

Formulation and Physicochemical Evaluation of an Herbal Anti-Dandruff Washable Oil

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Abstract:

Dandruff is a prevalent scalp condition affecting a significant portion of the population, often leading to discomfort and social concerns. Conventional anti-dandruff treatments rely on chemical formulations that may cause scalp irritation and long-term adverse effects. This study focuses on the formulation and evaluation of a herbal anti-dandruff washable oil using natural ingredients such as Aloe Vera, Reetha, Mustard Oil, and Sesame Oil. The formulation was prepared through herbal extraction and infusion techniques, ensuring a blend that is safe, effective, and easily washable. The developed oil was evaluated for its physicochemical properties, including pH, stability, washability, and foam formation. Anti-dandruff efficacy tests demonstrated a significant reduction in scalp flaking and irritation over a two-week period. The results indicate that the formulated herbal oil is a promising natural alternative to synthetic anti-dandruff products, offering improved scalp health with minimal side effects. Further studies and clinical evaluations are recommended to enhance its efficacy and commercial viability.

Keywords: Dandruff, Herbal Formulation, Anti-Dandruff Oil, Aloe Vera, Reetha, Scalp Health

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1.Introduction

Understanding Dandruff

Today a large population both man and women use shampoo for washing the hair. One of the main functions of shampoo is to remove dirt on the hair, sweat residue, oily layer, flakes of horny layer sebum, and hair care cosmetics residues, dust and other external matter may present as dirt.

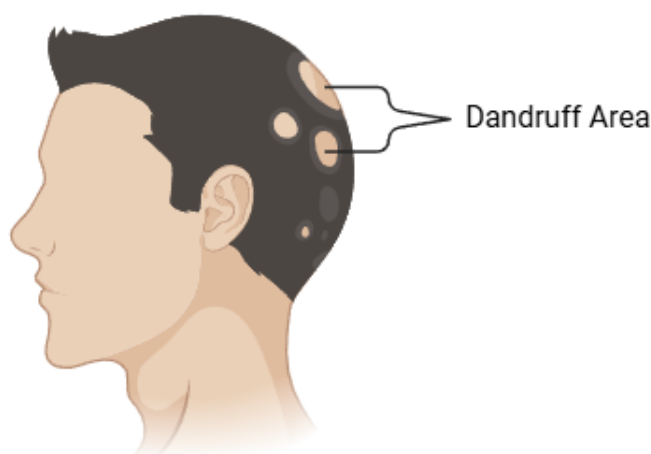
Dandruff

Dandruff, considered as a group of skin cells overproduced on the scalp, is the main scalp problem, and afflicts more than half of the people in the world. Dandruff is a common scalp disorder affecting almost half of the population at the post pubertal age and of any sex and

ethnicity. Condition characterized by the shedding of white or grey flakes of skin. It is often accompanied by itchiness, irritation, and redness of the scalp. Dandruff can be caused by several factors, including dry skin, oily scalp, fungal infections (such as *Malassezia*), and sensitivity to hair care products ¹⁻².

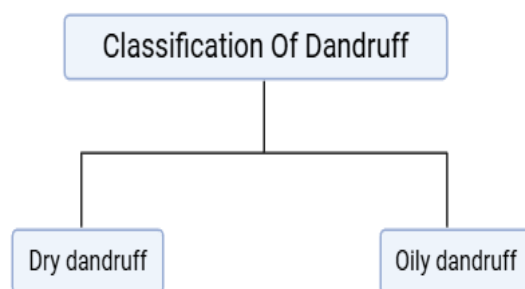
Anti-dandruff products are essential for managing and preventing dandruff effectively. Selecting the right product based on your scalp type and severity of dandruff is crucial for achieving optimal results. Regular use, along with proper scalp hygiene, ensures long-term relief and healthy hair.

Anti-dandruff products are specifically designed to address these underlying causes and alleviate the symptoms of dandruff. They typically come in the form of shampoos, conditioners, lotions, and scalp treatments, containing active ingredients that work to reduce dandruff and promote scalp health ³⁻⁴.



