Keywords: polyherbal, powder shampoo, evaluation, standardization. SEM

INTRODUCTION

Herbal cosmetics are becoming very famous throughout the world. Herbs play an exceptional role in beauty treatments and also in uplifting the overall health. Herbal products are extracts obtained from natural sources that may enhance your life time. Hair is the most important part that adds beauty to your appearance.^[1] In Hair care products shampooing is the best solution to clean your hair from various dirt particles that are muddy, greasy and oily containing sebum. In olden days nature is found to be the best therapist for any health issues.^[2] Natural products produced are now a days being replaced by chemical products that the society has started to realize. In the year of 1940, Stephanie Brooke Company belongs to New Jersey was the first company to develop 'Minipoo', the first commercial brand produced as dry powder shampoo. As of now there are many people in the world going through hair loss, baldness, hair damage etc. Choosing herbal shampoo and conditioner is one of the predominant ways to start up ancient remedies. Natural cosmetics have been formulated to overtake the chemical products as it contains harmful agents that not only leads to hair loss, skin damage but, also pollutes environment. Several chemicals in

synthetic shampoos like sodium lauryl sulphate, parabens, Diethanolamine etc.^[3] Using cosmetics like shampoo that contain harmful chemicals can lead to several consequences leading to eye irritation, skin irritation, hair fall, rashes in scalp and skin. The beneficial effect of good shampoo is found in its ability to protect hair color, prevent hair fall, thickening hair follicles and by acting as a conditioning agent. Exemplary characters of shampoo include, a) It should make hair smooth and silky, b) It should remove dust and oil, c) It should not cause itching of scalp and irritation, d) It should not make hair dry and rough, e) It should reduce dandruff and should have a pleasant smell.^[4] Currently natural products are alluring over synthetic products. In present study herbal shampoo powder is formulated using 20 natural herbs and evaluation parameters are carried out to produce a cost effective and user-friendly shampoo.

MATERIALS AND METHODS

Collection of raw materials:

Our desired herbal plants were collected from natural gardens and some of them were obtained from Coimbatore local market. The raw materials used for formulation is shown in Table.1 and Figure.1. After that they have washed and

cleaned in order to prevent the deterioration of phyto-chemicals present in those plants. The advantage of herbal plants is that they will not contain any herbicides, pesticides and insecticides^[5] Then the herbal plants were washed in double distilled water and kept at 37°C until completely dried. The dried herbal plant materials were grounded into powder in an electric blender and stored in aseptic plant bags at 3°C to 4°C for further research analysis.

Evaluation Parameters:

Organoleptic studies:

This study was performed via taking the samples for the parameters like color, odor, froth, taste and texture. Generally shampoo powder characteristics included particle size, bulk density, tapped density and angle of repose, which can affect other external properties like flow property, etc. so they were observed.^[6]

Determination of pH:

The pH of the synthetic shampoo and the formulated shampoo powder was determined.^[7]

Determine percent of solids contents:

4 grams of shampoo added to the clean dry petriplate which was already weighed separately. Then petriplate with shampoo was weighed. The exact weight of the shampoo was calculated by the evaporation process i.e.), the plate with shampoo was placed on the hot plate. The weight of the solid shampoo was calculated after drying.

Dirt dispersion test:

Put three drops of formulated shampoo in a large test tube. Add 10 to 15ml of distilled water and 1 drop of Indian ink. Stopper the test tube and shake it for 15 times. Estimate the amount of ink in the foam as None, Light, Moderate, or Heavy and record. We already have known that shampoos that cause the ink to concentrate in the foam are considered as poor quality. So the dirt should stay in the foam. Dirt that stays in the water portion will be difficult to rinse away. It will redeposit on the hair.^[8]

Wetting time:

The canvas was cut into discs approximately of 0.44 g. The disc was allowed to float on the surface of shampoo solution of 1% w/v and the stopwatch started. The wetting time was calculated by the time taken for the disc to begin to sink in the shampoo solution.^[9]

Cleaning action:

By using non-absorbent cotton 1 gram of grease or vaseline is taken by wiped and placed inside the flask (conical) containing 1% shampoo solution. Then conical flask is kept for 1 hour in mechanical shaker. After 1 hour, the solution was removed and the cotton is taken out, dried, and weighed. The amount of grease or vaseline

removed was calculated by using the following equation: $DP = 100 (1-T/C)$, where, DP - Percentage of detergency power, T - Weight of grease in test sample, C - Weight of grease in control sample.^[9]

