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Formulation and Evaluation of a Multicomponent Herbal Shampoo for Enhanced Hair and Scalp Health

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Herbal shampoo, surfactant activity, foaming stability, hair care, Ayurvedic formulation, natural cleanser

Abstract

The study focuses on the formulation and evaluation of a novel herbal shampoo as a natural alternative to synthetic commercial products. Synthetic shampoos, though effective, are often associated with adverse effects such as scalp irritation, hair dryness, and hair fall due to the presence of harsh detergents and chemical additives. In response, the present research aimed to develop a safe, eco-friendly, and effective herbal formulation using traditional medicinal plants, including bhringraj, soap nut, shikakai, amla, Senna, hibiscus, aloe vera, lemon juice, rose oil, and gelatin. The shampoo was prepared through Soxhlet extraction and evaluated for its physicochemical and functional properties. Tests performed included physical appearance, pH measurement, per cent solid content, wetting time, dirt dispersion, foaming ability, foam stability, and surface tension analysis. Results revealed that the herbal shampoo had a mildly acidic pH (6.5), consistent with ideal hair care standards. Solid content was measured at 1%, indicating a light formulation. The wetting time was three seconds, demonstrating quick cleansing action, while the dirt dispersion test showed adequate cleansing capacity. Foaming studies confirmed moderate foam stability, and surface tension measurements (30–40 dynes/cm) highlighted vigorous surfactant activity comparable to synthetic shampoos. Overall, the formulated herbal shampoo demonstrated desirable qualities, including effective cleansing, good surface activity, and environmental safety, validating the potential of herbal alternatives in the personal care industry. The findings support consumer preferences for natural, safe, and sustainable products that do not compromise performance or quality.

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1. Introduction

Shampoos are widely recognized as cosmetic products primarily used to maintain scalp and hair hygiene in daily routines. They often serve a dual purpose, not only cleansing the hair but also enhancing its appearance. Typically, shampoos are thick liquid formulations consisting of detergents blended with preservatives, additives, and active ingredients. The application process involves spreading the shampoo on damp hair, gently massaging it into the scalp, and rinsing it off using water [1]. Most shampoos are detergent-based solutions that may include additional agents to offer benefits such as conditioning, lubrication, or therapeutic effects. Presently, the market provides a range of synthetic, herbal, medicated, and unmedicated shampoo options. Among these, herbal shampoos have gained significant popularity due to the perception that they are entirely natural and carry a lower risk of adverse effects. Surfactants are usually added to enhance the lathering and cleansing properties of shampoos [2]. However, prolonged or frequent use may contribute to issues such as hair dryness, hair loss, and eye irritation. Shampoos are among the most commonly used cosmetic products in our everyday routines, primarily for cleansing the hair and scalp. Herbal shampoos are a type of cosmetic formulation that incorporates

traditional Ayurvedic herbs to serve the same cleansing purpose as regular shampoos. These herbal variants are particularly effective in removing oil, dandruff, dirt, and environmental pollutants. Unlike conventional shampoos, which often rely on synthetic chemicals, herbal shampoos utilize plant-derived ingredients and are considered a safer, more health-conscious alternative. Their growing popularity is primarily attributed to the belief that natural merchandise is gentler and devoid of adverse effects [3].

Modern shampoos come in a wide range of types, including herbal, synthetic, and non-medicinal varieties. However, there is a noticeable shift among consumers toward herbal products. This pattern is fuelled by growing awareness and concern about the possible side effects of synthetic shampoos, which often contain surfactants that can cause scalp and eye irritation, hair dryness, and even hair loss with prolonged use [4]. Herbal shampoos, by contrast, are perceived as safer because they are formulated from natural sources. Still, creating an entirely natural shampoo that matches the cleansing power, foaming ability, and solid content of synthetic ones is quite challenging. Many medicinal plants, renowned for their beneficial effects on hair health, have been utilized for centuries in various parts of the world. These herbal ingredients can be employed in multiple forms, such as crude powders, purified extracts, or derivatives [5].

Despite their appeal, herbal shampoo formulations present several challenges. It isn't easy to develop a product using only one natural ingredient that can compete with synthetic shampoos in terms of performance. A successful herbal shampoo must effectively cleanse, produce adequate foam, and condition the hair without causing harm [6]. Thus, formulating a herbal shampoo often involves combining multiple plant-based ingredients that are traditionally recognized for their beneficial effects on hair care. In regions like India and the Gulf countries, particularly Oman, traditional plant-based methods for hair washing remain popular. This has inspired continued innovation and research into herbal shampoos that align with cultural practices and meet modern consumer expectations for safety, efficacy, and environmental responsibility [7].

