

Herbal Shampoo Formulation and Evaluation: A Scientific Approach to Sustainable Hair Care

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Abstract—The creation and assessment of a polyherbal shampoo as a natural, chemical-free substitute for store-bought hair care products is the main objective of the study. This formulation uses botanically derived chemicals to provide gentle yet efficient cleansing, conditioning, and scalp nourishment, in contrast to traditional shampoos that contain sulfates, parabens, silicones, and artificial preservatives.

The shampoo is enriched with Sidr (*Ziziphus spina-christi*), Tulsi (*Ocimum sanctum*), Moringa (*Moringa oleifera*), Aloe Vera (*Aloe barbadensis*), and Coco Glucoside, a biodegradable, plant-based surfactant that provides gentle cleansing while preserving the scalp's natural oils. Each herbal component was selected for its therapeutic properties, such as antibacterial, antifungal, anti-inflammatory, antioxidant, and hair-strengthening benefits. The formulation was meticulously developed to ensure optimal pH balance (4.5–5.5), maintaining scalp health and minimizing irritation. Comprehensive physicochemical evaluations were conducted, including pH determination, foaming ability, viscosity, wetting time, cleansing efficiency, conditioning properties, and microbiological stability. The shampoo exhibited good lathering capacity, effective dirt dispersion, and excellent conditioning effects without causing dryness or irritation. It successfully removed excess oil and impurities, leaving hair soft, manageable, and lustrous. This research demonstrates the potential of herbal formulations in modern hair care, offering an ecofriendly, non-toxic, and dermatologically safe alternative to synthetic shampoos. By merging ancient herbal knowledge with contemporary scientific validation, this study paves the way for sustainable, natural hair care solutions while addressing consumer demand for clean beauty products.

Index Terms—Herbal shampoo, Sidr, Tulsi, Moringa, Coco Glucoside, Natural Surfactants, Antibacterial, Scalp Health. pH balanced, Sulfate-free shampoo, Antifungal, Scalp Nourishment, Hair Strengthening, Eco-friendly, Biodegradable

I. INTRODUCTION

Hair care has long relied on natural ingredients for cleansing and nourishment. However, modern shampoos often contain harsh chemicals like sulfates, parabens, and silicones, which can cause scalp irritation, dryness, and environmental harm. As consumers seek gentler, eco-friendly alternatives, the demand for herbal, sulfate-free shampoos is rising. This project aims to develop a polyherbal shampoo using plant-based extracts and natural surfactants, ensuring effective cleansing, scalp nourishment, and sustainability.

This study integrates ancient botanical knowledge with modern scientific advancements to develop a mild yet effective herbal shampoo. The key ingredients in this formulation include:

Sidr Leaves (*Ziziphus Spina-Christi*): Used for centuries in Middle Eastern and Islamic traditions, Sidr leaves are rich in saponins, flavonoids, and tannins, making them a powerful natural cleanser, antibacterial agent, and scalp conditioner. Sidr is also mentioned in TibbeNabawi (Prophetic Medicine) for its purifying and healing properties, emphasizing its importance in holistic hair care.



Figure. No..01Sidr Tree



Figure. No..02Sidr Leaves

Tulsi (Ocimum Sanctum): Known for its potent antibacterial, antifungal, and anti-inflammatory effects, Tulsi helps to control dandruff, soothe scalp irritation, and strengthen hair follicles. It has been widely used in Ayurvedic medicine to combat hair fall and premature graying.



Figure.No 3 Tulsi Plant



Figure.No 4 Tulsi Leaves

Moringa (Moringa Oleifera): Often referred to as the "Miracle Tree," Moringa is a nutrient powerhouse packed with vitamins A, C, E, iron, and zinc, all of which are essential for hair growth, scalp hydration, and protection against oxidative stress.