Foaming ability:

This was performed by using cylinder shake method. In a 250 ml graduated cylinder, 50 ml of the 1% shampoo solution was prepared and covered with hand and shaken for 10 to 15 times. After 1 minute of continuous shaking the total volumes of the foam which have contents were recorded. Only the foam volume was calculated. Immediately after shaking the volume of foam at 1 minute intervals for 4 minutes were recorded.^[10]

Surface characterization:

Morphology of the hair surface was examined by using Scanning Electron Microscopy (SEM). By using double side stitching tape, the hair samples were mounted directly on the SEM sample stub. For surface characterization the suitable magnification photomicrographs were obtained. The following hair samples were used for surface characterization: Sample 1 served as untreated hair sample, Sample 2 is hair sample treated with shampoo A, Sample 3 is hair sample treated with shampoo B, and Sample 4 is hair sample treated with herbal shampoo.

Antimicrobial activity:

The antimicrobial activity of the plant extracts was evaluated using the agar well diffusion method and compared with the optimized herbal shampoo powder formulation against the following pathogenic microorganisms: *Staphylococcus aureus*, *Streptococcus* spp., (gram-positive bacteria) and *Proteus* spp., *Klebsiella pneumoniae* (gram-negative bacteria). The antimicrobial activity was performed using a culture grown at 37°C for 24 hours. Fifteen milliliters of nutrient agar for bacteria were poured into sterile petri dishes and allowed to solidify. Then, in the agar plates wells were made using sterile cork pores that were 5 mm in diameter. Two hundred microliters of the suspensions were spread over the agar plates using a sterile glass spreader or cotton buds. Our sample was dissolved in 1 mL of Di Methyl Sulfoxide (DMSO) and then, 100 µL to 400 µL of sample was added to the appropriate wells in the petri dishes separately. Chloramphenicol (200 µg) was used as a standard drug for bacteria. The experiment was carried out in triplicate, and the average zone of inhibition was calculated.^[11]

Estimation of mineral content:

The mineral content was determined by using wet digestion method where the sample was digested by concentrated sulfuric acid with the help of a

digestion catalyst (a mixture of copper sulfate and anhydrous sodium sulfate, 1:10). The resulting solution was then measured using an atomic absorption spectrophotometer. [12]

Gas chromatography–Mass Spectrometry (GC–MS): For GC-MS analysis, the samples were injected into an Rxi2@/MS column (30 m X 0.25 mm i.d with 0.25 µm film thickness), GEMS QP 2010 plus GC-MS model. Following chromatographic conditions were used: Helium as carrier gas, total flow rate of 14.4 mL/min; and the injector was operated at 280°C and column oven temperature was programmed as 70-280°C at a split injection mode. Following MS conditions were used: ionization voltage of 70 eV; ion source temperature of 200°C; interface temperature of 250°C; mass range of 40-800 mass units. [13]

Ease of distribution: The time taken to complete the distribution was measured by 5ml of the formulation was applied over the wet hair. **Ease of rinsing:** Ease of rinsing was performed by applying 5 ml of the shampoo and the time taken to remove the detergent and also time taken for complete removal of frothing from wash water was determined. **Ease of combing (Wet):** It was done over the wet hair by passing a comb and

checking whether the comb glides gently or not. **Speed of Drying:** It was done by applying 5ml of the shampoo in hair and dried after washing. The drying of hair was performed by using a table fan with constant speed and distance from the subject. **Ease of Combing (Dry):** It was done over the dry hair by passing a comb and checking whether the comb glides gently or not. **Nature of hair after wash:** It was performed by applying a small quantity of the formulated shampoo on hair, washed and then observed. [14, 23]

Statistical analysis:

Observed values are represented as mean of at least three independent replicates and the results are expressed as Mean±SD (± Standard Deviation).

RESULTS AND DISCUSSION

Organoleptic evaluation:

The polyherbal powder shampoo formulation were represented in Table.1 and Figure.1 The results of visual inspection for herbal shampoo powder were observed for odour, colour and taste and in terms of their flow property, appearance and texture. They are somewhat shows distinct change in colour.