2. Anatomy of Hair

The structure of hair and the scalp is composed of several key components, each playing a crucial role in maintaining hair health and function. The visible, non-living portion of the hair that extends above the scalp is referred to as the hair shaft. It is the portion of hair with three layers the Cuticle, Cortex, and occasionally the medulla, mainly composed of keratin and styled, cut, or coloured. While it does not influence hair growth, the condition of the shaft reflects how well the hair has been maintained and protected from damage [8]. The sebaceous glands are located in the skin and connected to hair follicles. They secrete sebum, a natural oil that moisturizes both the scalp and hair. Sebum prevents dryness, reduces frizz, protects from environmental damage, and gives hair its natural shine and smoothness. Beneath the scalp lies the hair's base, which is embedded in the hair shaft. This section is vital for hair growth, as it receives nutrients and oxygen via blood vessels connected to the dermal papilla. The follicle surrounding the root provides structural support and houses the cells that multiply and form the hair strand [9].

The dermal papilla, which is at the follicle's base, plays an integral part in nourishing the hair. It is rich in blood vessels that supply essential nutrients and oxygen directly to the hair root, promoting the growth of strong and healthy hair. Without it, hair would lack the resources needed for proper development. Supporting both nourishment and sensory function are the nerves and blood vessels within the dermal papilla [10]. They not only transport nutrients but also transmit environmental signals, contributing to the scalp's sensitivity and protective responses. Ultimately, the sweat glands in the scalp play a crucial role in regulating body temperature and facilitating skin detoxification. By producing sweat, they help cool the body and remove minor waste products through the skin, thereby maintaining a healthy and balanced environment on the scalp [11].

Hair is primarily composed of keratin, a protein that is fibrous and has a helical structure that makes up about 95% of its composition. As an extension of the skin, hair shares similarities with other keratinized structures, including body hair and nails. The hair shaft is structurally divided into three primary layers: the medulla, Cortex, and Cuticle. The Cuticle, the outermost layer, serves as a protective shield and consists of keratinized cells shaped like overlapping scales, each approximately 60 micrometres in length and 6 micrometres in width [12]. This layer plays a crucial role in maintaining hair health. The Cortex, which is the part that lies beneath the Cuticle, is the central and most substantial part of the hair. The hair's strength, flexibility, and elasticity are all due to its long chains of keratin. The cortex cells are held together by an intercellular matrix rich in proteins and lipids, which further supports the hair's structural integrity. At the core, the medulla is part of the hair shaft. The innermost layer is made up of a soft, oily, and amorphous material. While the medulla's exact function remains unclear, it is believed to be involved in the overall structure of specific hair types [13].

Figure 1 is a diagrammatic representation of hair anatomy, showing a cross-section of the scalp and the hair's structure as it is rooted in the skin layers. It clearly distinguishes the external Hair Shaft, composed of the protective Cuticle, the structural Cortex, and the central Medulla, from the internal structures. The hair's base, or Hair Root, is encased by the Hair Follicle, which is essential for growth. Crucially, the diagram highlights the Dermal Papilla, rich in Blood Vessels that provide necessary nourishment, as well as accessory organs like the Sebaceous Gland for natural lubrication and the Arrector Pili Muscle. This visual serves as a fundamental reference for understanding the health and biological mechanics of hair [14].