1.1 Classification of Dandruff

Dandruff is classified on the basis on two main types:



A) Dry dandruff: It is also called as pityriasis simplex characterize by excessive formation of minute scales which accumulate on the scalp area. This type of dandruff does not cause excessive hair loss. In this type, skin inflammation is not observed. The scales are first found in middle of the scalp and then spread frontal, parietal and occipital areas.

B) Oily dandruff: Clinically it is called as Pityriasis steatoides. It may cause due to the scalp with sebum production. It may occur during puberty. There may be inflammation on

the scalp with dirty yellow colour oily scales. Due to these reasons, hair fall may occur in this condition. The most common site affected by this type of dandruff is scalp, behind the ears, over breast bone, armpits⁵⁻⁶.

Global Prevalence and Statistics of Dandruff

Dandruff is a widespread scalp condition affecting a significant portion of the global population. While it is not a serious medical issue, it has a considerable impact on quality of life due to itching, flaking, and self-consciousness.

Global Prevalence

- Dandruff affects up to 50% of the adult population worldwide.
- It is more common in adolescents and adults due to increased sebaceous (oil) gland activity.
- Men are more frequently affected than women, likely due to differences in scalp oil production and hormonal influences.
- The condition is prevalent across all ethnic groups, though its severity may vary based on genetic and environmental factors.

Regional Statistics

- **Asia:** Reports suggest that 40–60% of the population experiences dandruff, with higher cases in humid regions where fungal overgrowth is common.
- **Europe & North America:** Studies indicate that 15–30% of individuals actively seek treatment for dandruff.
- **Africa:** The prevalence is high, though specific studies are limited. Dry scalp and environmental factors contribute to the condition.
- **Latin America:** Dandruff is widespread, with 40% or more of people experiencing symptoms at some point.

The scalp is a specialized skin structure rich in hair follicles and sebaceous glands that play a central role in maintaining scalp health. Sebaceous glands are small oil-producing glands attached to hair follicles. They secrete sebum, a lipid-rich substance that lubricates the scalp, prevents excessive dryness, and supports the integrity of the skin barrier. A balanced level of sebum keeps the scalp hydrated and protected. However, any imbalance in sebum production can contribute directly to dandruff formation⁷⁻⁸.

Sebum also influences the growth of *Malassezia*, a lipophilic fungus that naturally inhabits the scalp. Under normal conditions, this microorganism coexists without causing harm. When sebum production increases, particularly due to hormonal stimulation such as elevated androgen levels, *Malassezia* proliferates excessively. The fungus metabolizes sebum and releases by-products such as oleic acid. In susceptible individuals, oleic acid disrupts the scalp barrier, leading to irritation, inflammation, and accelerated turnover of skin cells. The result is visible flaking, itching, and scalp discomfort, which are hallmark features of dandruff.

Sebaceous gland activity is largely regulated by hormones, especially androgens like testosterone. This explains the higher prevalence of dandruff during puberty and its greater occurrence in males. Overactive glands create an oily environment that favors fungal

overgrowth, while insufficient sebum may lead to a dry, flaky scalp. Thus, both excess and deficiency of sebum can contribute to dandruff, though through slightly different mechanisms.

Interaction of *Malassezia* with Sebum

The development of dandruff typically follows a clear sequence. Excess sebum production creates a lipid-rich environment on the scalp. *Malassezia* feeds on this sebum and proliferates. During lipid metabolism, the fungus releases oleic acid, which penetrates the scalp barrier. This leads to irritation and inflammation. In response, the scalp accelerates cell turnover, resulting in flaking, itching, and visible dandruff⁹⁻¹⁰.

Factors Contributing to Dandruff

Hormonal changes significantly influence dandruff development. Increased androgen levels stimulate sebaceous gland activity, leading to excess sebum production. Dietary habits also play a role. High intake of sugar and processed foods may promote fungal imbalance, while deficiencies in zinc, B-complex vitamins, and omega-3 fatty acids can compromise scalp health. Environmental factors such as pollution, dust, smoke, UV exposure, harsh weather, and hard water further disrupt the scalp barrier and aggravate inflammation.