Fig.1: Plants used to formulate the polyherbal powder shampoo. (Source: Google Images)

Table 1: List of plants used in formulation of polyherbal shampoo powder

S.No	Scientific name	Common name	Uses
1.	Trigonella foenum-graceum	Fenugreek	Used for its cleaning and softening activity.
2.	Hibiscus rosa-sinensis	Hibiscus	Conditioning agent.
3.	Lawsonia inermis	Henna	Hair coloring and hair growth promoter.
4.	Citrus limon	Lemon	Antidandruff, natural cleanser, pH modifier.
5.	Chrysopogon zizanioides	Vetiver	Coolant and anti-bacterial agent.
6.	Indigofera tinctoria	Neeliamari	Used to promote hair growth.
7.	Withania somnifera	Aswagandha	Improve circulation of the scalp.
8.	Acacia concinna	Shikkakai	Detergent.

9.	Eclipta prostrata	Karisalaankanni	Used as a natural hair dye.
10.	Ocimum sanctum	Holy basil	Antimicrobial agent.
11.	Phyllanthus emblica	Amla	Strengthen hair, antidandruff agent, promotion of hair growth
12.	Bacopa monnieri	Brahmi	Support hair growth.
13.	Phyla nodiflora	Poduthalaipodi	Reduces dandruff.
14.	Senna auriculata	Avarampoo	Antibacterial and anti-inflammation.
15.	Nigella sativa	Black cumin	Provides nourishment and thicker the hair.
16.	Psoralin corrylifolia	Kaarbogaarisi	Act as scalp disinfectant.
17.	Aloe vera	Kathalai	Moisturizer and anti-irritant.
18.	Sapindus mukorossi	Reetha	Cleanser, insecticide (lice) and surfactant.
19.	Prunus dulcis	Almond	Strengthen the hair strands.
20.	Rosa indica	Rose	Provides perfumery

Determination of pH:

Most significant effect of shampoo depends on its pH balance. At low pH the hair cuticles are well sealed so, that the hair is stronger and helps in fighting against bacteria and fungi. Table 2, clearly gives the pH of shampoo is slightly acidic and ranges from 4.95 to 5.95.^[15]

Solid content test:

A Shampoo is said to be perfect when it has less solid content. High solid content is not favorable as it becomes difficult to wash away and sticks to the hair. Table 2, clearly shows that all the three shampoos have less solid content.^[16]

Table 2: Evaluation of pH, percent solid content, dirt dispersion, wetting time and cleaning action:

Sample	pH	Percent of solid content (gm.)	Dirt dispersion (presence of ink in foam)	Wetting time (sec)	Cleaning action
Shampoo A	4.9±0.02	0.88±0.02	Light	10±1.0	16.25±0.05
Shampoo B	5.6±0.03	0.95±0.05	Light	15±2.25	14.88±0.04
Herbal shampoo	5.9±0.03	0.48±0.07	Light	16±1.4	14.25±0.02

Dirt dispersion test:

Dirt dispersion is one of the most important criteria for a good shampoo. Shampoos that cause the ink to concentrate in foam are said to be of low quality. Ink should stay in water otherwise it becomes difficult to rinse and dirt gets deposited in the hair. Table 2, clearly shows that the concentration of ink in foam in all the three shampoos is light.^[17]

Wetting time:

Wetting ability of a surfactant defines the efficiency of the shampoo to clean the hair in short time. Table 2, clearly give the picture about the wetting time of all three shampoos are minimum and there is minimal variation in the timings when compared with^[18] studies reported by (Draves et al., 1931) and all the three are of good standard.

Cleaning action test:

In this the efficacy of shampoo to remove grease from non-adsorbent cotton was observed as shown in Table.2. Percentage of cleaning action was found out in comparison with synthetic shampoos. The overall action behind enhanced cleansing property was due to presence of reetha and shikakai.^[19]

Foaming ability test:

Though foaming does not decide the cleaning property of a shampoo. Frothing is of supreme importance for customers and therefore adds value in judging a product. The results were calculated at a time interval of 0, 5, 10, 15minutes. It was found that, the polyherbal powder shampoo had less foam when compared to other two shampoos as shown in Table.3.^[20]

Table 3: Foaming ability test:

Time (mins)	Shampoo A (ml)	Shampoo B (ml)	Polyherbal Powder Shampoo (ml)
0	198±1.82	223±0.5	124±0.7
5	64.2±0.72	69.8±1.8	65.2±0.2
10	32.5±0.84	34.5±0.8	31.4±0.2
15	20.5±0.66	15.8±0.8	10.1±0.3