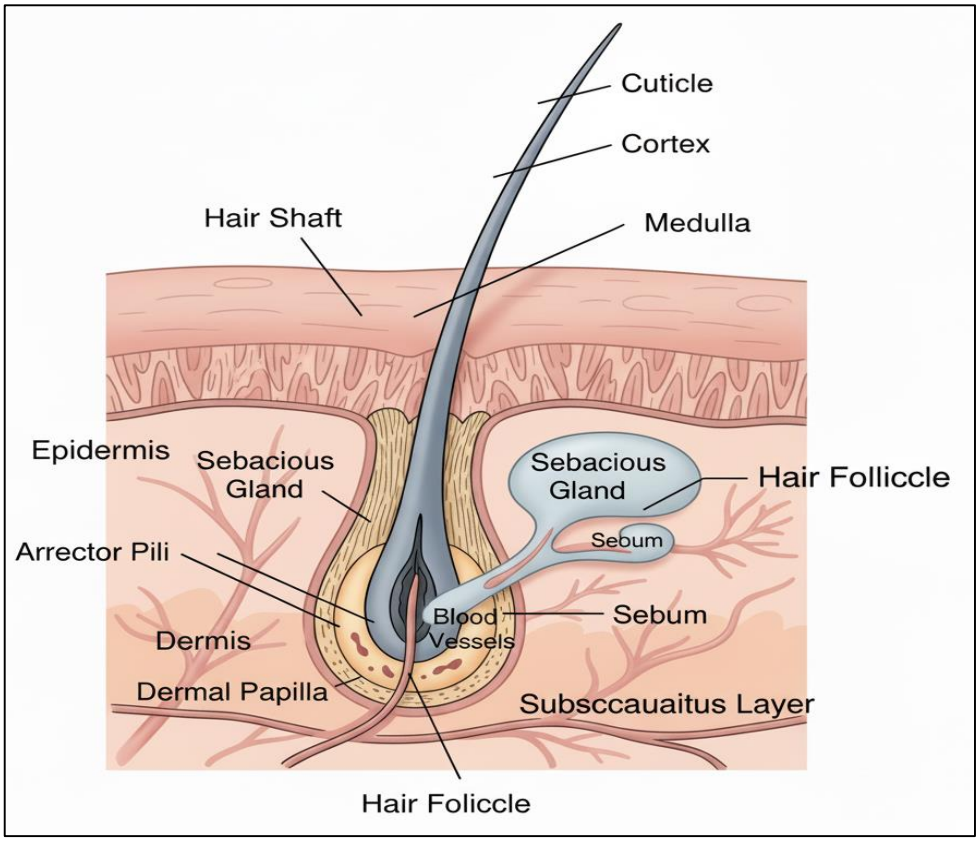

Figure 1: Diagrammatic representation of hair anatomy showing the structural components of the hair shaft and follicle; *The Figure clearly delineates the key structures of hair anatomy, which is crucial for understanding the product's function. The visible part, the Hair Shaft, is detailed with its layers: Cuticle, Cortex, and Medulla. Below the skin, the Hair Follicle houses the Hair Root and connects to the Dermal Papilla, which is sustained by Blood Vessels and a Nerve. Accessory organs are also labelled, including the oil-producing Sebaceous Gland and the Arrector Pili Muscle, all embedded within the Epidermis and Dermis layers of the scalp.*

2.1 Hair Problems

Hair is susceptible to a variety of common problems that can affect its health, appearance, and growth. One such issue is dandruff**,** a mild, non-inflammatory scalp condition characterized by the shedding of flaky skin. Although not harmful, dandruff can cause discomfort and may be associated with hair thinning due to scalp irritation, with flakes often clinging to the roots [15]. Another prevalent concern is hair loss**,** which psychological stress, hormonal imbalances, the use of certain medications, or the overuse of hairstyling products can cause. These factors disrupt the normal hair growth cycle, resulting in thinning or excessive shedding. Oily or greasy hair occurs when the sebaceous glands produce excess sebum, making the scalp and hair appear greasy even after frequent washing [16].

In contrast**,** dry hair is often a result of inadequate protein or essential nutrient intake. Hormonal changes, such as menopause, anaemia, or the use of hormonal contraceptives, can also influence it. This lack of moisture leads to brittle, dull strands. Lastly, split ends are a sign of hair damage, often caused by dehydration, excessive heat styling, chemical treatments, or environmental stressors. Hair weakens and splits at the ends when exposed to damaging conditions, compromising its overall health and appearance [17].

2.2 Benefits of Using Herbal Shampoo

Herbal shampoos are gaining popularity due to their gentle nature, natural composition, and numerous benefits for both the scalp and hair. Unlike conventional shampoos, which frequently contain synthetic fragrances, sulphates, harsh chemicals, and parabens, herbal shampoos are formulated with ingredients derived from plants that complement the body's natural processes. One of the primary benefits of herbal shampoos is their ability to enhance the natural shine and radiance of the hair. With regular use, they nourish each strand from root to tip, reviving dull, lifeless hair and bringing out its inherent lustre. This results in a smoother, more polished appearance that reflects overall hair health, all without the need for artificial glossing agents or silicones [18].

Another key benefit of herbal shampoos lies in their mild and soothing formulations. These products are designed with skin-friendly ingredients that are gentle on the scalp, making them suitable for all skin types, including sensitive or allergy-prone individuals. Herbal shampoos help maintain the scalp’s natural oil balance, which is crucial in preventing dryness, flaking, and irritation. Ingredients such as aloe vera, neem, tea tree oil, and chamomile are frequently used for calming and anti-inflammatory properties. Because they are free from harmful chemicals, these shampoos are less likely to cause long-term damage or allergic reactions, offering a safer and more natural alternative for daily use [19].

In addition to cleansing and soothing the scalp, herbal shampoos also provide excellent protection for colour-treated hair. Many formulas are enriched with

ingredients that form a protective barrier around the hair shaft, locking in colour and shielding it from fading due to sun exposure, pollution, and frequent washing. This helps maintain the richness and vibrancy of hair colour over a more extended period, reducing the need for frequent salon visits or touch-ups [20].

