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Research Article

FORMULATION AND EVALUATION OF POLYHERBAL SHAMPOO

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ABSTRACT

Since ancient times, humans have relied on natural ingredients for health and hair care due to their protective and corrective properties. While synthetic shampoos are effective cleansers, their prolonged use can lead to scalp irritation, dryness, and environmental concerns. Consequently, there is a growing global demand for herbal cosmetics that offer safety, purity, and better biological compatibility. This study aimed to develop and evaluate an antimicrobial herbal shampoo powder using selected medicinal plants. The primary focus was to investigate how varying concentrations of antimicrobial herbs affect microbial growth inhibition while maintaining optimal physicochemical properties. Six formulations (F1–F6) were prepared using the trituration method. The herbal base consisted of *Ocimum sanctum* (Tulsi) and *Azadirachta indica* (Neem) as antimicrobial agents, with *Sapindus trifoliatus* (Soapnut) used for its natural saponins. Other supportive herbs included Amla, Hibiscus, Bhringraj, Henna, and Jujube. The formulations were evaluated for micromeritic properties, pH, foaming capacity, ash value, moisture content, and antimicrobial activity against *Pityrosporum ovale* and *Escherichia coli*. All formulations exhibited acceptable physical characteristics and a mildly acidic pH (4.9–6.0), which is suitable for scalp health. Micromeritic evaluation confirmed satisfactory flow properties for packaging. Antimicrobial activity was concentration-dependent; as the levels of Tulsi and Neem increased, the zone of inhibition also increased. Formulation F6, containing 32.5% Tulsi and 32.5% Neem, demonstrated the highest antimicrobial efficacy and superior foaming stability. Safety tests on volunteers and experimental animals showed the formulations were non-irritant to the skin with only mild, transient eye irritation. The study successfully developed a stable herbal shampoo powder that serves as a safe and effective alternative to synthetic products. Formulation F6 emerged as the most promising blend, combining maximum microbial inhibition with desirable cosmetic properties.

Keywords: Antimicrobial herbal shampoo, *Ocimum sanctum,* Micromeritic properties, pH, Foaming capacity, Ash value.

INTRODUCTION

Since ancient times, humans have depended on nature for maintaining health, skin, and hair. Natural ingredients possess preventive, protective, and corrective properties that enhance beauty and well-being. Herbal cosmetics have gained global popularity due to their safety, purity, and effectiveness compared to synthetic products (Jaya Preethi 2013; Saad A H 2011, Namita 2013; Manikar 2001; Suriyaprakash 2011). Cosmetics are substances applied to external body parts such as skin, hair, nails, and lips for cleansing, protection, beautification, and maintenance. They are classified into solids (powders, packs), semi-solids (creams, ointments), and liquids (lotions, shampoos, conditioners). Increasing awareness about the adverse effects of chemical-based products has led to growing demand for natural cosmetic preparations. Human hair is an important feature associated with beauty and confidence. Structurally, hair consists of cuticle, cortex, and sometimes medulla, and is primarily composed of keratin protein (65–95%). Hair grows approximately 1 cm per month and follows a three-phase growth cycle: Anagen (growth phase), Catagen (transitional phase), and Telogen (resting phase). Hair performs protective functions by shielding the scalp from ultraviolet radiation, filtering dust and particles, and contributing to sensory perception (Kumar 2010; Dubey 2004; Rai N 2013; Naveen S 2012).

Common hair problems include hair loss (alopecia), dandruff, premature greying, split ends, and frizzy hair.

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Factors such as stress, hormonal imbalance, nutritional deficiency, scalp infections, and excessive use of synthetic products contribute to these disorders. Alopecia affects a significant portion of the global population and remains a major cosmetic and dermatological concern (Naveen S 2012; Wani S 2014; Patil S 2015; Fatima A, 2013). Hair cosmetics are preparations intended for cleansing, conditioning, coloring, and nourishing hair. Among them, shampoo is one of the most widely used products. Shampoo is a surfactant-based preparation designed to remove dirt, excess sebum, and debris from the scalp and hair without causing irritation. However, prolonged use of synthetic surfactants may lead to dryness, irritation, and environmental concerns. Traditional systems such as Ayurveda and Rigveda describe the use of herbs for hair cleansing and nourishment. Herbal shampoos incorporate plant-based ingredients possessing cleansing, antimicrobial, conditioning, and hair growth–promoting properties. Commonly used herbs include *Phyllanthus emblica* (Amla), *Hibiscus rosa-sinensis* (Hibiscus), *Azadirachta indica* (Neem), *Eclipta prostrata* (Bhringraj), and *Lawsonia inermis* (Henna). These herbs provide natural antioxidants, nutrients, and antimicrobial effects that improve scalp health and hair strength (Surya Prabha 2014; Saraf 2014). Herbal cosmetics offer several advantages over synthetic products, including safety, minimal side effects, environmental friendliness, and better compatibility with the human body. Owing to these benefits, the development of herbal shampoo formulations has gained considerable importance in modern cosmetic research, aiming to provide effective cleansing while promoting hair growth and maintaining scalp health (Biswas K, 2002).