Surface characterization using SEM analysis:

Figure.2 shows Scanning Electron Microscope (SEM) micrographs of different hair samples analysed. (A) Untreated hair with sebum. (B) Hair with sebum washed with commercial shampoo-A. (C) Hair with sebum washed with commercial shampoo-B. (D) Hair with sebum washed with polyherbal shampoo. Hair washed with polyherbal shampoo powder shown better results

when compare with the other shampoo used in the present study indicates its proven efficacy of the formulated polyherbal powder shampoo. The untreated hair shown normal architecture, and other two commercial shampoo shown moderate cleaning efficacy. Hairs treated with our polyherbal shampoo powder shown strong condition effect and hair scale edges were regularly oriented and flat in architecture.

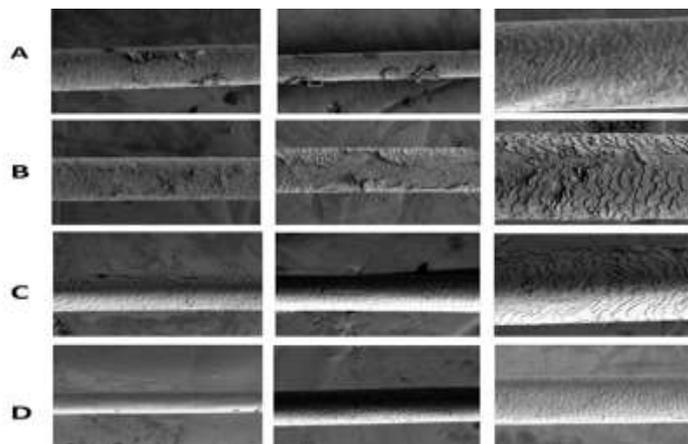


Fig.2: Scanning Electron Microscope (SEM) micrographs of different hair samples analysed.

Antimicrobial activity:

The extracts were screened for potential antimicrobial activity by measuring the Inhibition Zone (IZ) in millimetre (mm) against gram-positive and gram-negative bacteria. The data presented in Table 4, clearly showed the mean diameters of the IZs in mm of our herbal

shampoo powder against all the tested pathogens. Our sample exhibited the significant activity, which was comparable with that of the standard chloramphenicol, against *S. aureus* and *K. pneumoniae* whereas it showed moderate activity against *Streptococcus* spp. In addition, it exhibited weak activity against *Proteus* spp.

Table 4: Antimicrobial activity of the polyherbal shampoo powder expressed as the mean diameters of the inhibition zones (mm):

Pathogens	Herbal shampoo (100µl)	Herbal shampoo (200µl)	Herbal shampoo (300µl)	Herbal shampoo (400µl)	Chloramphenicol Standard drug (200µl)
Gram Positive					
Staphylococcus aureus	11±1.8	14±1.3	22±0.9	28±2.8	35±2.7
Streptococcus spp.	07±1.1	09±1.4	9.1±1.8	13±1.2	29±1.1
Gram Negative					
Proteus spp.	05±0.7	08±1.1	10±1.2	11±1.6	31±1.8
Klebsiella pneumoniae	13±0.9	18±2.8	23±0.7	28±1.2	30±2.2

Data are expressed as the mean zone of inhibition as Mean±SD.

Estimation of mineral content:

Minerals play an important role in hair health and so it has a vital importance in hair care product formulations. The mineral content in our polyherbal shampoo powder (shown in Table 5) had high levels of iron, zinc, copper and manganese. Iron and manganese is essential for

the production of natural antioxidant enzymes which have the capability to act against free radicals that promote thinning hair. Zinc is an important mineral for healthy hair, skin, and nails. Topical anti-aging compounds of interest in recent research include mineral such as copper, manganese, and zinc. [21]

Table 5: Mineral content of the polyherbal shampoo powder

Minerals (%)	Cu	Zn	Fe	K	Ca	Mg
Herbal shampoo	0.20	0.27	0.93	0.18	0.23	0.19

Content were analysed using an atomic absorption spectrophotometer and represented as in percentage value

GC-MS analysis:

GC-MS analysis was carried out for the methanolic extract of our sample and the eluted compounds were showed in Table 6 and Figure.3. Many acid compounds such as fatty acids that occurs naturally in various plants,

vegetable fats and oils has been observed. The presence of several compounds indicated in the Table.6 may be responsible for good growth of hair. Further research is needed to prove the efficacy of the compounds reported in GC-MS.