Herbal shampoos also contribute significantly to the strength and durability of hair. By delivering essential nutrients and moisture to the scalp and hair follicles, they help reduce breakage and prevent split ends. Ingredients such as amla, bhringraj, hibiscus, and fenugreek are renowned for their strengthening properties and are commonly found in herbal hair care products. These natural compounds fortify the hair from within, making it more resilient to damage caused by heat styling, chemical treatments, and environmental stress [21]. Another notable benefit is the ability of herbal shampoos to combat hair fall and promote healthier hair growth. They work by nourishing the scalp, stimulating blood circulation, and strengthening the roots. This reduces hair shedding and supports the natural growth cycle, resulting in thicker, fuller hair over time. Regular application of herbal shampoos can also improve scalp health by addressing issues like dandruff, itchiness, and inflammation, which are often the underlying causes of hair thinning [22].

Herbal shampoos offer a comprehensive approach to hair care by combining gentle cleansing with therapeutic and protective benefits. They enhance shine, protect colour, strengthen strands, and reduce maintenance and hair fall, all while being kind to the environment and free from harmful chemicals. For anyone seeking a natural, effective, and safe alternative, herbal shampoos are an excellent choice [23].

2.3 Essential Qualities of Herbal Shampoo

Herbal shampoos are favoured not only for their natural ingredients but also for the unique qualities that make them gentle, effective, and user-friendly. Among the most important attributes is their low irritation potential, making them ideal for people with sensitive skin. Unlike many commercial shampoos that contain sulphates and harsh detergents, herbal shampoos are designed to cleanse without triggering redness, itching, or dryness. They help maintain scalp comfort and are suitable for regular use, even for those prone to allergic reactions or scalp sensitivities. Their soothing ingredients, such as aloe vera, chamomile, or calendula, contribute to a balanced and calm scalp environment [24]. Another essential quality is the formulation stability of herbal shampoos. These products are designed to retain their effectiveness over time, with active botanical ingredients remaining potent and unaltered throughout their shelf life. This ensures consistent results with each use, even after prolonged storage. Stability is crucial because the breakdown of herbal extracts or oils over time can reduce a product's efficacy and alter its texture or fragrance [25]. A stable formulation provides users with confidence in the quality and performance of the shampoo from the first use to the last. Herbal shampoos are also known for their easy application and smooth distribution. Their lightweight texture allows them to spread evenly across the scalp and through the hair, ensuring that the product covers all areas without leaving buildup or residue. This makes the application process convenient and quick, regardless of hair type or length. Whether applied by hand or using an applicator, the even distribution of the shampoo ensures thorough cleansing and maximizes the benefits of its active ingredients [26].

A key function of any shampoo is cleansing, and herbal shampoos achieve this with a gentle yet effective cleaning action. They are capable of removing sweat, dirt, oil, and other impure substances from the hair and scalp without stripping the natural fats that are essential for hair health. This balanced cleansing helps maintain the health of your scalp. The microbiome helps prevent concerns such as dryness or excessive oil production. As a result, hair feels clean, refreshed, and naturally soft after each wash [27]. Lastly, herbal shampoos often provide conditioning and detangling benefits, which enhance manageability after washing. Many formulas include natural conditioning agents such as hibiscus, fenugreek, or coconut milk, which add slip and smoothness to the hair. This reduces friction between strands, making it easier to detangle wet hair and minimizing breakage during combing. These properties are particularly beneficial for individuals with long, curly, or easily tangled hair, making post-wash styling more efficient and less damaging. The essential qualities of a good herbal shampoo include skin-friendliness, formulation stability, ease of use, effective cleansing, and support for detangling. These attributes make herbal shampoos a reliable and beneficial choice for maintaining healthy, manageable hair with the added advantage of natural care [28].

2.4 Advantages of Choosing Herbal Shampoo

Entirely cruelty-free, developed without any form of animal testing at any stage of production. Committed to ethical standards, we ensure that no animals are harmed or used in our testing processes. This approach reflects a dedication to compassionate practices while delivering effective and safe results for consumers [29]. It is specially formulated to be gentle and safe for sensitive skin types. It contains mild ingredients that minimize the risk of irritation or adverse reactions, providing soothing care while maintaining skin comfort. Ideal for those with delicate skin, it delivers effective results without compromising safety or causing discomfort [30].

Using organic and environmentally friendly materials, reflecting a commitment to sustainability and eco-conscious practices. By incorporating natural, responsibly sourced ingredients, it minimizes environmental impact while ensuring safe and effective care. This approach supports both the health of consumers and the wellbeing of the planet. It is made from pure, unadulterated plant-based ingredients, ensuring a natural and wholesome formulation. Free from synthetic additives or chemicals, it harnesses the benefits of nature to provide gentle and effective care. This commitment to purity supports a healthier understanding of both the scalp and hair, aligning with clean beauty principles [31].

