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Formulation & Evaluation of Polyherbal Fruit Peel Shampoo

Research Article

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Abstract

Scalp disorders are now-a-days affecting all ages of people. Different types of Scalp disorders include dandruff, seborrheic dermatitis and even parasitic infections like Pediculosis capitis. Various microbes (Bacteria and Fungi) and Non-microbes are responsible for the scalp disorders. The study intends to formulate and evaluate the polyherbal fruit peel Shampoo. The formulated composition not only removes filth and dandruff but also leaves hair silky and lustrous and promotes hair development. The primary purpose of the current study is to develop and assess shampoo for treating various hair concerns. The composition minimizes the use of hazardous chemical compounds that affect hair. The formulation uses various fruit peels such as Pomegranate, Banana, grapes, and oranges for preparing shampoos with additives such as SLS, gelatin, and sodium benzoate which act as surfactants, viscosity modifiers and preservatives. The formulated shampoo was subjected to evaluation parameters like visual inspection, pH, viscosity, dirt dispersion, surface tension, foaming ability, foam stability, antimicrobial test and stability studies, etc. Invitro anti-bacterial activity was done against *Staphylococcus epidermidis* MTCC-435. Zone of Inhibition was found to be 9.5mm at 250µg/ml. The formulated shampoo has anti-bacterial activity and it is used in treating scalp problems which cannot be eliminated but can only be managed and effectively controlled.

Keywords: Fruit peels, Staphylococcus, Shampoo, Scalp disorders, Herbal products.

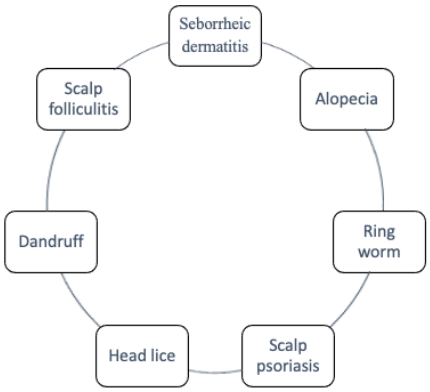
Introduction

Among human skin areas, the scalp is different. It is distinguished by an abundance of sebaceous glands and a thick layer of skin with a high follicular density. The pH of the hair shaft is 3.67 while the pH of the scalp is 5.5. The scalp is particularly susceptible to mycotic diseases such as dandruff, seborrheic dermatitis and parasitic infections such as pediculosis capitis due to these glands and the warm, dark environment surrounding them. Dandruff is most common between puberty and middle age, during which sebaceous gland activity is at its peak (1).

Seborrheic Dermatitis

Young adults and less often children are the target population for seborrheic dermatitis (SD), a prevalent chronic inflammatory skin disease. Clinical manifestations of SD in adults and adolescents can vary, ranging from diffuse white, yellowish patches in sebaceous gland-rich areas such as the scalp, face, and trunk to fine scaling of the scalp. Environmental triggers, such as cold winter temperatures and humidity, are likely to encourage its growth. Numerous other elements such as the colonization of fungal species Malassezia species and bacterial species including Corynebacterium, Streptococcus and Staphylococcus. Management of inflammation, reduction of microbial species colonization of the skin and regulation of sebum production are the goals of SD treatment (2).

Figure 1: Various Scalp disorders



Dandruff

Dandruff is a common scalp condition that affects people of all genders and ethnicities, about half of whom are pre-pubescent. Every population in every geographical area could not exist freely without experiencing dandruff at some point in their lives. During dandruff development, keratinocytes are crucial for the expression and production of immune responses. Dandruff does not cause inflammation (3). Dandruff is