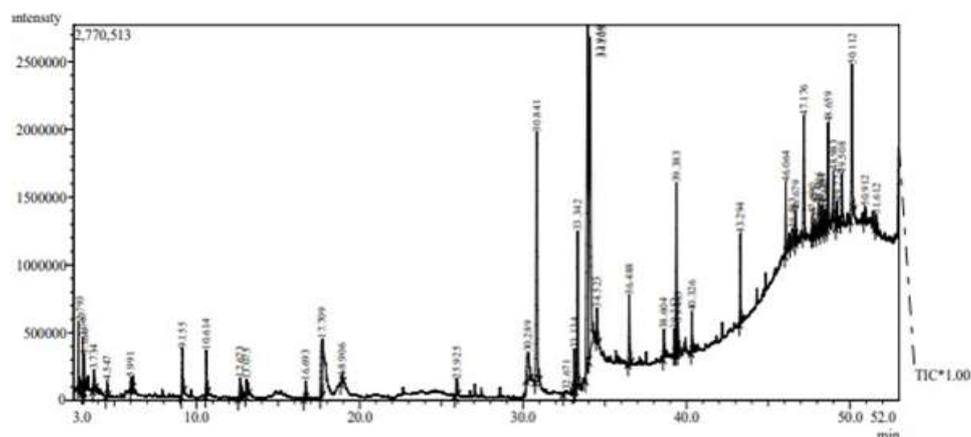


Fig.3: GC-MS Chromatogram of formulated polyherbal powder shampoo.

Table 6: GC-MS analysis of methanol extract of Polyherbal Powder Shampoo

S.No	Retention Time	Compounds	Mol. Wt. (g/mol)	Mol. Formula
1.	2.793	Pyrrolidine-.alpha.	75	C ₄ H ₅ D ₄ N
2.	3.166	Ethoxyacetaldehyde diethylacetal	162	C ₈ H ₁₈ O ₃
3.	4.547	2-Cyclopenten-1-one, 2-hydroxy-	98	C ₅ H ₆ O ₂
4.	5.991	2,4-Dihydroxy-2,5-dimethyl-3(2H)-furan-3	144	C ₆ H ₈ O ₄
5.	9.155	4H-Pyran-4-one, 3-hydroxy-2-methyl	126	C ₆ H ₆ O ₃
6.	10.614	4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxyl-6-methyl	144	C ₆ H ₈ O ₄
7.	17.709	1,2,3-Benzenetriol	126	C ₆ H ₆ O ₃
8.	30.841	N-Hexadecanoic acid	256	C ₁₆ H ₃₂ O ₂
9.	32.671	Docosanoic acid	340	C ₂₂ H ₄₄ O ₂
10.	33.134	9,12-Octadecadienoic acid (Z,Z)-, methyl ester	294	C ₁₉ H ₃₂ O ₂
11.	33.950	Cis-13,16-Docosadienoic acid	336	C ₂₂ H ₄₀ O ₂
12.	34.523	Octadecanoic acid	284	C ₁₈ H ₃₆ O ₂
13.	36.488	Hexadecanoic acid, 2-hydroxy-1,3-propanediyl ester	568	C ₃₅ H ₆₈ O ₅
14.	38.604	Oleoyl chloride	300	C ₁₈ H ₃₃ ClO
15.	39.383	9-Octadecenoic acid, 1,2,3-propanetriyl ester	884	C ₅₇ H ₁₀₄ O ₆
16.	39.483	8-Hexadecenal, 14-methyl-, (Z)	252	C ₁₇ H ₃₂ O
17.	40.326	Dotriacontane	450	C ₃₂ H ₆₆
18.	43.294	Hexatriacontane	506	C ₃₆ H ₇₄
19.	46.064	Tetrapentacontane	758	C ₅₄ H ₁₁₀
20.	46.679	Stigmast-5-en-3-ol, (3.beta.)	414	C ₂₉ H ₅₀ O
21.	48.467	Silane, Trimethyl [(3.beta.)-stigmast-5-en-3yl]oxy]	486	C ₃₂ H ₅₈ OSi
22.	49.224	Tetrapentacontane	758	C ₅₄ H ₁₁₀
23.	50.912	Campesterin	400	C ₂₈ H ₄₈ O
24.	51.612	Stigmasta-5, 23-dien-3-ol, (3.beta.)	412	C ₂₉ H ₄₈ O