Surfactants or foaming agents make it gentle and suitable for sensitive scalps and hair. By avoiding aggressive cleansing ingredients, it helps maintain the natural moisture balance while effectively cleansing the skin.

This mild formulation reduces the risk of dryness and irritation, promoting healthier hair and scalp with regular use [32].

4. Materials and Methods

4.1 Materials

IIMT College of Medical Sciences collected all the herbal materials used in this study. These included Bhringraj, soap nut, shikakai, amla, Senna, hibiscus, aloe vera, and gelatin. Additional materials such as lemon juice and rose oil were procured from the local market.

4.1.1 Bhringraj

Bhringraj (Eclipta Alba or Eclipta Prostrata) is a renowned herb in Ayurveda, often referred to as the "King of Hair" due to its outstanding benefits for hair health. It is primarily used to treat hair problems, including dandruff, baldness, hair loss, and premature greying. It is common practice to apply the oil that is made from its leaves to the scalp to nourish the roots and encourage hair growth [33]. Apart from hair care, Bhringraj is also known for its effectiveness in improving liver function. It acts as a natural detoxifier and supports the regeneration of liver cells. It is beneficial in treating conditions such as jaundice and fatty liver disease. In traditional medicine, Bhringraj is also used for skin disorders, respiratory issues, and digestive problems [34].

4.1.2 Soap Nut

Soap nut, also known as *Sapindus mukorossi*, is a natural and environmentally friendly cleanser that has been traditionally used for generations, particularly in Asian countries. It is derived from the dried outer shell of the soapberry fruit, which is rich in saponins —a natural substance that creates a gentle lather when mixed with water. This lather works as a natural detergent, suitable for cleaning laundry, personal care, and household surfaces. Because soap nuts are entirely free of synthetic chemicals and are biodegradable, they are an excellent choice for individuals with sensitive skin, allergies, or those who are mindful of reducing their environmental impact [35]. They have gained popularity among people striving for a zero-waste lifestyle, as they help reduce plastic packaging and exposure to chemicals. Beyond their everyday use in washing clothes, soap nuts are also used to make homemade products, such as shampoos, body cleansers, dishwashing liquids, and even insect repellents. They provide an effective yet gentle cleaning solution, proving to be a sustainable and versatile alternative to conventional cleaners. It helps minimize hair fall and plays a role in preventing dandruff. Additionally, it combats scalp infections and promotes healthy hair growth while serving as a natural cleanser for the scalp [36].

4.1.3 Shikakai

Shikakai is a well-known Ayurvedic herb, scientifically known as Acacia concinna, widely recognized for its natural cleansing and medicinal properties. Often referred to as "fruit for hair," shikakai has been used for centuries in India as a natural alternative to commercial shampoos. It contains essential nutrients, including vitamins A, C, D, and K, that nourish hair follicles, promoting growth and reducing dandruff. When used regularly, shikakai helps strengthen the hair from the roots, reduce hair fall, and add natural shine and softness. Unlike chemical shampoos, it does not strip the scalp of its natural oils, making it ideal for people with sensitive skin or dry scalp conditions [37]. Shikakai is typically used in powdered form or as an ingredient in herbal hair cleansers and masks. Its gentle, pH-balanced nature also helps detangle hair easily and keep it smooth without causing damage. Due to its antifungal and antibacterial properties, shikakai also promotes overall scalp health. In recent times, the popularity of natural and sustainable hair care products has brought shikakai back into the spotlight as a valuable, eco-friendly solution for maintaining healthy, beautiful hair. It helps manage hair fall while nourishing the hair to encourage rapid and healthy growth. This also helps prevent split ends, naturally cleanses the scalp and hair, and enhances overall shine and smoothness [38].

4.1.4 Amla

Amla, also known as Indian Gooseberry, botanically as Emblica officinalis, is one of the most important medicinal plants in Ayurveda. It is a rich source of Antioxidants, vitamin C, and essential nutrients that support overall health and wellbeing. Amla is primarily known for boosting immunity, improving digestion, and enhancing the health of skin and hair. The high Vitamin C content strengthens the immune system and helps the body fight infections [39]. Additionally, it is a potent antioxidant that slows down the ageing process and protects the body from oxidative stress. Amla also helps the heart by regulating blood pressure and reducing low-density lipoprotein (LDL) cholesterol. It helps treat respiratory issues and urinary tract infections thanks to its antibacterial and anti-inflammatory properties. It reduces hair fall and helps treat or prevent dandruff and scalp dryness. Additionally, it combats fungal and bacterial infections affecting the scalp and hair, while improving the hair's overall health and appearance [40].