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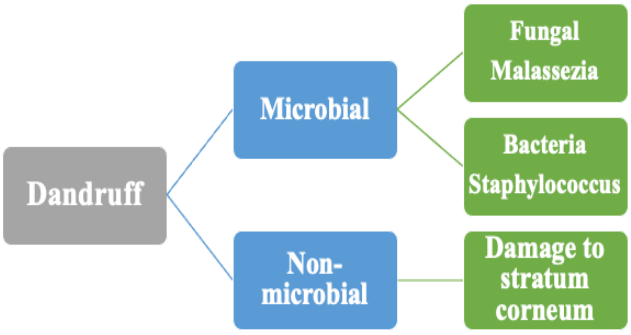
generally thought to be caused by a lipophilic yeast of the genus Malassezia. Many organisms, including Staphylococci, Propionibacterium and Malassezia species, use the scalp as a biosensor. The scalp is also affected by bacteria in response to fungal responses (4).

Etiology of Dandruff

Causative factors are divided in to two types – Microbial & Non-microbial.

Figure 2: Causative factors Dandruff



Both bacterial and fungal species are the causes of these scalp disorders. Malassezia is the most common scalp fungus. Bacteria such as Propionibacterium, Staphylococcus, Streptococcus, Pseudomonas, Acinetobacter. Scalp disorders are caused by an imbalance between the colonization of bacteria and fungi in the scalp. Staphylococcus epidermidis is the most colonized bacterium in the scalp (5).

Shampoos

Shampoos are basically solutions of detergents with the appropriate chemicals added for other benefits, including lubrication, medication, and improved hair conditioning, among others. Since shampoo is essential in personal care and widely used, shampoo preparation is a valued and necessary skill. It represents the largest category of hair cosmetics and is a basic hair care product.

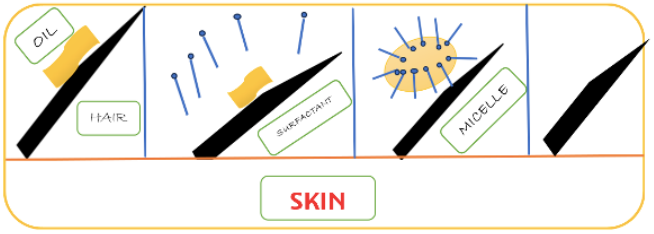
Shampoo is usually a viscous liquid, but occasionally it can be found in solid, anhydrous form as a bar. Formulated to remove excess sebum, dandruff, environmental dust and hair product residue from the scalp and hair, the shampoo replaced soap. Water is not enough to remove most impurities, including sebum, because it is insoluble in water. Consequently, a shampoo with different surfactants is required. The level of surfactant in shampoo usually ranges from 10% to 20% (6). It is interesting to note that the word "shampoo" came into use in English in India, where the Hindi word "champoo" meant "to press or massage", referring to the washing of hair and skin (7).

Shampoos are used to:
- Clean the scalp thoroughly
- Protect the hair
- Soothe the skin around the scalp
- Treat lice, dandruff and other scalp problems (8).

Mechanism of action of Shampoos

Oil and dirt are stuck on the skin and hair. Surfactant reduces the surface tension of water. Surfactants form micelles around dirt and oil, which are removed from the skin and hair. Micelles with oil, dirt and surfactant are removed with water during rinsing.

Figure 3: Mechanism of action of Shampoos



The shampoo has both a hydrophilic and a hydrophobic part. The hydrophobic part binds to the hair. Surfactants or detergents in shampoos have a hydrophilic component, so when you rinse your hair, the detergent is swept away by the water and carries away all the dirt, grease, sweat, and pollutants. Dandruff, dry hair, split ends, oily hair, and hair loss are the problems related to hair.

Herbal Shampoos

Currently, the market offers a wide range of synthetic, herbal, medicated, and non-medicated shampoos. However, consumers are increasingly choosing herbal shampoos because they feel that natural products are safe and without side effects (9).

The shampoo contains synthetic surfactants primarily for foaming and cleansing purposes; however, long-term use of these surfactants can cause hair loss, scalp discomfort, and eye irritation. Herbal products are considered a good substitute for synthetic shampoos, but it can be challenging to create cosmetics using only natural ingredients.