Coco Glucoside (Natural Surfactant): Unlike synthetic surfactants such as Sodium Lauryl Sulfate (SLS), Coco Glucoside is a biodegradable, non-ionic surfactant derived from coconut oil and glucose. It provides gentle cleansing, rich lather, and excellent foaming ability without stripping the scalp of its natural oils.

The shampoo is carefully designed using a combination of scientifically validated herbal ingredients known for their cleansing, antimicrobial, and hair-strengthening properties. Instead of relying on sulfate-based detergents, this formulation incorporates plant-derived surfactants like Coco Glucoside, which cleanse the scalp without causing dryness or irritation. The inclusion of natural conditioners, humectants, and antioxidants ensures that the shampoo provides moisture retention, damage protection, and enhanced hair texture.



Figure.No.5 Moringa Tree



Figure.No.6 Moringa Leaves

Key ingredients include Sidr leaves (*Ziziphus spina-christi*), known for their antimicrobial and scalp-soothing properties; Tulsi (*Ocimum sanctum*), with antibacterial and antifungal benefits that control dandruff and promote hair strength; and Moringa (*Moringa oleifera*), rich in vitamins and minerals essential for hydration and protection. Coco Glucoside, a biodegradable natural surfactant, is incorporated to provide gentle cleansing without disrupting scalp moisture balance. Research highlights the effectiveness of these ingredients. Sidr has shown antimicrobial and cleansing efficacy, Tulsi enhances blood circulation and strengthens follicles, while Moringa's nutrients protect against oxidative

stress. Studies confirm Coco Glucoside's gentle cleansing and scalp compatibility. The goal of the research is to develop a gentle, efficient, and environmentally friendly shampoo that nourishes and cleanses hair from root to tip. In order to guarantee that the shampoo satisfies all crucial quality requirements, such as pH balance, foaming ability, viscosity, cleansing effectiveness, and scalp compatibility, the recipe combines traditional herbal knowledge with contemporary scientific developments. This study also investigates the formulation's environmental sustainability, making sure it is safe for frequent usage, biodegradable, and environmentally beneficial. In line with contemporary customer desires for safe, efficient, and ecologically friendly personal care products, our study helps produce clean, ethical, and plant-based hair care solutions by fusing natural components with scientific evaluation. Recent years have seen a significant amount of study on the creation and assessment of herbal shampoos, with studies emphasizing the advantages of plant-based constituents over traditional synthetic formulations. Numerous studies have looked at how natural surfactants, herbal extracts, and bioactive components can enhance hair growth, scalp health, and cleaning effectiveness without having the negative side effects of chemical-laden shampoos.

III. AIM & OBJECTIVE

The primary aim of this research is to formulate and evaluate a scientifically validated polyherbal shampoo that is natural, sulfate-free, and eco-friendly, ensuring effective cleansing, scalp nourishment, and hair conditioning while avoiding the harmful effects of synthetic chemicals. This formulation integrates traditional herbal wisdom with modern scientific advancements to develop a mild yet highly effective alternative to commercial shampoos, promoting scalp health, hair strength, and sustainability. The objective of this research is to develop and evaluate a polyherbal shampoo that is natural, free from sulfates, parabens, silicones, and artificial additives, while ensuring optimal cleansing, scalp nourishment, and hair conditioning. This study aims to integrate scientific formulation techniques with traditional herbal knowledge, using plant-based surfactants, natural conditioners, and therapeutic

botanical extracts to create a mild yet effective shampoo suitable for all hair types. The study also aims to confirm conditioning attributes, ensuring that the shampoo enhances hair texture, shine, and manageability while preventing dryness, frizz, and breakage. A crucial aspect of this study is its environmental sustainability, emphasizing the use of biodegradable, eco-friendly ingredients that do not contribute to water pollution. By replacing harsh detergents with gentle, plant-based alternatives, this research supports the global movement towards clean beauty and sustainable hair care. This study will assess the market feasibility of the formulated shampoo, ensuring that it is cost-effective, commercially viable, and aligned with modern consumer preferences for safe, ethical, and plant-based hair care solutions. By achieving these objectives, this research aims to set new standards in herbal hair care, proving that natural formulations can be both effective and environmentally responsible.

