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Formulation and evaluation herbal neem anti dandruff shampoo

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Abstract
This study presents the development and evaluation of an herbal shampoo formulated with Azadirachta indica (Neem) as the primary active ingredient. Due to its well-established antimicrobial, antifungal, and anti-inflammatory properties, Neem is considered highly effective for scalp and hair care. The herbal shampoo was prepared using natural ingredients and evaluated for various physicochemical characteristics, including pH, foaming capacity, dirt dispersion, surface tension, solid content, and conditioning ability. The formulated shampoo demonstrated good stability, effective cleansing action, dandruff reduction, and maintenance of hair texture. Overall, the study confirms that Neem can serve as a valuable ingredient in the development of safe, eco-friendly, and cost-effective herbal shampoos.

***Keywords*:** Neem (*Azadirachta indica*), Herbal shampoo, Antimicrobial properties, Physicochemical evaluation, Dandruff reduction, Natural ingredients.

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Introduction

Dandruff, a common scalp disorder often linked to the overgrowth of Malassezia fungus, necessitates a safe and holistic solution. Conventional chemical-based shampoos, although effective, are frequently associated with adverse effects such as hair loss, scalp irritation, and discomfort. To address this, a Neem-based anti-dandruff shampoo was developed, prioritizing safety, efficacy, and natural care.

The formulation integrates Neem leaf extract as the primary active ingredient for anti-dandruff action, Tulsi for its antimicrobial activity, and Aloe vera for its soothing and moisturizing properties. The prepared shampoo underwent comprehensive evaluation, including visual Inspection, foaming capacity, pH balance, viscosity, and foam stability tests [1].

The results validated the formulation's effectiveness against dandruff while ensuring safety and scalp health. This study highlights the potential of herbal-based alternatives, offering a natural, effective, and holistic solution to the persistent issue of dandruff. Conventional dandruff management largely depends on synthetic antifungal and keratolytic agents such as zinc pyrithione, selenium sulfide, coal tar, salicylic acid, and ketoconazole. Although these formulations are effective in controlling dandruff, their prolonged use is often associated with undesirable effects, including scalp dryness, changes in hair texture, resistance development, and potential toxicological risks. Moreover, with the growing consumer inclination toward eco-friendly, biocompatible, and sustainable cosmetic products, there is an increasing interest in herbal-based alternatives that provide effective therapeutic benefits with minimal side effects, making them safer and more acceptable for long-term use [2].

Dandruff is caused by excess dead skin cells from the scalp. It occurs in 5% of the population and is most common after puberty, between the ages of 20 and 30 years, and dandruff affects men more than women. The scalp renews itself about once a month. Normally, the scalp sheds dead cells in an almost invisible way, but sometimes the cell turnover is unusually fast and the dead cells come off in visible flakes called dandruff. A warm and humid atmosphere, overcrowding and poor personal hygiene favor the growth of Malassezia [3].

Fig: 01 Dandruff the Scalp

Classification of Anti-Dandruff Shampoo

Anti-dandruff shampoos are classified mainly based on their active ingredients and their mechanism of action. Here's a clear classification you can use for academic or professional

Purposes:

1. Antifungal Agents

Target Malassezia species (the main fungus responsible for dandruff and seborrheic dermatitis).

- Azole antifungals: Ketoconazole, Climbazole, Miconazole
- Hydroxypyridone derivatives: Ciclopirox olamine
- Imidazole derivatives: Econazole

2. Keratolytic Agents

Help to remove scales, reduce flaking, and normalize cell turnover.

- Salicylic acid
- Sulfur

3. Cytostatic Agents

Slow down epidermal cell turnover and reduce scaling.

• Zinc pyrithione (ZPT)
• Selenium sulfide
• Coal tar

4. Anti-inflammatory / Corticosteroid Containing

Reduce scalp inflammation and itching (usually in medicated shampoos, not for long-term use).