Current Treatment Approaches

Modern dandruff management focuses on controlling fungal growth, reducing inflammation, and restoring scalp balance. Antifungal agents such as ketoconazole, zinc pyrithione, and selenium sulfide inhibit *Malassezia* proliferation. Keratolytic agents like salicylic acid and sulfur help remove accumulated dead skin cells and reduce flaking. Anti-inflammatory agents, including corticosteroids and coal tar, alleviate redness and itching. Moisturizing ingredients such as aloe vera, coconut oil, and tea tree oil soothe the scalp and reduce dryness. pH-balanced shampoos help maintain the scalp's natural acidity, preventing excessive oiliness or dryness. Probiotic and herbal remedies like neem, reetha, fenugreek, and apple cider vinegar aim to restore microbial balance naturally¹¹⁻¹².

Advantages of Herbal Formulations Over Chemical-Based Treatments

Herbal formulations offer several benefits compared to synthetic chemical treatments. They are generally free from harsh ingredients such as sulfates and parabens, reducing the risk of irritation. They tend to cause fewer side effects like dryness or allergic reactions. Being biodegradable, they are environmentally friendly and less likely to contribute to water pollution. Herbal ingredients often contain vitamins, antioxidants, and essential oils that nourish the scalp and improve long-term health rather than providing temporary symptom relief. They are particularly suitable for sensitive scalps and are derived from renewable plant sources, making them more sustainable.

Difference Between *Pityriasis Simplex Capillitii* and *Pityriasis Steatoides*

Pityriasis simplex capillitii, commonly known as dry dandruff, is characterized by fine, white, powdery flakes that easily fall onto clothing. It is usually associated with reduced sebum production and scalp dryness. The flakes are non-greasy, and itching may be mild to moderate. In contrast, *pityriasis steatoides*, or oily dandruff, presents with larger, yellowish, greasy flakes that adhere to the scalp and hair shafts. It is linked to excessive sebum production and increased

fungus activity. The scalp may appear oily, inflamed, and itchy. Oily dandruff is often more persistent and may be associated with seborrheic dermatitis if severe.

Understanding these distinctions is essential for selecting appropriate treatment strategies and tailoring formulations to specific scalp conditions ¹³⁻¹⁴.

Feature	Pityriasis Simplex Capillitii (Dry Dandruff)	Pityriasis Steatoides (Oily Dandruff)
Appearance	Small, white, dry flakes that fall off easily	Yellowish, greasy flakes that stick to the scalp ¹⁵
Scalp Condition	Dry and itchy scalp	Oily and inflamed scalp ¹⁶
Sebum Production	Low sebum production	Excessive sebum production ¹⁷
Cause	Dehydration, cold weather, harsh shampoos	Overactive sebaceous glands, fungal overgrowth ¹⁸
Symptoms	Mild itching, no redness	Intense itching, redness, possible odor ¹⁹
Severity	Mild and manageable	Severe and may lead to scalp infections ²⁰
Treatment	Moisturizing shampoos, gentle scalp care	Antifungal agents, oil control formulations ²¹

Traditional use of medicinal plants has been a common practice for addressing scalp issues like dandruff. These plants contain a variety of bioactive compounds, including alkaloids, flavonoids, tannins, terpenoids, and essential oils, which possess antifungal, anti-inflammatory, and skin-soothing effects. These natural substances can target the underlying factors of dandruff, such as microbial proliferation and scalp inflammation, while enhancing overall scalp health ²².