IV. MATERIALS AND METHODS

The formulation of the polyherbal shampoo involved carefully selected herbal extracts, natural surfactants, humectants, thickeners, preservatives, and essential oils to ensure optimal cleansing, conditioning, and microbial stability. All ingredients were cosmetic-grade and sourced from reliable suppliers. Sidr Leaf Extract, Tulsi Leaf Extract, Moringa Leaf Extract, Aloe Vera Gel, Coco Glucoside, Glycerin, Vitamin E, Rose Oil, Xanthan Gum, Germall Plus.

A. Extraction of Herbal Ingredients. Preparation of Sidr Leaf Extract: Sidr leaves (17g) were dried, powdered, and placed in a clean volumetric flask. 105mL distilled water and 45mL ethanol (30:70 hydroalcoholic solvent system) were added. The mixture was agitated in a shaking apparatus at room temperature for 24 hours for optimal phytochemical extraction. After filtration using muslin cloth, the extract was concentrated using a rotary evaporator at 40–50°C under reduced pressure. The final concentrated 25mL extract was stored in an amber glass container at 4°C for preservation.



Figure.No..7 Sidr Leaves Powder



Figure.No..8 Sidr Powder in Shaking Apparatus



Figure.No.9 Sidr Solution in Solvent on Rotary Evaporator

B. Preparation of Tulsi& Moringa Decoction: Tulsi powder (5g) and Moringa powder (6g) were transferred to separate beakers. Each was mixed with 150mL distilled water and heated to 80–90°C on a hot plate. The mixture was simmered for 30–45 minutes with occasional stirring to enhance phytochemical extraction. The decoction was allowed to cool naturally, then filtered using muslin cloth. The

clear aqueous decoctions were stored at 4°C for use in shampoo formulation.



Figure.No..10 Preparation of Tulsi Decoction and Moringa decoction on Hot Plate

C. Shampoo Formulation: The formulation process was divided into three phases:

i.Preparation of Aloe Vera Base :15g fresh Aloe Vera gel was transferred into a clean beaker.10mL Sidr extract and the contents of 1 Vitamin E capsule were added. The mixture was stirred continuously to form a homogeneous blend.



Figure.No.. 12 Aloe Vera, Sidr Extract & Vitamin E Blend

ii. Preparation of the Surfactant Phase 30mL Coco Glucoside was measured and mixed in a separate beaker. 15mL Tulsi decoction and 15mL Moringa decoction were added and stirred until fully blended. Since Coco Glucoside has a naturally alkaline pH (9–11), the pH was adjusted to 4.5–5.5 using citric acid, monitored with pH paper.

iii. Preparation of Thickening & Hydration Phase: 0.7g Xanthan Gum was first dispersed in 10mL Glycerin to ensure even hydration and prevent clumping. Germall Plus (0.5mL, preservative) was added to the mixture for microbial stability.

iv. Final Blending And pH Adjustments: The thickening and hydration phase was slowly poured into the Aloe Vera and surfactant mixture with continuous stirring to prevent lump formation. Few drops of Rose Oil were added for natural fragrance. The shampoo was allowed to rest for 3–4 hours to let the thickening agents fully hydrate and achieve the desired consistency. After the resting period, the pH of the shampoo was rechecked and further adjusted to

5.0 if necessary. Once the desired pH and viscosity were achieved, the shampoo was transferred into a sterilized container and stored in a cool, dry place for further evaluation.



Figure.No.13 Prepared Shampoo pH Check: pH 5

D.Evaluation of Herbal Shampoo

1.Physical appearance/visual inspection: The prepared formulation's clarity, color, odor, foam-producing capacity, and fluidity were assessed.

2.pH determination: A calibrated pH meter was used to determine the pH of a 10% v/v shampoo solution that had been made in distilled water.