Many medicinal plants are often used in shampoo formulations because of their purported positive effects on hair. These plant components can be used as powders, derivatives, refined extracts, or in their raw form. It is very challenging to produce a single natural ingredient herbal shampoo that is as safe and gentle as a synthetic one, while still competing favourably in terms of lather, detergency and solids content (10).

Phytochemical Methods

Plant compounds belonging to different categories of secondary metabolites various medicinal plants have been shown to contain flavonoids, terpenoids, polyphenols, saponins, tannins and other compounds with antifungal properties. The phytoconstituents contained in the extracts are identified by preliminary phytochemical research.

The primary steps in phytochemical approaches involve the extraction, isolation and purification of active components from extracts. The most commonly used extraction methods include decoction, maceration, hot and cold infusion, and soxhlation/continuous hot percolation (11).

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Fruit peels with Botanical names & their uses

Table 1: Selected fruit peels with their biological source and Uses

Fruit Peel	Botanical Name	Uses
Pomegranate	*Punica granatum Linn.*	Pomegranate peel powder contains polyphenols that darken hair colour, stop dandruff, and fight hair loss. It increases blood flow to the scalp and fortifies hair follicles through circulation, which promotes healthy hair development (12).
Banana	*Musa acuminata Linn.*	It has vitamins A, and C, and other antioxidants such as flavonoids that help eliminate UV radiation and free radicals that can harm the structure of the scalp and hair (13).
Grapes	*Vitis vinifera Linn.*	Antioxidant function opens the pores to allow for a thorough cleaning.
Oranges	*Citrus sinensis Linn.*	Cleansing agent for glossy, voluminous, smooth hair

Materials and Methods

Plant Collection

Peels from pomegranates, bananas, oranges, and grapes have been collected from fruits bought at the nearby Nellore market. Peels are sun-dried in a shaded area and then ground into a coarse powder. The samples were maintained under observation to avoid microbial growth and the loss of active components.

Preparation of Peel extract

Table 2: Depicts the Extraction process specifying the solvents used and time taken

Fruit Peel	Extraction Technique	Solvent Used	Time taken	Sample (gm)
Pome granate	Soxhlet	Hydro-alcoholic	56 hrs	50 g
Banana	Maceration	Hydro-alcoholic	72 hrs	50g
Grapes	Maceration	Hydro-alcoholic	72 hrs	50g
Oranges	Clevenger apparatus	Distilled water	24 hrs	100g

Figure 4: Fruit Peel Extracts

Composition of Polyherbal Fruit Peel Shampoo

Table 3 shows the formula used for developing a herbal shampoo. The herbal extracts were mixed with a 10% gelatin solution and shaken continuously every 30 minutes. 0.5% sodium benzoate is used as a preservative. The surfactant used is (10%) sodium lauryl sulfate. A sufficient amount of orange oil was added to the mixture to enhance its aroma. Glycerine is used to provide a cooling effect to the scalp.

Table 3: Composition of Polyherbal Fruit Peel Shampoo

S. No	Formulation Ingredients	Quantity
1	Pomegranate peel extract	10ml
2	Banana peel extract	5ml
3	Grape peel extract	5ml
4	Orange oil	5ml
5	SLS (10%)	10ml
6	Gelatin solution 10%	10ml
7	Sodium benzoate 0.5%	2ml
8	Glycerine	3ml

Evaluation of Shampoo

The product performance of the developed formulation was evaluated taking into account solids percentage, pH value and visual evaluation. Specific tests for surface tension, foam stability test, foam volume, rheological evaluation by Brookfield viscometer, soil dispersion and cleaning effect were performed according to a standard protocol to determine the nature of the formulation.

Appearance / Visual evaluation:

The colour, clarity and smell of the prepared product were evaluated.

