

Botanical Shampoo Formulation: A Sustainable Approach to Hair Care- A Brief Review

Mr. Mujeeb Muhamadhusen Shaikh¹, miss.Aamna Farooque Shaikh²

MCEs Allana COLlege of Pharmacy Pune

Abstract—The rising concerns regarding the adverse effects of synthetic hair care products have led to a shift towards herbal formulations. Botanical shampoos, enriched with natural plant extracts, offer a safe and effective alternative to commercial shampoos containing sulfates, parabens, and silicones. This review explores the formulation, benefits, and evaluation of a sulfate-free herbal shampoo composed of Sidr, Tulsi, Moringa, Aloe Vera, and Coco Glucoside. These natural ingredients exhibit antimicrobial, antifungal, anti-inflammatory, and antioxidant properties that promote scalp health, strengthen hair follicles, and improve overall hair texture. The study further evaluates essential parameters such as pH balance, foaming ability, cleansing efficiency, conditioning properties, and microbiological stability. Comparative analysis with conventional shampoos reveals the advantages of herbal shampoos, including their ability to cleanse gently, maintain scalp moisture, and reduce the risk of irritation. Future perspectives in herbal shampoo research focus on sustainability, advanced herbal ingredient formulations, and consumer acceptance in the natural cosmetics industry.

I. INTRODUCTION

Hair care has been an integral part of human grooming for centuries, with civilizations worldwide utilizing natural ingredients for cleansing and conditioning. Traditional practices in Ayurveda, Traditional Chinese Medicine (TCM), and Unani medicine have long incorporated herbal extracts such as Sidr (*Ziziphus spina-christi*), Tulsi (*Ocimum sanctum*), and Moringa (*Moringa oleifera*) for their therapeutic benefits. These botanicals have been recognized for their ability to nourish the scalp, reduce dandruff, and promote hair growth.

The advent of modern cosmetic formulations led to the introduction of synthetic shampoos containing chemical detergents such as sulfates, parabens, silicones, and artificial fragrances. While these shampoos provided immediate foaming and

cleansing, studies have demonstrated their association with scalp irritation, excessive dryness, and potential long-term health concerns. Research has shown that sulfates, such as Sodium Lauryl Sulfate (SLS), strip the scalp of natural oils, leading to increased sensitivity, dandruff, and breakage-prone hair. Additionally, silicones form a coating over hair strands, which can cause buildup over time, reducing the effectiveness of natural conditioning agents.

With the increasing awareness of clean beauty and sustainable hair care, consumers are shifting towards herbal shampoos that offer effective cleansing while being free from harmful chemicals. Herbal shampoos are formulated with natural surfactants such as Coco Glucoside, which provide gentle yet effective cleansing without disrupting the scalp's pH balance. These shampoos not only cleanse the hair but also provide nourishment, hydration, and protection against environmental stressors. The incorporation of scientifically validated botanical extracts ensures that herbal formulations meet modern consumer demands for safe, eco-friendly, and high-performance hair care solutions.

II. KEY INGREDIENTS AND THEIR BENEFITS

Sidr (*Ziziphus spina-christi*) has been widely used in traditional Middle Eastern medicine for its remarkable cleansing and therapeutic properties. Rich in saponins, flavonoids, and tannins, Sidr acts as a natural surfactant, effectively removing dirt, oil, and impurities while maintaining scalp hydration. Its antimicrobial and anti-inflammatory benefits help combat dandruff, soothe irritated scalps, and promote hair strength. The presence of antioxidants further protects the hair from environmental damage, preventing premature aging and weakening of the strands.

Tulsi (*Ocimum sanctum*) is a well-documented Ayurvedic herb renowned for its potent antibacterial, antifungal, and anti-inflammatory effects. Tulsi plays a critical role in maintaining scalp health by eliminating microbial infections that lead to dandruff and scalp irritation. It enhances blood circulation in the scalp, stimulating hair follicle activity and promoting hair growth. Furthermore, its high antioxidant content neutralizes free radicals, preventing oxidative stress-induced hair thinning and premature graying.

Moringa (*Moringa oleifera*) is often referred to as the "Miracle Tree" due to its exceptional nutritional profile. It is packed with essential vitamins (A, C, E), minerals (zinc and iron), and amino acids that are crucial for hair growth and scalp nourishment. Moringa strengthens the hair shaft, reducing breakage and split ends, while its hydrating properties prevent scalp dryness and flakiness. The presence of powerful antioxidants in Moringa protects hair from environmental aggressors, ensuring healthier and shinier strands over time.

Aloe Vera (*Aloe barbadensis*) is widely recognized for its soothing, hydrating, and healing properties. It serves as an excellent natural conditioner, restoring moisture balance to the scalp and hair. Aloe Vera contains proteolytic enzymes that help repair dead skin cells on the scalp, reducing dandruff and promoting a healthy environment for hair growth. Its antimicrobial and anti-inflammatory attributes help alleviate scalp irritation while maintaining the hair's natural pH balance. Regular use of Aloe Vera-infused shampoos enhances hair texture, leaving it soft, manageable, and glossy.