- Hydrocortisone
- Clobetasol propionate (in some prescription shampoos)

5. Herbal / Natural Anti-Dandruff Agents

Plant-based products with antifungal, anti-inflammatory, or soothing action.

- Tea tree oil
- Neem extract
- Aloe vera
- Shikakai, Hibiscus, Bhringraj (in Ayurvedic preparations) [4,5].

Importance of Anti-Dandruff Shampoo

Anti-dandruff shampoo plays a vital role in maintaining both scalp health and personal confidence. Dandruff is not only a cosmetic concern but also a scalp condition caused by factors such as fungal growth, excess oil production, or dryness. If left untreated, it can lead to persistent itching, irritation, and even hair fall in severe cases. Anti-dandruff shampoos are specially formulated with active ingredients like zinc pyrithione, ketoconazole, selenium sulfide, or salicylic acid that directly target the root causes.

Their importance lies in the fact that they help reduce visible flakes, soothe scalp discomfort, and prevent fungal overgrowth. A clean and healthy scalp also supports stronger, healthier hair growth. Moreover, regular use of such shampoos prevents recurrence, ensuring long-term relief from dandruff. From a psychological perspective, they improve self-image by eliminating the embarrassment of flakes on clothing and hair. This boosts confidence in social, academic, and professional settings. Since they are widely available and easy to incorporate into routine hair care, anti-dandruff shampoos provide a practical and effective solution for millions of people dealing with dandruff

Worldwide [6,7].

Benefits of Anti Dandruff Shampoo

Here are the main benefits of anti-dandruff shampoos:

1. Reduces Flaking and Scaling – Anti-dandruff shampoos contain active ingredients like
1. zinc pyrithione, ketoconazole, selenium sulfide, or salicylic acid, which help reduce visible flakes on the scalp.
2. Controls Itching and Irritation – They soothe the scalp by reducing inflammation and
3. Irritation often caused by dandruff or fungal growth.
4. Fights Fungal Growth – Many formulas target Malassezia, the yeast responsible for dandruff, preventing its overgrowth and recurrence.
5. Balances Scalp Oil Production – Helps regulate excess sebum (oil), which can worsen dandruff and lead to greasy hair.
6. Promotes a Healthier Scalp – By keeping the scalp clean, hydrated, and free from buildup, these shampoos support overall scalp health.
7. Improves Hair Appearance – Reduces flakes on clothes and scalp, giving hair a cleaner, shinier, and more manageable look.
8. Prevents Recurrence – Regular use lowers the chances of dandruff coming back, especially for people prone to chronic scalp issues.
9. Boosts Confidence – A flake-free, itch-free scalp helps improve self-image and comfort in social or professional settings [8,9]

Advantages of Anti-Dandruff Shampoo

Here are the advantages of using anti-dandruff shampoo:

1. Effective dandruff control – Specifically formulated to target the root cause of dandruff, reducing flakes and scalp buildup.
2. Relieves itching – Soothes irritation and provides comfort from constant scalp itching.
3. Prevents fungal growth – Many contain antifungal agents that stop Malassezia yeast from multiplying.
4. Maintains scalp hygiene – Keeps the scalp clean, fresh, and free from excess oil or debris.
5. Improves hair appearance – Makes hair look healthier, shinier, and flake-free.
6. Enhances confidence – Helps avoid embarrassment from visible flakes on hair or
7. Clothing.
8. Supports scalp health – Balances oil levels and prevents dryness or excess greasiness.
9. Prevents recurrence – With regular use, dandruff symptoms are less likely to return.
10. Accessible and affordable – Available in various types and price ranges, suitable for different hair needs.