Medicinal Plant	Components	Properties	Mechanism	Usage
Neem (Azadirachta indica)	Azadirachtin, nimbidin, nimbolide	Antifungal, antibacterial, anti-inflammatory	Disrupts fungal cell membranes; reduces scalp irritation	Boil leaves in water for rinsing or apply neem oil to the scalp ²³ .
(Aloe barbadensis)	Aloin, polysaccharides, vitamins	Moisturizing, anti-inflammatory, antimicrobial	Hydrates scalp; inhibits fungal growth; soothes irritation	Apply fresh gel directly to the scalp or mix with

				essential oils for added benefits ²⁴ .
Reetha (Sapindus mukorossi)	Saponins, flavonoids, fatty acids	Antimicrobial, cleansing, moisturizing	Natural cleanser; removes excess oil and dandruff while maintaining scalp pH	Soak reetha pods in water overnight, boil, and use the liquid to wash hair ²⁵ .
Tea Tree Oil (Melaleuca alternifolia)	Terpinen-4-ol, cineole	Antifungal, antibacterial, anti-inflammatory	Inhibits Malassezia; reduces scalp inflammation	Add a few drops to carrier oil or shampoo and massage into the scalp ²⁶ .
Tulsi (Ocimum sanctum)	Eugenol, camphor, flavonoids	Antimicrobial, antioxidant	Improves scalp circulation; inhibits fungal growth	Use a paste of ground leaves or tulsi-infused oil for scalp massage ²⁷ .
Fenugreek (Trigonella foenum-graecum)	Saponins, nicotinic acid, lecithin	Antifungal, moisturizing, nourishing	Strengthens hair roots; reduces fungal activity	Apply paste of soaked seeds to the scalp or use fenugreek oil ²⁸ .
Hibiscus (Hibiscus rosa-sinensis)	Flavonoids, anthocyanins, mucilage	Moisturizing, anti-inflammatory	Nourishes scalp; restores moisture balance; reduces inflammation	Use a paste of leaves/flowers or hibiscus oil as a pre-wash treatment ²⁹ .
Lemon (Citrus limon)	Citric acid, vitamin C, limonene	Antimicrobial, exfoliating, pH-balancing	Reduces oiliness; inhibits fungal growth; exfoliates dead skin	Apply diluted juice to the scalp for 5–10 minutes; rinse thoroughly ³⁰ .
Rosemary (Rosmarinus officinalis)	Rosmarinic acid, camphor	Antifungal, antimicrobial, circulation-boosting	Improves blood flow; prevents fungal infections	Use rosemary oil mixed with carrier oil or as an herbal rinse.
Turmeric (Curcuma longa)	Curcumin, turmerone, zingiberene	Antimicrobial, anti-inflammatory	Reduces inflammation; inhibits microbial growth	Mix turmeric powder with aloe vera or oil for a scalp mask.

Green Tea (Camellia sinensis)	Catechins, polyphenols, tannins	Antioxidant, antimicrobial, soothing	Reduces fungal activity; calms scalp irritation	Use brewed tea as a rinse or combine with aloe vera for enhanced hydration ³¹ .
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2.Literature Review

Skin Diseases Associated with Malassezia Species

conducted a comprehensive study on the role of *Malassezia* species in various skin diseases, including dandruff, seborrheic dermatitis, and other fungal-related scalp conditions. The research highlighted how *Malassezia*, a naturally occurring fungus on human skin, can become pathogenic under certain conditions, such as excessive sebum production, hormonal changes, and environmental factors. The study examined the different strains of *Malassezia* and their association with scalp disorders, emphasizing their role in causing inflammation, barrier disruption, and increased scalp flaking.

The authors reviewed treatment strategies, including antifungal agents like ketoconazole, zinc pyrithione, and selenium sulfide, which inhibit fungal growth and reduce dandruff symptoms. They also discussed the limitations of chemical-based treatments, which may cause scalp irritation with prolonged use. The study underscored the need for alternative therapies, including herbal-based formulations, to manage *Malassezia*-associated skin conditions effectively ³²⁻³³.

Formulation and Evaluation of Herbal Anti-Dandruff Shampoo

conducted a study on the formulation and evaluation of a herbal anti-dandruff shampoo using natural plant-based ingredients. The research aimed to develop an effective, safe, and eco-friendly alternative to conventional shampoos that often contain harsh chemicals leading to scalp irritation and hair damage. The study incorporated herbal extracts with antifungal, antibacterial, and scalp-nourishing properties to target *Malassezia* species, the primary cause of dandruff.