Homogeneity test

A Petri dish containing different concentrations of shampoo (10% and 20%) is filled and monitored. Coarse particles must not be visible in the shampoo. The Shampoo should be in uniform composition (14).

Determination of pH

10% of the sample is made from the extract, and a PH meter is used to measure it. Using pH paper at room temperature, the pH of the herbal shampoo was determined by dipping the universal pH into the shampoo mixture and watching the colour of the paper change. The colour produced and the pH indicator is then compared to determine the pH range of the preparation. The pH range that specifies requirements is 5.0 to 9.0. In this pH range, it can protect hair from damage (15).

Solid Content

The quality of the shampoo is determined by an indicator called the solid content. A shampoo with a high concentration of solids is difficult to mix and rinse from the hair, while a shampoo with a low solids content is fluid and can dry out of the hair quickly.

Weigh approximately 4 grams of shampoo into a sterile, dry Petri dish. The liquid component of the

shampoo evaporated in the bowl by placing it on a hot plate. After the shampoo had completely dried, the weight and percentage of its solids were determined. The entire process is repeated for confirmation of the solid contents. The ideal solids concentration range for commercial shampoos is considered to be between 20 and 30 percent (16).

Viscosity

Many shampoo properties, including consistency and spreadability, are significantly affected by viscosity. The consistency of the shampoo is better, if it's a higher viscosity. In addition, shampoo viscosity affects product aesthetics, including spreadability when applied to the hair, clarity, ease of flow from the box and consistency in the package, as well as storage stability.

A Brookfield viscometer was used to measure viscosity. The shampoo solution was placed in a glass beaker and placed under a suitable spindle-mounted Brookfield DV-E viscometer. Next, the product is applied to the spindle (62S) until it is completely submerged (17).

Dirt dispersion test

While low-quality shampoo concentrates impurities on the foam product, high-quality shampoo concentrates impurities in the water.

To perform this test, add water to a tube containing 0.1 ml of shampoo until the volume reaches 10 ml. Then fill the test tube with two drops of liquid ink, close it and shake vigorously ten times. Make sure the ink stays in the watery part by watching how much is dispersed in the foam.

Foam ability & stability

The most attractive shampoos are those with the most volume and the longest retention time.

Cylinder shake method was used to measure the foam height. A 250 ml graduated cylinder was filled with approximately 50 ml of the formulated Polyherbal shampoo solution (1%) and vigorously shaken ten times. After five minutes, measure the height of the foam. Foam height requirements range from 1.3 to 22 cm.

Surface tension

Shampoo that has been diluted to 10% with distilled water and allowed to stand at room temperature can be used to measure the surface tension using a stalagmometer. Then measure the amount of solution that falls between two predefined points (three times for each shampoo solution).

Surface tension is measured by the following equation:

R2 = (W3-W1) N1 x R1 (W2 -W1) N2

W1: weight of empty beaker.
W2: weight of beaker with distilled water.
W3: weight of beaker with a shampoo solution.
N1: the number of distilled water droplets
N2: number of drops of shampoo solution.
R1: surface tension of distilled water at room temperature.
R2: surface tension of shampoo solution

The surface tension of clean water at 25°C can be reduced from 72 to less than 40 dyne/cm by properly preparing the shampoo. Shampoos with high detergent (cleansing power) are therefore those that reduce the surface tension of water (18).

Wettability

Higher Wettability correlates with higher surfactant concentrations. Shampoos with the shortest soaking time are best. A canvas disc approach is used for this. The amount of time it took the canvas to completely submerge was recorded to calculate the wetting time. One inch in diameter was cut from a 0.44g piece of canvas. A disc of tissue paper was placed on the surface of the shampoo (1% v/v) and a stopwatch was used to time how long it took the paper to sink (19).