4.1.5 Senna

Senna is a well-known medicinal plant primarily utilized for its powerful laxative properties. The botanical name of Senna is *Senna alexandrina*, and it has been used for centuries in traditional medicine. Systems like Ayurveda, Unani, and Western herbal medicine. The active compounds in Senna are called sennosides, which stimulate the body's muscles and intestines and help relieve constipation [41]. Due to its effectiveness, Senna is commonly used in herbal teas, tablets, and powders formulated for the short-term treatment of constipation and bowel cleansing before medical examinations, such as colonoscopies. In Ayurveda, Senna (also known as Swarnapatri) is valued for its ability to balance the Vata, Kapha, and doshas. It not only relieves constipation but also helps in detoxification, assisting in the elimination of ama (toxins) from the digestive tract [42].

4.1.6 Hibiscus

Hibiscus is a flowering plant known for its vibrant, colourful blooms and a wide range of medicinal and cosmetic uses. The botanical name of the commonly used species is *Hibiscus rosa-sinensis*, and it is revered in Ayurveda, Unani, and traditional folk medicine systems. Hibiscus flowers and leaves are rich in vitamins, including vitamin C, and natural antioxidants. One of its most popular uses is in hair care**.** Hibiscus is known to

promote hair growth, prevent hair loss, and delay premature greying. It also helps treat dandruff and nourish the scalp, making hair soft and lustrous. Hibiscus oil and powder are often used in herbal shampoos and hair masks [43]. In Ayurveda, Hibiscus is used as a rejuvenating herb**.** It is believed to balance all three doshas Vata, Pitta**,** and Kapha but is especially beneficial for Pitta by cooling the body. The flower is also used in making herbal teas (Hibiscus tea), which are known to help in lowering blood pressure, enhancing cardiovascular health, and aiding in weight loss. It encourages hair regrowth while restoring lost volume and shine. The treatment deeply conditions the hair, helping to prevent baldness with effects similar to those of Minoxidil and Finasteride [44].

4.1.7 Aloe Vera

Aloe Vera, also known as Aloe barbadensis Miller, is a succulent plant renowned for its remarkable cosmetic and therapeutic properties. It has been used in Ayurveda, Unani, Chinese, and other traditional medical systems for centuries. Minerals (calcium, magnesium and zinc), vitamins (A, C, E, B12), enzymes, amino acids, and antioxidants can all be found in the gel that is extracted from Aloe Vera leaves [45]. Skin care is one of its most common applications. The healing and calming properties of aloe vera gel are well-known. It treats sunburn, minor cuts, wounds, acne, and other skin irritations. It nourishes the skin, reduces inflammation, and encourages skin tissue regeneration. It functions as a natural conditioner and moisturizer, promoting hair growth and enhancing natural curls. Additionally, it helps reduce frizz and tangles, soothes an itchy scalp, removes excess oil, and strengthens hair strands [46].

4.1.8 Lemon Juice

Lemon juice, extracted from fresh lemons (*Citrus limon*), is a rich natural source of vitamin C, citric Acid, antioxidants, and flavonoids. It is widely used not only for its refreshing taste and culinary applications but also for its numerous health and medicinal benefits. One of the most well-known benefits of lemon juice is its immune-boosting property [47]. The high content of Vitamin C protects the body from infections, strengthens the immune system, and fights colds and flu. It also supports wound healing and stimulates the production of collagen, a protein essential for maintaining healthy skin, joints, and tissue. It enhances hair shine, aids in the removal of dandruff, treats split ends, reduces hair loss, and provides a hue that is characteristic of the hair [48].

4.1.9 Rose Oil

Rose oil, often referred to as "liquid Gold," is a precious essential oil extracted from the petals of various types of roses, primarily Rosa damascena (Damask rose) and Rosa centifolia. The process of extraction is delicate and labour-intensive, typically involving steam distillation or solvent extraction to preserve the potent aromatic and therapeutic properties of the oil. It takes thousands of rose petals to produce just a few milliliters of rose oil, which is why it is considered one of the most luxurious and expensive essential oils in the world. Its aroma is rich, floral, sweet, and intoxicating, making it a favourite in perfumery and high-end skincare. It stimulates hair growth, helps reduce dandruff, imparts a pleasant fragrance to hair products, and aids in repairing damaged hair [49].

4.1.10 Gelatin

Gelatin is a natural, translucent, and flavourless substance derived from collagen, a protein found in the connective tissues, bones, and skin of animals, particularly cows and pigs. It is obtained through a process of boiling these animal parts, which breaks down the collagen into a soluble form. When cooled, this substance forms a jelly-like consistency, which is what we know as gelatin. Though it may seem simple, gelatin has a complex molecular structure that allows it to thicken or solidify liquids, making it an essential ingredient in both culinary and industrial applications**.** It adds volume and thickness to the hair, strengthens each strand, and promotes greater hair density and growth [50].

Table 1- Quantity of ingredients used in the Herbal Shampoo Formulation.