The formulated shampoo was assessed for its physicochemical properties, including pH, viscosity, foaming ability, cleansing efficiency, and stability under different storage conditions. The antifungal activity was evaluated against *Malassezia furfur*, demonstrating significant inhibition of fungal growth. The shampoo also showed good cleansing properties, mildness to the scalp, and prolonged stability without phase separation.

anti-dandruff washable oil, further reinforcing the efficacy of plant-based treatments in scalp care ³⁴⁻³⁵.

Formulation and Evaluation of Natural-Based Cosmeceutical Ointments: An Approach to Manage Dry Scalp Dandruff

Salako et al. (2024) conducted a study on the formulation and evaluation of natural-based cosmeceutical ointments aimed at managing dry scalp dandruff. The research focused on the use of plant-derived ingredients with antifungal, anti-inflammatory, and moisturizing

properties to address the underlying causes of dandruff while maintaining scalp health. The study involved the development of ointments incorporating herbal extracts and essential oils known for their therapeutic benefits.

The formulated ointments were evaluated based on their physicochemical properties, including pH, viscosity, spreadability, and stability under different storage conditions. The researchers also assessed their antifungal efficacy against *Malassezia* species, a key contributor to dandruff. The results demonstrated significant improvements in scalp hydration, reduced flaking, and inhibition of fungal growth. The study concluded that herbal-based cosmeceuticals could serve as a safer and more effective alternative to conventional chemical-based anti-dandruff treatments³⁶⁻³⁷.

A Practical Guide to Scalp Disorders

provided a comprehensive overview of common scalp disorders, including dandruff, seborrheic dermatitis, and other conditions affecting scalp health. The study examined the etiology, clinical presentation, and treatment options for various scalp disorders, with a focus on the role of scalp microbiota, sebaceous gland activity, and external environmental factors in their development. The research emphasized that dandruff is primarily caused by *Malassezia* species, which thrive in oily scalp conditions and contribute to flaking, irritation, and inflammation.

The study reviewed different treatment approaches, including antifungal agents, keratolytic agents, and scalp hygiene practices. It also highlighted the limitations of conventional treatments, such as the potential for skin irritation and resistance to antifungal medications. The author advocated for the development of milder, long-term solutions, including the use of herbal and natural formulations for scalp care³⁸⁻³⁹.

Traditional Herbal Medicines for Anti-Dandruff and Hair Care: A Review

conducted a review on the use of traditional herbal medicines for anti-dandruff treatment and overall hair care. The study explored various medicinal plants known for their antifungal, antibacterial, and scalp-nourishing properties. It highlighted the significance of herbal ingredients such as Neem (*Azadirachta indica*), Reetha (*Sapindus mukorossi*), Aloe Vera (*Aloe barbadensis miller*), Fenugreek (*Trigonella foenum-graecum*), and Tea Tree Oil (*Melaleuca alternifolia*) in managing dandruff and promoting scalp health⁴⁰⁻⁴¹.

The review analyzed the mechanisms of herbal formulations, emphasizing their ability to regulate sebum production, inhibit *Malassezia* fungus, and reduce inflammation. It also discussed the advantages of herbal-based treatments over synthetic anti-dandruff products, such as reduced scalp irritation, fewer side effects, and long-term scalp nourishment. Furthermore, the study stressed the importance of formulation techniques in improving the efficacy and stability of herbal products. The primary aim of this study is to formulate and evaluate an herbal anti-dandruff washable oil using natural ingredients with scientifically proven therapeutic properties. The formulation is designed to effectively reduce dandruff, improve scalp health, and provide a safe, long-term alternative to conventional chemical-based treatments. The objectives of this research are as follows:

Scientific Rationale for Herbal Ingredients Selection: The study focuses on selecting herbal ingredients based on their scientifically validated antimicrobial, anti-inflammatory, and scalp-nourishing properties. Aloe Vera (*Aloe barbadensis miller*), Reetha (*Sapindus mukorossi*), Mustard Oil (*Brassica nigra*), and Sesame Oil (*Sesamum indicum*) were chosen for their effectiveness in cleansing the scalp, reducing microbial growth, and maintaining scalp hydration.