Other evaluation parameters:

Table 7, clearly reveals the evaluation parameters;

Curly hair: Ease of distribution was a fall back for herbal shampoo when compared to other two shampoos. Ease of rinsing was quiet good for

herbal shampoo and wet combing was difficult for all other shampoos. Speed of drying was less for herbal shampoo when compared to synthetic formulations. Ease of combing dry was very effective with herbal shampoo and nature of hair was soft and feasible. [22] **Straight hair** : Ease of distribution and rinsing was good with herbal shampoo in contradiction to other two shampoos. Ease of wet and dry combing was moderate with all the three shampoos. Speed of drying was quick for herbal formulation then other formulations. Nature of hair after wash was

smooth. **Wavy hair**: Herbal shampoo was found to be good at distribution and rinsing. Ease of wet combing was moderate and dry combing was very good for herbal shampoo. Speed of drying was 8mins for herbal whereas for others it was 10 mins. Nature of hair after wash was smooth and silky [23].

Table 7

Other evaluation parameters include ease of distribution, rinse, combing (dry & wet), speed of drying and nature of hair after wash.

Table 7a: Curly hair

Parameters	Shampoo A	Shampoo B	Polyherbal Powder Shampoo
Ease of distribution	***	***	**
Ease of rinsing	**	*	***
Ease of combing (wet)	*	*	**
Speed of drying	15mins	13mins	10mins
Ease of combing (dry)	*	**	***
Nature of hair after wash	Soft	Soft	Soft and manageable

*Satisfactory; **good and ***excellent

Table 7b: Straight hair

Parameters	Shampoo A	Shampoo B	Polyherbal Powder Shampoo
Ease of Distribution	**	***	***
Ease of rinsing	**	**	***
Ease of combing(wet)	*	**	**
Speed of drying	15mins	10mins	8mins
Ease of combing (dry)	*	**	**
Nature of hair after wash	Less smooth	Fairly smooth	Smooth

*Satisfactory; **good and ***excellent

Table 7c: Wavy hair

Parameters	Shampoo A	Shampoo B	Polyherbal Powder Shampoo
Ease of Distribution	**	***	***
Ease of rinsing	**	**	***
Ease of combing(wet)	*	*	**
Speed of drying	10mins	10mins	8mins
Ease of combing (dry)	**	*	***
Nature of hair after wash	Soft and manageable	Less smooth	Smooth, soft and manageable

*Satisfactory; **good and ***excellent

CONCLUSION

In recent years consumer’s attraction towards natural hair care products are increasing rapidly and their necessity should be fulfilled by producing a herbal formulation in affordable cost. The present investigation was done to bring about herbal shampoo powder that is constructed with 20 natural herb individually has got medicinal properties that are made into powders that strengthens hair and reduce hair fall. The efficacy of the shampoo was comparatively better in contradiction to both synthetic formulations. Herbal shampoo is formulated with no side effects and is cost effective.