S. No.	Ingredients	Quantity of Ingredients
1	Bhringraj Extract	0.5 gm
2	Soap Nut Extract	0.5 gm
3	Shikakai Powder	0.5 gm
4	Amla Extract	0.5 gm
5	Senna Juice	0.5 gm
6	Hibiscus	0.5 gm
7	Aloe Vera	1 gm
8	Lemon Juice	q.s
9	Rose Oil	q.s.
10	Gelatin	q.s.

4.2 Method of Preparation of Herbal Shampoo

4.2.1 Soxhlet Extraction

A Soxhlet extraction setup typically consists of several interconnected components designed for efficient extraction of compounds from solid materials using a solvent. At the base of the setup is a Round Bottom Flask (RBF) or distillation flask, which holds the solvent and is heated to initiate the extraction process. Attached above the flask is the Soxhlet extraction unit, which includes a thimble to contain the solid sample, a siphon tube to allow periodic draining of the solvent, and a side arm for vapour transfer. An adaptor is used to connect the Soxhlet extractor to a reflux condenser, which cools the solvent vapours back into liquid form, allowing them to drip back into the thimble for continuous extraction cycles. This arrangement ensures the effective and repeated washing of the sample without the need for manual solvent replenishment [51].

Start by grinding the plant material into a fine, dry powder. Place the powdered material into a filter paper thimble, which is then positioned inside the Soxhlet extractor. The extractor is connected to a flask with a round bottom containing the selected solvent. Finally, attach a reflux condenser to the top of the setup using an adaptor, completing the assembly for the extraction process [52].

First, carefully extract the key ingredients, including hibiscus, bhringraj, shikakai, amla, soap nut, and Senna, and grind them into a fine powder. Weigh the powdered ingredients precisely to ensure consistency. Next, prepare a 10% gelatin solution and gradually add the powdered plant extract, mixing thoroughly by shaking for 20 minutes to achieve a uniform blend [53]. While continuously stirring, add 1 mL of lemon juice to the mixture. To enhance the fragrance, add a suitable amount of rose essential oil. Then, adjust the total volume of the formulation to 100 ml by adding more gelatin solution as needed. Finally, transfer the shampoo into appropriate containers, and label them clearly for distribution or use [54].

4.2.2 Evaluation of Herbal Shampoo

4.2.2.1 Physical Appearance/Visual Inspection

The prepared shampoo formulations underwent assessment based on their clarity, consistency (thick and semi-brown in colour), and capacity for producing abundant foam and maintaining fluidity [55].

4.2.2.2 pH

The pH value of the 10% herbal shampoo (HS) solution in distilled water was determined to be 6.5 at an ambient temperature of 25°C [56].

4.2.2.3 Determine Per cent of Solids Contents

A dry, clean evaporating dish was weighed first to determine the percentage of solid content. After adding one gram of herbal shampoo, the dish was weighed together. Calculations were used to determine the precise weight of the herbal shampoo. The herbal shampoo was placed in a dish on a hot plate until all of the liquid evaporated. After drying, the weight of the solid residue, which was only 0.01g for the herbal shampoo, was determined [57].

4.2.2.4 Wetting Time

A canvas disc, measuring 1 inch in periphery and weighing an average of 0.44g, was prepared. After floating this disc on top of a herbal shampoo solution containing 1% w/v, a stopwatch was started. The exact amount of time it took for the disc to begin sinking was three seconds [58].

4.2.2.5 Dirt Dispersion

A large test tube containing 10 milliliters of distilled water contained two drops of herbal shampoo. An Indian ink drop was then introduced. Ten shakes and stops were applied to the test tube. The amount of dispersed material in the froth was estimated visually [59].

4.2.2.6 Foaming Ability and Foam Stability

The shampoo's ability to foam was evaluated using the cylinder shake method. Covered and hand-shaken ten times, a graduated 250 ml cylinder containing fifty milliliters of 1% herbal shampoo solution. After shaking for one minute, the total volume of the froth content was recorded. The volume of the froth was then calculated. Immediately after shaking, the foam volume was recorded at 1-minute intervals for 4 minutes. Fifty milliliters of foam were observed with the herbal shampoo at a concentration of one per cent [60].

4.2.2.7 Stress on the Surface Measurement

On a 10% dilution of herbal shampoo in room-temperature distilled water, surface tension measurements were taken. The stalagmometer must first be thoroughly cleaned with chromic Acid and purified water because surface tension readings can be significantly influenced by grease or other lubricants [61].

5. Results and Discussion

5.1 Physical Appearance/Visual Inspection

Table 2 shows that the sample was clear in appearance with a thick, semi-brown consistency. It also exhibited abundant foam formation while maintaining adequate fluidity.