Specific gravity

The specific gravity measurement is carried out using a pycnometer. Weigh an empty and dry container using an incubator. Fill the container with a known volume of shampoo, making sure to remove any air bubbles. Weigh the container with the shampoo. Calculate the mass of the shampoo by subtracting the weight of the empty container from the weight of the container with the shampoo. Measure the volume of the shampoo in the container. Divide the mass of the shampoo by its volume to get the specific gravity.
The formula for specific gravity is:

Specific Gravity = Mass of Shampoo / Volume of Shampoo

Short term stability studies

The product should be kept at room temperature for 24 hours and then at 10 degrees Celsius for another 24. One cycle is finished with this. Once the product successfully completes three cycles, you can be quite certain in its stability. A five-cycle test from -10oC to 45oC is significantly more challenging.

Invitro Anti-Microbial activity

The antimicrobial activity of the shampoo concentrations was evaluated by agar well diffusion method. Bacteria were grown in Nutrient Agar media to match the turbidity of 0.5 McFarland standards to be inoculated on Nutrient Agar media agar. After the inoculation plates were set aside for 15 minutes and the wells were drilled with sterilised cork borers. Once wells were formed, they were filled with 50µL of isolates and blank (water). Plates were incubated for 24 h at 37 °C to allow leaf extracts to diffuse through the agar media to form zones of inhibition. The diameters of the zone of inhibition for different isolates against different bacteria were measured in millimetres for further analysis. A 6-mm agar well with no zone of inhibition was believed to have no antibacterial action (20, 21).

Results

Phytochemical Analysis

Phytochemical analysis of various fruit peel extracts was carried out and the active components

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present in the extracts were identified. Carbohydrates, alkaloids, tannins, phenols, saponins, and proteins have been identified as phytoconstituents in the extract, which are responsible for exhibiting various pharmacological activities. The technology of herbal medicines is gaining importance nowadays due to the presence of chemical components in various plants.

Table 4: Phytochemical screening of active constituents from peel extracts

S. No	Tests	Different Herbal Peel extracts		
		Punica	*Musa*	Vitis
1	**Carbohydrates**			
	Molisch's	+	+	+
	Fehling's	+	+	+
2	**Proteins**			
	Biuret	+	+	+
	Millions	+	+	+
3	**Alkaloids**			
	Dragendrof	+	+	+
	Mayer's	-	-	-
4	**Tannins & Phenols**			
	Lead	+	+	+
	$FeCl_3$ test	+	+	+
5	**Saponins**			
	Foam test	-	+	-

Percentage yield of Herbal peel extracts:

Table 5: Depicts regarding % yield of Herbal peel extracts

Name of the Fruit peel	Solvent	%Yield (%w/w)	Colour and nature of extract
Punica granatum	Hydro-alcoholic	23.60%	Black and sticky substance
Musa paradisiaca	Hydro-alcoholic	21.30%	Dark brown and sticky
Vitis vinifera	Hydro-alcoholic	15.78%	violet and sticky
Citrus sinensis	Water	4.5%	Orange colour

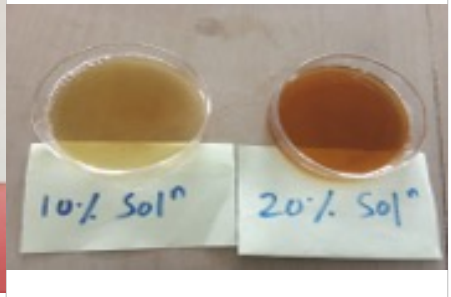
Physicochemical parameters of herbal shampoo

Physical appearance / Visual inspection

The formulated herbal shampoo as shown in Figure 5 is reddish brown. It has a pleasant aroma from the fragrance in the components, as well as a good foaming ability.

Figure 5: Polyherbal fruit peel Shampoo

Figure 6: Determination of Homogeneity



Homogeneity test

The presence or absence of coarse particles in the shampoo formulation was carried out to determine homogeneity. From the figure below, it is visible that there are no coarse particles in the formulation concluding it as a consistent composition.