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ETHICAL CLEARANCE

Not Applicable

SOURCE OF FUNDING

NIL

CONFLICT OF INTEREST

No conflict of interest

REFERENCES

1. Mithal, B. M., & Saha, R. N. (2000). A handbook of cosmetics. Vallabh Prakashan, New Delhi, 141, 110-112.
2. Kumar, N., Rungseevijitprapa, W., Narkkhong, N. A., Suttajit, M., & Chaiyasut, C. (2012). 5 α -reductase inhibition and hair growth promotion of some Thai plants traditionally used for hair treatment. *Journal of Ethnopharmacology*, 139(3), 765-771.
3. Arora, P., Nanda, A., & Karan, M. (2011). Shampoos based on synthetic ingredients vis-a-vis shampoos based on herbal ingredients: a review. *International Journal of Pharmaceutical Sciences Review and Research*, 7(1), 42-46.
4. Preethi, P. J., Padmini, K., Srikanth, J., Lohita, M., Swetha, K. P. V. R., & Rao, P. V. (2013). A review on herbal shampoo and its evaluation. *Asian Journal of Pharmaceutical Analysis*, 3(4), 153-156.
5. Banu, K. S., & Cathrine, L. (2015). General techniques involved in phytochemical analysis. *International Journal of Advanced Research in Chemical Science*, 2(4), 25-32.
6. Nikhil, A. (2015). Preparation and evaluation of shampoo powder containing herbal ingredients. *Asian Journal of Pharmaceutical and Clinical Research*, 266-270.
7. Guruvayoorappan, C., Jacob, R., Sakthivel, K. M., & Kannan, N. (2015). Formulation of cost effective herbal shampoo powder: a comparative study with market shampoos. *International Journal of Current Research*, 7(2), 12645-12649.
8. Shinde, P. R., Tatiya, A. U., & Surana, S. J. (2013). Formulation development and evaluation of herbal antidandruff shampoo. *International Journal of Research in Cosmetic Science*, 3(2), 25-33.
9. Krunali, T., Dhara, P., Meshram, D. B., & Mitesh, P. (2013). Evaluation of standards of some selected shampoo preparation. *World Journal of Pharmacy and Pharmaceutical Sciences*, 2(5), 3622-3630.
10. Deshmukh, S., Kaushal, B., & Ghode, S. (2012). Formulations and evaluation of herbal shampoo and comparative studies with herbal marketed shampoo. *International Journal of Pharma and Bio Sciences*, 3(3) 638-645.
11. Bakr, R. O., Amer, R. I., Fayed, M. A., & Ragab, T. I. (2019). A completely polyherbal conditioning and antioxidant shampoo: A phytochemical study and pharmaceutical evaluation. *Journal of Pharmacy & Bioallied Sciences*, 11(2), 105.
12. Williams, S. (1984). Official methods of analysis (No. 630.24 A8 1984). Association of Official Analytical Chemists.
13. Siouffi, A. M. (2005). From paper to planar: 60 years of thin layer chromatography. *Separation & Purification Reviews*, 34(2), 155-180.
14. Manisha, S., Swati, D., Manisha, C., & Sonia, S. (2013). Preparation and evaluation of polyherbal shampoo powder. *International Journal Of Pharmacy And Biological Sciences*, 392, 151-159.
15. Baran, R., & Maibach, H. I. (Eds.). (2017). *Textbook of cosmetic dermatology*. CRC Press.
16. Sharma, R. M., Shah, K., & Patel, J. (2011). Evaluation of prepared herbal shampoo formulations and to compare formulated shampoo with marketed shampoos. *International Journal of Pharma and Pharmaceutical Science*, 3(4), 402-405.
17. Saad, A. H., Kadhim, R. B., & Rasool, B. K. A. (2011). Formulation and evaluation of herbal shampoo from *Ziziphus spina Christi* leaves extract. *International Journal of Research in Ayurveda and Pharmacy*, 2, 1802-1806.
18. Azadbakht, M., Monadi, T., Esmaeili, Z., Chabra, A., & Tavakoli, N. (2018). Formulation and evaluation of licorice shampoo in comparison with commercial shampoo. *Journal of Pharmacy & Bioallied Sciences*, 10(4), 208.
19. Chandran, S., Vipin, K. V., Augusthy, A. R., Lindumol, K. V., & Shirwaikar, A. (2013). Development and evaluation of antidandruff shampoo based on natural sources. *Journal of Pharmacy and Phytotherapeutics*, 1(4), 2321-5895.
20. Dessai, P., & Phatarpekar, S. (2016). Formulation and evaluation of herbal shampoo and to compare formulated shampoo with marketed shampoos. *World Journal of Pharma and Pharmaceutical Science*, 5, 1467-77.
21. Trüeb, R. M. (2006). Pharmacologic interventions in aging hair. *Clinical Interventions in Aging*, 1(2), 121.
22. Al Badi, K., & Khan, S. A. (2014). Formulation, evaluation and comparison of the herbal shampoo with the commercial shampoos. *Ben-Suef University Journal of Basic and Applied Sciences*, 3(4), 301-305.
23. and Shirwaikar, A. 2013. Development and evaluation of antidandruff shampoo based on natural sources. *Journal of Chandran, S., Vipin, K.V., Augusthy, A.R., Lindumol, K.V.*
24. Patel, I. M. R. A. N., & Talathi, A. D. N. Y. A. (2016). Use of traditional Indian herbs for the formulation of shampoo and their comparative analysis. *International Journal of Pharmacy and Pharmaceutical Sciences*, 8(3), 28-32.