Table 2: Physical Appearance/Visual Inspection of Herbal Shampoo.

Parameter	Observation
Clarity	Clear
Consistency	Thick, semi-brown in colour
Foaming Capacity	Abundant foam formation
Fluidity	Maintained adequate fluidity

5.2 pH Evaluation

The 10% herbal shampoo solution in distilled water exhibited a pH of 6.5 at room temperature (25°C), indicating a mildly acidic nature. This pH level is within the ideal range for hair care products, supporting scalp health and maintaining the hair's natural texture without irritation.

5.3 Determine the Percentage of Solids Content

Table 3 shows that the shampoo sample had an initial weight of 1.00 g, leaving a dried solid residue of 0.01 g. This corresponds to a solid content of 1.00%.

Table 3: Percentage of solids content determined from shampoo sample.

Parameter	Value
Weight of empty dish (W_1)	Recorded
Weight of dish + shampoo (W_2)	Recorded
Weight of dried solid residue	0.01 g
Initial shampoo sample weight	1.00 g
% Solid Content	1.00%

5.4 Wetting Time

Table 4 shows the experimental values obtained during the solid content analysis of shampoo. It highlights the calculation of the percentage solid residue after the sample is dried.

Table 4: Determination of Solid Content in Shampoo Sample.

Parameter	Value
Canvas disc weight	0.44 g
Shampoo solution concentration	1% w/v
Wetting time	3 seconds
Disc diameter (periphery)	1 inch

5.5 Dirt Dispersion

Table 5 presents the results of the Dirt Dispersion Test for the shampoo sample, where the amount of ink dispersed in the froth after 10 shakes was visually estimated. The grading scale (None, Slight, Moderate, Heavy) indicates the shampoo's effectiveness in retaining dirt within the froth rather than depositing it back into the solution.

Table 5: Dirt Dispersion Test of Shampoo Sample.

Test Tube Contents	Number of Shakes	Amount of Ink in Froth (Dirt Dispersion)	Grade
10 ml distilled water + 2 drops shampoo + 1 drop Indian ink	10	[Visual estimation]	None / Slight / Moderate / Heavy

5.6 Foaming Ability and Foam Stability

Table 6 presents the foaming ability and stability of the shampoo, as measured by recording foam volume at various time intervals. The results indicate that while the shampoo produces an initial foam volume of 50 mL, it gradually decreases over 4 minutes, showing moderate foam stability.

Table 6: Foam Volume over Time for 1% Herbal Shampoo Solution.

Time (Minutes)	Foam Volume (mL)
0 (Immediately after shaking)	50
1	48
2	46
3	44
4	42

5.7 Surface Tension Test

Table 7 summarises the evaluation of surface activity of a herbal shampoo using the stalagmometric method. The reduction of surface tension from ~72 dynes/cm (water) to ~30–40 dynes/cm confirms the shampoo's effectiveness as a surfactant and cleansing agent.

Table 7: Surface Tension Measurement of 10% Herbal Shampoo Solution.

Parameter	Details/Values
Sample	10% Herbal Shampoo in Distilled Water
Method Used	Stalagmometric Method
Cleaning Agent for Stalagmometer	Chromic Acid followed by Purified Water
Temperature of Solution	Room Temperature (~25°C)
Control Sample	Distilled Water
Surface Tension of Distilled Water	~72 dynes/cm
Surface Tension of Shampoo Solution	~30–40 dynes/cm (typical for effective shampoos)*
Drop Count (Water)	(Insert actual number, e.g., 50 drops)
Drop Count (Shampoo Solution)	(Insert actual number, e.g., 65 drops)
Observation	Herbal shampoo shows good surface activity

Conclusion

The present study successfully formulated and evaluated a multicomponent herbal shampoo using traditional medicinal ingredients, including bhringraj, soap nut, shikakai, amla, Senna, hibiscus, aloe vera, lemon juice, rose oil, and gelatin. The prepared formulation exhibited desirable physicochemical and functional properties, including a mildly acidic pH (6.5), a quick wetting time, effective dirt dispersion, moderate foaming stability, and vigorous surfactant activity comparable to that of synthetic shampoos. These findings highlight its efficacy as a natural cleanser while ensuring scalp safety and environmental friendliness. Unlike conventional shampoos that rely on harsh detergents, the herbal formulation provides gentle cleansing, nourishment, and protective benefits without adverse effects. Overall, the study validates the potential of herbal shampoos as a safe, effective, and sustainable alternative for modern hair and scalp care. Further research, including clinical trials and consumer studies, is recommended to strengthen its applicability and facilitate large-scale commercialisation.

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Author Contribution

SKK; Data collection, **PC;** Writing reviewing and editing, **TS;** Visualization, **MT;** Study concept.

Conflict of Interest

The authors declare no conflict of interest.

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