Dandruff Reduction and Scalp Health Improvement: The formulated oil aims to combat dandruff by targeting its root causes, including excessive sebum production, fungal overgrowth, and scalp dryness. The combined action of herbal ingredients helps to restore the natural balance of the scalp, reducing flaking, itchiness, and irritation while promoting a healthy scalp environment.

Ensuring Long-Term Safety and Effectiveness: Unlike conventional anti-dandruff products that may contain harsh chemicals leading to side effects such as scalp dryness or irritation, this herbal formulation is developed to be mild and safe for regular use. The study also aims to evaluate the stability and efficacy of the formulation to ensure its long-term benefits without causing adverse effects ⁴³⁻⁴⁴.

3.MATERIALS AND METHODS

Materials and Ingredients Used

The formulation of the anti-dandruff washable oil was developed using a combination of herbal and natural ingredients, selected based on their therapeutic properties to ensure efficacy, safety, and scalp nourishment. The ingredients used in the formulation include Mustard Oil (*Brassica nigra*), which was procured from the market due to its availability and purity. Sesame Oil (*Sesamum indicum*), known for its nourishing and anti-inflammatory properties, was also obtained from the market to ensure consistency in quality.

Aloe Vera (*Aloe barbadensis miller*) gel was freshly extracted from Aloe Vera plants grown at home, ensuring the retention of its bioactive compounds. Reetha (*Sapindus mukorossi*) powder, an essential ingredient for its natural cleansing and antifungal properties, was sourced from the market in powdered form for ease of formulation. Distilled water, which served as the solvent for extraction and formulation processes, was obtained from the laboratory, with a measured quantity of 25 mL to maintain the appropriate formulation consistency.

All ingredients were selected based on their functional benefits in addressing dandruff, scalp irritation, and microbial infections, contributing to the overall effectiveness of the formulated anti-dandruff washable oil.

METHODOLOGY AND PREPARATION

Methodology

The methodology for the formulation and evaluation of anti-dandruff washable oil involves a series of systematic steps, including ingredient selection, extraction, formulation, and assessment of its physicochemical and therapeutic properties. The study aims to develop a stable and effective herbal formulation that provides dandruff control, scalp nourishment, and safety for regular use.

Preparation of Extracts

1. Extraction of Reetha and Aloe Vera with Sesame Oil

The preparation of the anti-dandruff washable oil involves the extraction of bioactive compounds from Reetha (*Sapindus mukorossi*) and Aloe Vera (*Aloe barbadensis miller*), followed by their infusion into Sesame Oil (*Sesamum indicum*). The formulation process is carefully designed to ensure optimal extraction of active constituents, which contribute to the oil's anti-dandruff, antifungal, and scalp-nourishing properties.

2. Reetha Extraction

Reetha, known for its natural cleansing and antifungal properties due to its high saponin content, is extracted using an aqueous method to ensure the efficient release of active compounds. Five grams of dried Reetha powder is accurately weighed and transferred to a clean, heat-resistant glass beaker. Distilled water (25 mL) is added, and the mixture is heated to a controlled temperature of 90–95°C. The boiling process is maintained for 10–15 minutes while stirring continuously to promote uniform extraction. After heating, the mixture is allowed to cool to room temperature. The cooled extract is then filtered using a muslin cloth to remove solid residues, yielding a clear, saponin-rich liquid extract. This extract is stored in a sterile container under refrigeration (4–8°C) to preserve its bioactive properties until further use.

3. Aloe Vera Extraction

Aloe Vera gel, recognized for its soothing, moisturizing, and antifungal properties, is extracted from fresh Aloe Vera leaves. The leaves are thoroughly washed with distilled water to remove any impurities. Using a sterile knife, the outer green layer is carefully removed, and the transparent gel is extracted. A total of 5g of fresh Aloe Vera gel is collected and blended with a small quantity of distilled water to ensure homogeneity. This blended extract is stored in an airtight container at 4–8°C to maintain its stability and prevent microbial contamination.