Coco Glucoside is a plant-derived surfactant obtained from coconut oil and glucose, making it an eco-friendly and biodegradable alternative to synthetic detergents. It provides mild yet effective cleansing, ensuring that excess oil and dirt are gently removed without stripping the scalp's natural moisture. Coco Glucoside is known for its excellent foaming ability, contributing to a luxurious lather while maintaining a non-irritating and sulfate-free formulation. Its compatibility with sensitive scalps makes it a preferred choice in herbal shampoo formulations designed for daily use.

III. FORMULATION AND EVALUATION PARAMETERS

The herbal shampoo was formulated using a combination of bioactive herbal extracts, natural surfactants, and conditioning agents to ensure a balanced and effective formulation. The evaluation process focused on essential physicochemical parameters to assess its efficacy, stability, and safety. The pH of the shampoo was maintained within the ideal range of 4.5–5.5 to match the natural pH of the scalp, preventing irritation and maintaining hair's protective barrier. The foaming ability and foam stability were measured to ensure the shampoo provided sufficient lathering while being sulfate-free. The cleansing efficiency was tested by evaluating its ability to remove dirt, oil, and environmental pollutants without causing excessive dryness. Additionally, conditioning attributes were assessed to confirm that the formulation left hair soft, manageable, and frizz-free.

Microbiological stability tests ensured that the formulation remained free from bacterial and fungal contamination over time, ensuring product safety and longevity. The viscosity and surface tension of the shampoo were optimized to provide ease of application and efficient cleansing action. Dermatological safety tests confirmed that the shampoo was non-irritating, making it suitable for sensitive scalps.

IV. RESULTS AND DISCUSSION

The formulated herbal shampoo underwent a comprehensive evaluation based on key physicochemical parameters, including pH balance, foaming ability, cleansing efficiency, conditioning effects, and stability. The pH of the shampoo was found to be 5.09, which falls within the optimal range (4.5–5.5) for scalp health, ensuring mild cleansing without causing irritation. The shampoo exhibited excellent foaming capacity, producing a stable foam that remained intact for over 5 minutes, indicating effective surfactant activity despite being sulfate-free. The cleansing action of the herbal shampoo was tested on hair that had accumulated oil and dirt over a week. The formulation effectively removed excess oil and impurities without stripping natural scalp moisture. The dirt dispersion test confirmed efficient

emulsification of sebum and particulate matter, preventing redeposition onto the scalp.

The conditioning attributes were also evaluated post-application. Users reported improved hair texture, reduced tangling, and enhanced softness. The presence of Aloe Vera and Moringa contributed to hydration and nourishment, while Coco Glucoside ensured a gentle yet thorough cleansing experience. Additionally, skin irritation tests confirmed that the shampoo was hypoallergenic and safe for sensitive scalps.

Rheological analysis revealed that the shampoo had an ideal viscosity of 2.27 Pa·s, ensuring ease of application and uniform distribution across the scalp. The surface tension was measured at 22 mN/m, which indicated strong surfactant activity and effective spreading of the formulation. Furthermore, microbial stability tests confirmed that the shampoo remained free from bacterial and fungal contamination over an extended storage period, demonstrating product safety and longevity.

V. CONCLUSION

The formulated herbal shampoo demonstrated excellent cleansing efficiency, adequate foaming ability, and strong conditioning effects while maintaining a safe pH of 5.09. The shampoo effectively removed dirt and excess oil without stripping natural moisture, ensuring a gentle yet effective cleansing action. The foaming capacity, with a maximum foam height of 6 cm, indicated good surfactant efficiency despite being sulfate-free.

The conditioning properties were notable, as the shampoo left hair soft, manageable, and shiny without causing dryness. The wetting time of 5 seconds showed rapid penetration, and dirt dispersion tests confirmed effective emulsification of oils and impurities. No skin irritation was observed, supporting its suitability for sensitive scalps.

Furthermore, the shampoo exhibited ideal viscosity (2.27 Pa·s), ensuring ease of application, and a surface tension of 22 mN/m, indicating optimal surfactant activity. The solid content of 20% ensured stability and consistency in formulation.

The formulated herbal shampoo successfully meets the criteria for an effective, chemical-free, eco-friendly hair care product. By using natural surfactants, botanical extracts, and plant-based

thickeners, the shampoo provides mild yet efficient cleansing, hydration, and conditioning properties. The absence of sulfates, parabens, and synthetic chemicals ensures minimal scalp irritation, making it a safe and sustainable alternative to commercial shampoos. The study highlights the potential of traditional herbal formulations in modern personal care, paving the way for scientifically validated, naturally derived hair care solutions.

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