Evaluation of pH

The pH of the formulated shampoo was 5.8, which falls within the ideal pH range for shampoo, which is between 5 and 9. The formulated shampoo is balanced with acids that are close to the skin's pH.

Solid Contents

If the shampoo has too many solids, it will be difficult to work into the hair or too difficult to wash out. The percent solids result was found to be 1.15% and indicated that it could be easily washed out. The low solid content of the shampoo washes the hair easily.

Foam ability and stability

The presence of foam in the shampoo reduces friction, hair damage. It is convenient for easy hair cleaning. It is clear from the test that the foam of the shampoo is stable and the height of the foam was found to be 14 cm.

Viscosity

The viscosity of the shampoo plays an important role in determining its shelf life, ease of flow when removed from the package and spreading. On the application to the hair and the consistency of the product in the package. The viscosity of the formulated shampoo was found to be 467.9 Cps at 77.9% torque which was good enough for its usability.

Dirt dispersion

Shampoo that causes ink to concentrate in the foam appears to be low-quality; contaminants should remain in the water. Dirt that remains in the foam will be difficult to wash off. It settles back into the hair. The estimated amount of ink in the foam was light, so the results indicate that the prepared formulation is satisfactory.

Figure 7: Determination of Foam ability & stability

Figure 8: Determination of Foam height

Figure 9: Dirt dispersion

Cleansing action

There is a weight difference in the hair after cleaning with the shampoo, which shows the dirt is removed from the human hair when it is washed and dried. So, we can conclude that the cleansing action of the shampoo is good.

Specific gravity

Specific gravity is assessed to determine if the shampoo will float or sink on hair. The specific gravity of water is 1. Shampoo will float if its specific gravity is less than 1, meaning it is less dense than water. It will sink if its density is more than 1 because it is denser than water. From the data, it is evident that the shampoo sinks into the hair and has a specific gravity of 1.049.

Surface tension

Surface tension is a measurable quantity that is associated with a solution's capacity to eliminate dirt. Reduced surface tension improves the formulation's spreading, liquid's ability to seep into the hair, and its foaming qualities. The findings showed that the herbal shampoo's surface tension was 0.3181. As a result, the herbal shampoo has a lower surface tension than water and is similar to commercial shampoos. Thus, the shampoo's foaming and spreadability were both good.

Wettability

The Wetting time of the Shampoo was found to be 18 seconds.

Stability studies

After the repetition of 3 cycles, the formulation was found to be stable.

Table 6: Summarisation of Physicochemical parameters of the herbal shampoo

S.No.	Evaluation Parameter	Formulated Herbal shampoo
1	Colour	Reddish brown
2	Transparency	Clear
3	Odour	Pleasant
4	Homogeneity test	Homogenous composition
4	pH of 10% solution	5.8
5	Solid contents (%)	1.15%
6	Foam ability & stability	14 cm, foam is stable
7	Foam type	dense, small
8	Skin Irritation	Nil
9	Viscosity (62 S)	467.9 Cps at 77.9% Torque
10	Dirt dispersion	Concentrates dirt in the water
11	Cleansing action	Good
12	Specific gravity	1.049
13	Wetting time	18 sec
14	Stability studies (Short term)	Stable during the storage period

Determination of Surface tension

Table 7: Determination of Surface tension by Stalagmometer

Sample	No. of. Drops			Average of the drops	Density	Surface tension
	1	2	3			
Distilled water	38	37	35	36.6	0.977	72
Herbal Shampoo	140	139	135	138	1.183	0.3181
Commercial Shampoo	101	99	98	99.3	1.01	0.3734

Invitro anti-microbial evaluation

The area surrounding the antibiotic site in which bacterial colonies do not proliferate is known as the "zone of inhibition." For the Polyherbal fruit peel shampoo, the antibacterial action was demonstrated. The zone of inhibition for the sample mentioned above at various concentrations (µg/ml) is calculated and shown in the table below:

Table 8: Results for Anti-microbial activity

Concentration (µg/ml)	Zone of Inhibition (mm)	
	Shampoo	Standard
1000	12.5	15.8
500	11.0	13.8
250	9.5	12.5
100	5.8	8.5
10	2.5	6.8
1	---	2.5

Figure 10: ZOI at different concentrations for Shampoo and Standard

Discussion

Dandruff, a chronic inflammatory disorder becomes one of the most common problems in Dermatology characterized by flakes on the scalp skin, itching of the skin, and affects the tissue present on the scalp. People with oily skin texture on the scalp and usage of poor quality of water are the major causative factors for dandruff. Dandruff is caused by

microorganisms such as bacteria and fungi. In this work herbal based compounds are used instead of chemicals. WHO also promotes the traditional herbal medicines as an effective therapy.

Literature says that various plants (Tulasi, Neem, Hibiscus) possess anti-microbial activity. The underlying Research is proposed in such a way that different peels are considered to make a polyherbal fruit peel formulation. Selected fruit peels (Pomegranate, Banana, Grapes, Oranges) possess anti-microbial activities. Fruit peels consist of Polyphenols and Flavonoids stops dandruff, decrease hair loss, increase blood flow to the circulation. The PH of the shampoo was discovered to be 5.8, which is appropriate for the scalp and causes no skin irritation (22).

The evaluation study demonstrated good wetting ability, cleansing action, stability, and dense and tiny foam. *Staphylococcus epidermidis* is one of the primary factors of scalp disorders (23). An anti-microbial investigation against this species revealed a Zone of Inhibition at 250 µg/ml was found to be 9.5mm. These findings suggest that the Polyherbal fruit peel shampoo is effective in treating scalp conditions such as seborrheic dermatitis and dandruff. Finally, based on the evaluation and formulation characteristics, herbal active ingredients will be more popular with consumers due to their superior performance and stability, as well as their safety over synthetic ones.

Conclusion

The study achieved its goal of developing a stable and effective herbal shampoo formulation while eliminating synthetic chemicals. The antimicrobial activity of the formulation was evaluated in tests using Staphylococcus epidermidis. SLS (10%) functions as a surfactant, enabling the production of synthetic foam. If synthetic components are used in the manufacturing of herbal shampoo, they must be included to prevent bacteria from multiplying. The best sources for microbial growth are those found in nature. The active components in the formulation should be from herbal sources. The formulated herbal shampoo gently clears dirt and dandruff. The shampoo provides nutrition to hair and scalp. Natural products are used all over the world because they have minimal side effects when compared to chemical substances.

Abbreviations

- ZOI: Zone of Inhibition
- SLS: Sodium Lauryl Sulfate
- WHO: World Health Organization

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Conflict of Interest: The authors declare no conflicts of interest for this study.