3.Calculating the percentage of solid content: Four grams of shampoo were put to a dry, clean evaporating dish after it had been weighed. The shampoo-filled evaporating dish was set on the hot plate until the liquid was gone. After drying, the weight of the shampoo's solid ingredients was determined.

4.Wetting time: Place a dry cotton ball on the surface of a 1% shampoo solution, making sure it floats on its own without being forced under. Note the amount of time that passes between the cotton ball touching the solution's surface and it fully sinking.

5.Dirt dispersion: 10ml of distilled water was placed in a falcon tube with a wide opening, and two drops of herbal shampoo were added. After adding one drop of India ink, the falcon tube was covered and given 10 shakes. None, Light, Moderate, or Heavy were the estimated amounts of ink in the foam.

6.Cleaning action: To test the herbal shampoo's cleansing ability, it was applied to hair that hadn't been washed in seven days. The human subjects' hair was washed with shampoo after applying oil for four to five hours. The shampoo's effectiveness was evaluated based on its capacity to cleanse the scalp of greasy debris.

7.Foaming ability and foam stability: The foaming ability was assessed using the cylinder shake method. A 250 ml graduated cylinder was filled with 50 ml of the 1% herbal shampoo solution, and the cylinder was covered with hands and shook for ten minutes.

Following a minute of shaking, the total amount of the foam content was noted. As soon as the foam was shaken, the volume was measured every minute for ten minutes. The foam volume stays constant for around five minutes, indicating that the shampoo's produced foam contains good stability and that the prepared shampoo has higher foam properties, maybe as a result of the soapnut.

8.Skin Irritation Test: After applying a prepared herbal shampoo to the skin for five minutes, it was rinsed off and examined for signs of inflammation or irritation.

9.Conditioning attributes: Following a shampoo wash, the shampoo's conditioning impact on the hair was assessed. All of the desired advantages that are given to the hair, such as increased mass, enhanced luster, softness, and silkiness, are referred to as conditioning qualities.

10.Rheological evaluation: Ostwald's viscometer was used to measure the herbal shampoo's viscosity. By counting the drops of herbal shampoo from the mark to the bottom, the viscosity of the product was determined.

$$\eta_{ny} = \eta_{nw} \frac{\rho_{ty}}{\rho_{wtw}}$$

▪ η_{nw} : water viscosity ▪ η_{ny} : liquid viscosity under test

▪ ρ_{ty} : density of the liquid being tested ▪ ρ_{wtw} : density of water

▪ t_y : time of water runoff ▪ t_w : timing of liquid test runoff

11. Surface tension measurement: Using a stalagnometer and herbal shampoo, measurements were made. The idea is to determine the fluid's surface tension by weighing the drops of herbal shampoo that fall from a capillary glass tube. By counting the falling drips, we can calculate their weight. It allows us to calculate the surface tension as follows:

$$ST = \frac{n_l}{n_w} \times \frac{d_l}{d_w} \times t_w$$

▪ n_l : number of liquid droplets ▪ n_w : number of water droplets ▪ d_l : liquid density

▪ d_w : water density ▪ t_w : 71.2 dyne/cm

V. RESULTS AND DISCUSSION

1.Physical Appearance: Colour: Brown, Odour: Floral (rose), Texture: Gel like



Figure.No..14physical Attributes of Shampoo

2.Determination of pH: pH determination: It was discovered that the herbal shampoo had a pH of 5.09. The ideal pH range for hair care products is between 4.5 and 5.5.



Figure.No..15 Prepared Shampoo pH Check

3.Calculation of solid content percentage: It was discovered that the herbal shampoo had 0.6 grams of solid content. It was discovered that the solid content was 20%. This shows the percentage of non-volatile ingredients in the mixture, which enhances the product's overall stability, uniformity.



Figure.No.16 Solid Content

4.Wetting time: The cotton ball soaked in water in under five seconds, demonstrating the herbal shampoo's strong wetting capacity. A shorter wetting time indicates efficient surfactant activity, which facilitates shampoo penetration and spread for improved cleaning results.