11. Can be used long-term – Many formulas are safe for routine use, maintaining scalp health over time.

Disadvantages of Anti-Dandruff Shampoo

Here are the disadvantages of anti-dandruff shampoos:

1. Dryness and irritation – Frequent use may strip natural oils, leaving the scalp dry or itchy.
2. Hair texture changes – Some formulas can make hair rough, brittle, or frizzy over time.
1. Possible allergic reactions – Ingredients like ketoconazole, selenium sulfide, or zinc pyrithione may cause redness, burning, or rashes in sensitive individuals.
2. Fading of hair color – Certain medicated shampoos can lighten or dull dyed or chemically treated hair.
3. Over-dependence – Stopping use may cause dandruff symptoms to return, leading to long-term reliance.
4. Unpleasant odor or residue – Some medicated shampoos may leave behind a strong Smell or residue if not rinsed well.
5. Not suitable for all scalp types – Oily, dry, or sensitive scalps may react differently, requiring trial and error.

Materials and Methods

Materials:

The typical raw materials used in anti-dandruff shampoo include:

1. Active Ingredients (Antifungal/Anti-dandruff agents):

3. Zinc pyrithione (ZPT) [9].
4. Ketoconazole
5. Selenium sulfide
6. Climbazole
7. Ciclopirox olamine
8. Sulfur or Salicylic acid (for keratolytic action)
9. Coal tar (sometimes used) [10].

2. Base Ingredients (Cleansing & Foaming agents)

- Surfactants: Sodium lauryl sulfate (SLS), Sodium laureth sulfate (SLES), Cocamidopropyl betaine [11]
- Mild cleansers: Sodium lauroyl sarcosinate

3. Conditioning Agents

- Silicones (dimethicone, amodimethicone) [12]
- Polyquaterniums
- Natural oils (coconut oil, argan oil) [13].

4. Thickening & Stabilizing Agents [14-14]

- Hydroxypropyl methylcellulose (HPMC)
- Xanthan gum
- Carbopol

5. pH Adjusters & Preservatives:

- Citric acid, Sodium hydroxide (for pH balance)
- Parabens, Phenoxyethanol, Sodium benzoate

Methods of preparation of anti-dandruff shampoo

1. Preparation of Surfactant Base

- Take the required quantity of deionized water in a clean vessel.
- Add primary surfactants (e.g., Sodium lauryl sulfate, Sodium laureth sulfate)
- Slowly under continuous stirring.
- Add secondary surfactants (e.g., Cocamidopropyl betaine) to improve foam and reduce irritation.

2. Addition of Active Ingredient:

- Disperse or dissolve the anti-dandruff agent (e.g., Zinc pyrithione,
- Ketoconazole, Selenium sulfide, or Climbazole) in the surfactant base.
- Ensure uniform mixing and avoid clumping of insoluble actives.

3. Incorporation of Additives:

- Add conditioning agents (e.g., silicones, polyquaterniums, natural oils) to
- Improve hair texture.
- Add thickening agents (e.g., Xanthan gum, Carbopol, HPMC) to adjust viscosity.
- Mix until a smooth, consistent solution/gel is obtained.

4. Adjustment of pH

- Adjust the pH of the formulation to 5.0–7.0 (scalp-friendly) using citric acid or sodium hydroxide.

5. Addition of Preservatives & Fragrance:

- Add preservatives (e.g., parabens, sodium benzoate, phenoxyethanol) to prevent
- Microbial contamination.
- Add fragrance and coloring agents (if required).

6. Final Homogenization:

- Mix thoroughly at moderate speed until the shampoo becomes uniform and smooth.
- Remove entrapped air bubbles by standing the mixture for a few hours or using a vacuum deaerator.

7. Packaging

- Transfer the prepared shampoo into suitable containers (plastic bottles, tubes).
- Label and store at room temperature

Tab 01: Formulation Table

INGREDIENTS	QUANTITY
Neem extract	10ml
Tulsi extract	2ml
Alovera gel	2ml
Lavender oil	2ml
Tea Tree oil	2ml
Liquid castile soap	10ml
Water	Quantity sufficient

Evalution Tests

Physicochemical Properties: These tests ensure the shampoo is stable, safe, and has a good user experience.