References

1. Dias MF, de Almeida AM, Cecato PM, Adriano AR, Pichler J. The shampoo pH can affect the hair: myth or reality. Int. J. Trichology. 2014;6(3):95-99.
2. Schoch JJ, Monir RL, Satcher KG, Harris J, Triplett E, Neu J. The infantile cutaneous microbiome: A review. Pediatr. Dermatol. 2019;36(5):574-80.
3. Leyden JJ, McGinley KJ, Kligman AM. Role of microorganisms in dandruff. *Arch Dermatol.* 1976;112:333–338.
4. Pierard FC, Arrese JE, Pierard GE. Immunohistochemical aspects of the link between Malassezia ovalis and seborrheic dermatitis. *J Eur Acad Dermatol Venereol.* 1995;4:14–19.
5. Clavaud C, Jourdain R, Bar-Hen A, Tichit M, Bouchier C, Pouradier F, El Rawadi C, Guillot J, Ménard-Szczebara F, Breton L, Latgé JP. Dandruff is associated with disequilibrium in the proportion of the major bacterial and fungal populations colonizing the scalp. PloS one. 2013;8(3):e58203.
6. Sakamoto K, Lochhead RY, Maibach HI, Yamashita Y, editors. Cosmetic science and technology: theoretical principles and applications. Elsevier. 2017.
7. Draelos ZD. Essentials of hair care often neglected: hair cleansing. Int. J. Trichology. 2010;2(1):24-29.
8. Barel AO, Paye M, Maibach HI. Handbook of cosmetic science and technology. CRC press. 2014.
9. Mainkar AR, Jolly CI. Formulation of natural shampoos. Int. J. Cosme. Sci. 2001;23(1):59-62.
10. Halith SM, Abirami A, Jayaprakash S, Karthikeyini C, Pillai KK, Firthouse PM. Effect of Ocimum sanctum and Azadiracta indica on the formulation of antidandruff herbal shampoo powder. Pharm Lett. 2009;1(2):68-76.
11. Abubakar AR, Haque M. Preparation of medicinal plants: Basic extraction and fractionation procedures for experimental purposes. J Pharm Bioallied Sci. 2020;12(1):1-10.
12. Malpani T, Jeithliya M, Pal N, Puri P. Formulation and evaluation of Pomegranate based herbal shampoo. J Pharmacogn Phytochem. 2020;9(4):1439-44.
13. Broto W, Arifan F, Wardani OK, Faisal MM, Nugraheni A. Shampoo Formulation Based on Banana Extract Using the Maceration Method. Waste Technol. 2022;10(2):67-70.
14. Singh, J., Kaur, H.P., Verma, A., Chahal, A.S., Jajoria, K., Rasane, P., Kaur, S., Kaur, J., Gunjal, M., Ercisli, S. and Choudhary, R. Pomegranate peel phytochemistry, pharmacological properties, methods of extraction, and its application: a comprehensive review. ACS omega. 2023;*8*(39):35452-35469.
15. Insanu M, Karimah H, Pramastya H, Fidrianny I. Phytochemical compounds and pharmacological activities of Vitis vinifera L.: An updated review. Biointerface Res. Appl. Chem. 2021;11(5):13829-13849.

16. Barua N, Das M. An overview on pharmacological activities of Musa sapientum and Musa paradisiaca. IJPPR. 2013;4(2):852-858.
17. Mojo T, Sutrisno S, Marfuah S. Chemical Content and Pharmacology of Sweet Orange (Citrus sinensis) Fruit Peel: A Review. InE3S Web of Conferences. 2024;481:06002). EDP Sciences.
18. Al Badi K, Khan SA. Formulation, evaluation and comparison of the herbal shampoo with the commercial shampoos. Beni-Suef University Journal of Basic and Applied Sciences. 2014;3(4):301-305.
19. Pérez-Rivero C, López-Gómez JP. Unlocking the Potential of Fermentation in Cosmetics: A Review. Fermentation. 2023;9(5):463.
20. Atikya Farjana, Nagma Zerin, Md. Shahidul Kabir. Antimicrobial activity of medicinal plant leaf extracts against pathogenic bacteria. Asian Pac J Trop Dis. 2014; 4(Suppl 2):920-923.
21. Indranil Bhattacharjee, Soroj Kumar Chatterjee, Anupam Ghosh, Goutam Chandra. Antibacterial activities of some plant extracts used in Indian traditional folk medicine. Asian Pacific Journal of Tropical Biomedicine. 2011;165 – 169.
22. Pal RS, Saraswat N, Wal P, Wal A, Pal Y. Preparation & assessment of poly-herbal anti-dandruff formulation. The Open Dermatology Journal. 2020;14(1).
23. Saxena R, Mittal P, Clavaud C, Dhakan DB, Hegde P, Veeranagaiah MM, Saha S, Souverain L, Roy N, Breton L, Misra N. Comparison of healthy and dandruff scalp microbiome reveals the role of commensals in scalp health. Frontiers in cellular and infection microbiology. 2018;8:346.

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