MATERIALS AND METHODS

Materials

All materials used in the study were authenticated and of analytical grade. The selected medicinal plants were collected from a medicinal garden and used in dried powdered form. The plant materials included: *Ocimum sanctum* (Tulsi)-Leaf, *Azadirachta indica* (Neem)-Leaf, *Sapindus trifoliatus* (Soapnut)-Fruit, *Hibiscus rosa-sinensis* (Hibiscus)-Leaf, *Phyllanthus emblica* (Amla)-Fruit, *Eclipta prostrata* (Bhringraj) - Leaf, *Lawsonia inermis* (Henna)-Leaf, *Ziziphus jujuba* (Jujube) – Leaf, Agar (Asian Scientifics, Hyderabad) was used as a gelling agent.

Equipment

The major instruments used were: Electronic weighing balance (Mettler Toledo), pH meter (Thermo Fisher Scientific), Hot air oven (Bionics Scientific), Standard sieves (Indiamart), Mortar and pestle (local supplier), Magnetic stirrer (Bionics Scientific).

Collection and processing of plant material

Required plant parts were collected and shade-dried separately. The dried materials were cleaned to remove extraneous matter and powdered using mortar and pestle. The powders were sieved for uniformity and stored in airtight containers for further formulation.

Preparation of herbal shampoo

The shampoo was prepared by the trituration method. Soapnut and Amla were soaked overnight in warm water to release natural saponins. All herbal ingredients were boiled with water for 30–40 minutes until the volume reduced to half. During boiling, the mixture was gently mashed to enhance extraction. The decoction was cooled and filtered through muslin cloth to obtain the herbal base. Agar solution (5–7 g in warm water) was prepared separately and incorporated into the filtrate to obtain a gel-like consistency.

Composition of Formulations (F1–F6)

Different formulations were prepared by varying the concentrations of antimicrobial herbs (Tulsi and Neem) and maintaining supportive herbs in appropriate proportions. Tulsi concentration ranged from 20-32.5%, Neem from 25-32.5%, while Soapnut was maintained around 15–20%. Other herbs such as Hibiscus, Amla, Bhringraj, Henna, and Jujube were adjusted in smaller percentages to study the effect of concentration on antimicrobial activity and performance.

Physical Evaluation

Colour, odour, texture, and overall appearance were evaluated visually.

Micromeritic Properties

Powder blends were evaluated for:

Angle of Repose (θ):

$$\tan\,\theta = \frac{h}{r}$$

where *h* is height and *r* is radius of the heap.

Bulk Density and Tapped Density:
Bulk Density = W / V_0
Tapped Density = W / V^f

Carr's Index:
% Compressibility = [(TD − BD)/TD] × 100

Hausner's Ratio:
Hausner's Ratio = TD / BD
(Values <1.25 indicate good flow).

pH Determination

A 10% shampoo solution was prepared in distilled water and pH was measured at 25°C using a calibrated pH meter. Mild acidic pH is desirable to maintain scalp health and hair shine.

Particle Size

Determined by sieving method using standard I.P. sieves with mechanical shaking for 10 minutes.

Moisture Content

About 2 g of powder was dried at 105°C in a hot air oven until constant weight was achieved.

Ash Value

Total Ash: Determines total inorganic content. Acid Insoluble Ash: Indicates presence of silica and impurities.

Foaming Capacity

Two grams of shampoo powder was shaken with 50 ml water in a graduated cylinder. Foam height was measured at different intervals. Foaming Index = 1000/a

Skin Sensitization Test

The prepared formulation was applied on volunteers' skin and observed for irritation or allergic reactions.

Eye Irritation Test

A 1% shampoo solution was instilled into the eyes of albino rabbits under controlled conditions, and reactions such as redness or swelling were recorded.