5.Dirt dispersion: The fact that the ink was discovered in the foam suggests that the shampoo has a strong cleaning capacity. In order to prevent redeposition, effective dirt dispersion guarantees that oils and dirt are appropriately emulsified and removed from the hair after washing.

6. Cleaning action: The herbal shampoo demonstrated good cleansing action by successfully removing greasy debris from the scalp. The

shampoo's ability to break down and remove accumulated impurities was demonstrated by the hair's appearance after washing, which was clean and devoid of excess oil.

7. Foaming ability & foam stability: By measuring the height of the foam at various shampoo concentrations, the herbal shampoo's foaming ability was assessed. The following were the outcomes: 3.5 cm of foam height for 1 mL of shampoo 4 cm of foam height → 2 mL of shampoo 3 mL of shampoo → 6 cm of foam

This suggests that a substantial amount of foam is produced by the shampoo, with the foam height increasing as the shampoo concentration rises

8. Skin Irritation Test: The herbal shampoo was tested for skin irritation, and upon application, no symptoms of redness, itching, or irritations were seen. This suggests that the shampoo is gentle and safe making it appropriate for frequent use.

9.Conditioning Attributes: Good conditioning qualities were demonstrated by the herbal shampoo. Following application, there was less tangling and the hair felt pliable and soft. The hair maintained its natural sheen and was not overly dry. These findings imply that the shampoo has sufficient conditioning benefits, enhancing the texture and general look of the hair.

10.Rheological Evaluation: The herbal shampoo's viscosity, as determined by rheological study, was 2.27 Pa (2270 cP), falling within the ideal range for shampoos. This viscosity offers efficient foaming and washing qualities while guaranteeing a smooth, pourable consistency that is simple to apply and spread over the hair.



Figure.No.17Rheological evaluation with oswalds viscometer

11. Surface tension measurement: Using a stalagmometer, the herbal shampoo's surface tension was determined to be 22 mN/m. The optimal range of 30 to 40 mN/m, which indicates significant surfactant activity, is exceeded by this. Lower surface tension enhances foaming and spreading, but it might also signal excessive foaming or quicker rinsing, which could reduce the effectiveness of cleansing.



Figure.No.18 Surface tension determination of shampoo with Stalagmometer

VI. CONCLUSION

While keeping a healthy pH of 5.09, the herbal shampoo formulation showed good cleansing effectiveness, sufficient foaming power, and potent conditioning effects. The shampoo ensured a mild yet efficient washing action by successfully removing debris and extra oil without depleting natural moisture. Despite being sulfate-free, the foaming capability showed good surfactant efficacy with a maximum foam height of 6 cm. The shampoo's conditioning qualities were noteworthy since it left hair feeling lustrous, manageable, and soft without making it dry. Fast penetration was demonstrated by the 5-second soaking time, and tests of dirt dispersion verified that oils and pollutants were effectively emulsified. Its suitability for sensitive scalps is supported by the absence of skin irritation.

Additionally, the shampoo had a surface tension of 22 mN/m, which indicated appropriate surfactant activity, and an ideal viscosity (2.27 Pa·s), which ensured ease of application. Stability and consistency in the formulation were guaranteed by the 20% solid content.

The herbal shampoo effectively satisfies the requirements for an eco-friendly, chemical-free, and

efficient hair care product. The shampoo offers gentle yet effective cleansing, moisturizing, and conditioning qualities through the use of natural surfactants, botanical extracts, and plant-based thickeners. Because it doesn't contain sulfates, parabens, or artificial chemicals, it causes less irritation to the scalp, making it a sustainable and safe substitute for store-bought shampoos. The study opens the door for organically derived, scientifically validated hair care products by highlighting the potential of ancient herbal compositions in contemporary personal care.

The purity, efficacy, and environmental safety of this herbal shampoo formulation may be preserved while it is further developed for commercial viability.

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