4. Infusion with Sesame Oil

The final step involves the infusion of the herbal extracts into Sesame Oil, which serves as the carrier oil due to its anti-inflammatory, antimicrobial, and scalp-nourishing properties. Twenty milliliters of Sesame Oil is taken in a heat-resistant beaker and placed in a double boiler setup to maintain a controlled temperature of 60°C. The filtered Reetha extract is gradually introduced into the warm Sesame Oil while stirring continuously with a glass rod to facilitate uniform dispersion. Subsequently, the Aloe Vera extract is added slowly, ensuring proper blending and emulsification. The mixture is continuously stirred for 10–15 minutes to enhance the solubility of active compounds. After thorough mixing, the beaker is removed from the heat source, and the formulation is allowed to cool to room temperature. The prepared anti-dandruff washable oil is then transferred into sterilized amber glass bottles to prevent light-induced degradation and stored under appropriate conditions for further evaluation.

Evaluation of Formulations

The formulated anti-dandruff washable oil was subjected to a series of evaluations to determine its physical, chemical, and functional properties. These assessments were conducted to ensure that the formulation met the necessary quality standards, efficacy, and stability requirements.

for practical application. The evaluation parameters included color, texture, pH, stability, washability, foam formation, and anti-dandruff efficacy.

1. Color Analysis

The color of the formulated anti-dandruff oil was observed to be brownish-orange, which is consistent with herbal formulations containing plant extracts. The presence of natural ingredients such as Reetha and Aloe Vera contributed to this characteristic coloration. The color stability was monitored over time to detect any significant changes that might indicate degradation of active compounds.

2. Texture and Consistency

The texture of the formulation was assessed visually and by touch. The oil exhibited a smooth and homogeneous consistency, free from visible particles, clumps, or phase separation. The uniform blending of the herbal extracts with Sesame Oil ensured a stable emulsion, making it suitable for application on the scalp without leaving a greasy or sticky residue.

3. pH Determination

The pH of the formulation was measured using a calibrated pH meter to ensure its compatibility with the scalp's natural pH. The pH was found to be 6.45, which falls within the ideal range (4.5–6.5) for scalp health. This pH level ensures mildness and minimizes the risk of irritation, making the formulation suitable for regular use on both normal and sensitive scalps.

4. Stability Studies

The stability of the formulation was evaluated by observing its physical appearance and consistency over a specific period under different storage conditions. The formulation remained mostly stable, with no significant changes in texture, color, or phase separation. However, slight layering was observed in some samples, suggesting a potential phase separation that may require further formulation adjustments or emulsifying agents to enhance long-term stability.

5. Washability Assessment

One of the critical factors in an oil-based anti-dandruff formulation is its ease of removal. The formulated oil was applied to the scalp and later washed off using lukewarm water and a mild herbal shampoo. The formulation exhibited good washability, indicating that it does not leave excessive residue or greasiness after cleansing. This property enhances consumer acceptability and ensures convenient use.

6. Foam Formation and Cleansing Ability

Foam formation is an essential parameter for evaluating the cleansing efficiency of the formulation. Although the formulation is primarily oil-based, the presence of Reetha, which contains natural saponins, contributed to mild foaming. The foam stability was assessed, and the formulation demonstrated an adequate level of cleansing action, effectively removing dirt, excess sebum, and dandruff flakes from the scalp.

7. Stability Testing Under Different Storage Conditions

To assess the formulation's long-term stability, samples were stored at varying temperatures, including room temperature (25°C), refrigeration (4°C), and elevated temperature (40°C). The formulations were monitored over a four-week period to check for any changes in phase separation, viscosity, or microbial growth. The results indicated that the formulation maintained its stability under moderate conditions but required further modifications to enhance its shelf life under extreme temperature variations.

8. Anti-Dandruff Efficacy Evaluation

The efficacy of the formulated oil in reducing dandruff was tested on individuals experiencing mild to moderate dandruff conditions. The oil was applied to affected scalp areas three times a week over a period of two weeks. Observations included a reduction in scalp flaking, itchiness, and irritation. The results indicated a significant improvement in scalp condition, with noticeable reductions in dandruff symptoms. The combination of Aloe Vera, Reetha, and Sesame Oil contributed to antifungal, anti-inflammatory, and moisturizing effects, confirming the effectiveness of the formulation.