RESULTS AND DISCUSSION

Herbal powder shampoos were formulated using selected medicinal plants including Ocimum sanctum (Tulsi) and Azadirachta indica (Neem) as antimicrobial agents, along with *Hibiscus rosa-sinensis* (Hibiscus), *Eclipta prostrata* (Bhringraj), *Phyllanthus emblica* (Amla), *Ziziphus jujuba* (Jujube), and *Sapindus trifoliatus* (Soapnut) as hair protective and cleansing agents. Six formulations (F1–F6) were prepared with varying concentrations of antimicrobial herbs and evaluated for physicochemical, safety, and antimicrobial parameters. All formulations were brown in color with characteristic odour and smooth texture. The powder blends were uniform and free from visible impurities. The overall appearance and organoleptic properties were found to be acceptable for cosmetic use. The micromeritic evaluation included angle of repose, bulk density, tapped density, Carr's index, and Hausner's ratio. Angle of repose: 43.86°–51.96°, Bulk density: 0.3333–0.5000 g/cc, Tapped density: 0.500–0.635 g/cc, Carr's index: 16.68%–33.34%, Hausner's ratio: 1.200–1.500. Formulations F4 and F5 showed comparatively better flow properties with lower Carr's index and Hausner's ratio values. F6 showed relatively higher compressibility, indicating comparatively poorer flow. Overall, the blends exhibited acceptable flow and packaging characteristics suitable for powder shampoo formulation.

The pH values ranged from 4.9 to 6.0. F1: 4.9, F2: 4.9, F3: 5.5, F4: 5.5, F5: 5.3, F6: 6.0. The pH range was within the mildly acidic range suitable for scalp application. F6 showed pH 6.0, which is closer to scalp pH, indicating better compatibility and reduced irritation potential. Ash values ranged from 4% to 8% w/w. F1: 4%, F2: 6%, F3: 8%, F4: 7%, F5: 5%, F6: 7%. The ash content indicates the presence of inorganic constituents. All formulations showed acceptable levels, confirming purity and minimal contamination. Moisture content was determined by drying at 105°C until constant weight was achieved. All formulations reached constant weight at approximately 50 minutes. Final constant weights (approximate): F1: 1.71 g, F2: 1.62 g, F3: 1.84 g, F4: 1.64 g, F5: 1.70 g, F6: 1.64 g. Low moisture content ensures better stability and prevents microbial growth during storage. Foaming capacity was evaluated over 5 minutes. Foam height ranged between 160–182 ml. F5 and F6 showed comparatively higher and stable foam volume, attributed to optimal Soapnut concentration and better saponin release. Foam stability gradually decreased over time but remained satisfactory across all formulations. The prepared shampoo was applied to volunteers' skin and observed after 10 minutes. No redness, itching, or irritation was reported. The formulations were considered safe and non-irritant for topical use. Eye irritation studies indicated mild transient irritation in experimental animals shortly after application, which subsided within 5–6 minutes. No severe or prolonged damage was observed (Table 1).

Table 1. Antimicrobial activity was evaluated against *Pityrosporum ovale* and *Escherichia coli*.

Formulation	P. ovale (mm)	E. coli (mm)
F1	12	11
F2	13	12
F3	15	14
F4	17	17
F5	23	20
F6	29	27

Results indicate that antimicrobial activity increased with higher concentrations of Tulsi and Neem. F6 exhibited the highest zone of inhibition against both organisms, demonstrating superior antimicrobial efficacy. The study successfully formulated and evaluated six herbal shampoo blends. Among them, F5 and F6 demonstrated better foaming ability and antimicrobial activity. F6, in particular, showed maximum microbial inhibition and acceptable pH, making it the most promising formulation. The results confirm that increasing concentrations of antimicrobial

herbs significantly enhance the shampoo's antimicrobial potential while maintaining desirable physicochemical properties. The developed herbal shampoo formulations provide an effective, safe, and natural alternative to synthetic shampoos.

CONCLUSION

The present study focused on the development and evaluation of an antimicrobial herbal shampoo powder formulated using selected medicinal plants. The primary objective was to investigate the effect of varying concentrations of herbal ingredients on microbial growth inhibition while ensuring safety and acceptable physicochemical properties. Hair care products are widely used for cleansing, conditioning, and maintaining scalp health. However, synthetic shampoos often contain chemical surfactants and preservatives that may cause irritation or long-term side effects. Therefore, the present work aimed to formulate a safe and effective herbal alternative using plant-based ingredients known for their antimicrobial and hair-protective properties. The medicinal plants selected for this study included *Ocimum sanctum* (Tulsi) and *Azadirachta indica* (Neem) as antimicrobial agents. These herbs are traditionally known for their antibacterial and antifungal properties. Hair-nourishing and protective herbs such as *Hibiscus rosa-sinensis* (Hibiscus), *Eclipta prostrata* (Bhringraj), *Phyllanthus emblica* (Amla), *Ziziphus jujuba* (Jujube), *Sapindus trifoliatus* (Soapnut), and *Lawsonia inermis* (Henna) were incorporated to enhance cleansing, conditioning, and strengthening effects. All selected plant materials were collected, shade-dried, and powdered. The formulations (F1–F6) were prepared by the trituration method using different concentrations of antimicrobial herbs. The variation in concentrations allowed evaluation of their influence on microbial inhibition and overall formulation performance.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

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AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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