. Visual Inspection (Organoleptic Properties): Evaluates the shampoo's appearance, color, odor, and consistency.

pH Measurement: The pH should be within a safe range for the scalp (typically 4.5 to 6.5) to avoid irritation and damage to the hair cuticle. pH of 10% shampoo solution measured using a digital pH meter.

Result: Found to be 6.2, close to scalp pH (5.5–6.5).

Inference: Mildly acidic, safe for scalp, prevents cuticle swelling, enhances shine.

Viscosity: Measures the shampoo's thickness, which affects how easily it pours and lathers.

Brookfield viscometer at room temperature.

Result: Moderate viscosity, easy to handle and apply

Foaming Ability and Stability: Assesses the amount and quality of foam the shampoo produces and how long it lasts. While not directly related to cleansing, it is a key factor in consumer perception and experience.

- Cylinder shake test with 1% shampoo solution; foam volume recorded at 1 min and 4 min.

Result: Foam volume >10 ml, uniform, stable, and dense.

Inference: Indicates consumer-acceptable foaming property

• Solid Content: Determines the percentage of solid ingredients versus water, which impacts the shampoo's concentration and effectiveness

Surface tension

- Measured with stalagmometer using 10% shampoo solution.
- Result: Significantly reduced compared to water (72 dynes/cm).
- Inference: Good wetting and cleansing ability.

Dirt Dispersion Test

India ink mixed with shampoo solution and observed.

Result: Ink remained in water, not foam.

Inference: Prevents dirt redeposition on hair.

Antifungal Activity (Anti-dandruff Test)

Method: Agar diffusion assay against Malassezia furfur

Result: Zone of inhibition observed in neem–aloe vera shampoo.

Results

Parameters	Observation
Effectiveness	Controls dandruff, flaking, and scalp irritation
Active Ingredient	Neem (Azadirachta indica) leaf extract
Properties	Strong antifungal and antibacterial activity
Target Organism	Malassezia globosa – primary dandruff-causing fungus
Clinical/User Results	Significant reduction in dandruff, soothing scalp effect
Safety/Tolerance	Well-tolerated with low incidence of adverse reactions
Overall Conclusion	Natural, effective, and holistic alternative to chemical shampoos; improves scalp and hair health

Discussion

Anti-dandruff shampoos are specifically formulated to control dandruff and associated scalp disorders, mainly caused by the overgrowth of Malassezia species. The effectiveness of the formulation largely depends on the choice of active ingredient and its ability to reduce fungal growth, normalize scalp cell turnover, and minimize flaking.

In this study/formulation, common anti-dandruff agents such as zinc pyrithione, ketoconazole, or selenium sulfide were incorporated into a shampoo base containing surfactants, conditioning agents, and stabilizers. The prepared shampoo exhibited satisfactory pH (5.0–7.0), suitable for scalp application, and showed adequate foam stability and viscosity, which are essential for consumer acceptability.

The antifungal evaluation demonstrated promising results against dandruff-causing fungi, confirming the therapeutic potential of the active ingredient. Additionally, the conditioning agents improved the texture and feel of the hair, while preservatives ensured product stability during storage.

However, the formulation may present some limitations such as scalp irritation in sensitive individuals, reduced efficacy with irregular use, or instability of certain actives over prolonged storage. Future improvements can include the use of herbal anti-dandruff agents (like neem, tea tree oil, aloe vera, or rosemary extracts) to reduce side effects and improve consumer preference for natural products.

Conclusion

The formulated anti-dandruff shampoo was found to be effective, stable, and cosmetically acceptable, fulfilling the essential quality parameters such as pH balance, viscosity, Formability, and antifungal activity. The inclusion of an active antifungal agent successfully reduced dandruff-related issues, while conditioning agents enhanced hair softness and manageability. Thus, anti-dandruff shampoos play a crucial role in maintaining scalp health and improving hair quality. With further optimization and incorporation of herbal/natural ingredients, the formulation can be made safer, more sustainable, and more appealing to consumer

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No Conflict of Interest

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Not Applicable

Author Contribution

All authors are contributed equally.

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