4. Results and Discussion

The formulated oils exhibited a smooth consistency with good emulsification. The pH of both formulations was found to be within the optimal range for scalp application. The oils were easily washable with mild foaming, indicating effective cleansing properties. Stability tests confirmed that the formulations remained stable without phase separation for four weeks. The anti-dandruff efficacy test showed a significant reduction in scalp flaking and irritation, suggesting that the combination of Aloe Vera, Reetha, and Mustard/Sesame oil effectively reduces dandruff.



Figure 1. Prepared solution of the reetha anti-dandruff washable oil

5. Conclusion

The research on the formulation and evaluation of an anti-dandruff washable oil provides promising evidence that herbal-based solutions can serve as effective and safer alternatives to conventional chemical-based treatments. Utilizing natural ingredients such as Aloe Vera, Reetha, Mustard Oil, and Sesame Oil, the developed formulation demonstrated significant efficacy in reducing dandruff, improving scalp health, and maintaining an optimal pH balance for long-term usage.

The physicochemical evaluations confirmed that the oil possessed desirable properties, including smooth consistency, good emulsification, adequate washability, and mild foaming action. Stability tests indicated that the formulation remained intact under moderate conditions, though slight phase separation was observed, suggesting the need for further optimization.

Furthermore, the anti-dandruff efficacy tests showed a considerable reduction in scalp flaking, irritation, and itchiness within a two-week period, highlighting the therapeutic potential of these herbal ingredients. The natural antimicrobial and anti-inflammatory properties of Aloe Vera and Reetha contributed to the overall effectiveness of the formulation, making it a viable alternative for individuals with sensitive scalps or those looking for a chemical-free solution.

However, while the results are promising, further research is necessary to enhance the formulation's long-term stability, optimize cleansing efficiency, and conduct extensive dermatological studies to validate its efficacy across diverse scalp conditions. Additionally, comparative studies with commercially available anti-dandruff products will provide insights into its competitive advantages and potential for large-scale production.

Overall, this study reinforces the potential of herbal formulations in addressing dandruff-related concerns while promoting scalp health in a sustainable and eco-friendly manner. With further development and clinical trials, this anti-dandruff washable oil could pave the way for a more holistic and natural approach to scalp care.

6. Future Scope

Further improvement of the herbal formulation can focus on optimizing its cleansing efficiency, foaming capacity, and overall shelf-life stability. Refinement of ingredient concentrations and processing conditions may enhance performance without compromising the natural profile of the product. Incorporating additional potent herbal extracts with proven antifungal and antibacterial properties could further strengthen its anti-dandruff effectiveness and improve scalp health 45.

Comprehensive clinical and dermatological evaluations are essential to establish the safety and efficacy of the formulation across different scalp types and conditions. Controlled clinical trials can help assess parameters such as irritation potential, sensitivity reactions, and therapeutic benefits. Long-term studies may also be conducted to determine its influence on hair growth, scalp nourishment, reduction of hair fall, and maintenance of overall hair quality.

Comparative studies with commercially available shampoos would provide a clearer understanding of the formulation's strengths and limitations. Evaluating performance indicators such as cleansing ability, foam stability, fragrance retention, and conditioning effect

can highlight its competitive advantages. In addition, sensory evaluation and consumer preference studies can support product refinement and improve market acceptance ⁴⁶.

For commercialization, scaling up production while maintaining consistency and quality is a critical step. Standardization of manufacturing protocols and quality control measures should be established to ensure batch-to-batch uniformity. Stability studies under different environmental conditions, including variations in temperature and humidity, can help determine product shelf life and optimal storage requirements.

Sustainability considerations should also guide further development. The use of biodegradable and environmentally friendly packaging materials can reduce ecological impact. Additionally, ensuring that the formulation is easily biodegradable in wastewater systems and does not contribute to environmental pollution will strengthen its position as a safe and eco-conscious herbal alternative ⁴⁷.

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