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Review Article

Polyherbal Anti-Dandruff Shampoos: Pathophysiology of Dandruff, Medicinal Plants, and Therapeutic Advantages

Shreya Shubhashree*, Purnima Baghel, Hemlata Rathore

School of Pharmacy, Chouksey Engineering College, Bilaspur, Chhattisgarh

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ABSTRACT

Dandruff is a common chronic scalp disorder characterized by excessive flaking, itching, and irritation, affecting a significant portion of the global population. Its pathophysiology involves a complex interaction between the overgrowth of *Malassezia* species, increased sebum secretion, and scalp inflammation. Conventional anti-dandruff shampoos containing synthetic agents such as ketoconazole, zinc pyrithione, and selenium sulfide are widely used; however, their prolonged use is often associated with adverse effects including scalp dryness, hair damage, and allergic reactions. In recent years, polyherbal anti-dandruff formulations have emerged as safer and more effective alternatives due to their multi-targeted therapeutic action. These formulations utilize synergistic combinations of medicinal plants possessing antifungal, antibacterial, anti-inflammatory, and keratolytic properties, which help control dandruff while maintaining scalp health. Commonly used herbs include *Azadirachta indica* (neem), *Sapindus mukorossi* (reetha), *Trigonella foenum-graecum* (fenugreek), *Aloe vera*, and *Ocimum* species (tulsi). This review highlights the pathophysiology of dandruff, mechanisms of action of herbal ingredients, recent scientific advancements, and the advantages and limitations of polyherbal anti-dandruff shampoos. Overall, current evidence suggests that polyherbal formulations represent promising, eco-friendly, and holistic approaches for effective dandruff management.

INTRODUCTION

Dandruff is a common scalp disorder characterized by excessive flaking of the stratum corneum, accompanied by itching, irritation, and varying degrees of inflammation, and it represents one of the most prevalent scalp conditions worldwide,

affecting up to 50% of the global adult population at some point in life, while in India nearly 70% of individuals, particularly young adults, experience dandruff. Its etiology is multifactorial, with the overgrowth of *Malassezia* species, increased sebum secretion, and impaired scalp barrier function identified as major contributing factors.

***Corresponding Author:** Shreya Shubhashree

Address: School of Pharmacy, Chouksey Engineering College, Bilaspur, Chhattisgarh

Email ✉: rutujapagare1999@gmail.com

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Malassezia, a lipophilic yeast that constitutes a dominant component of the normal scalp microbiota, metabolizes triglycerides present in sebum and releases irritant free fatty acids that penetrate the compromised scalp barrier, trigger inflammatory responses, and accelerate epidermal turnover, ultimately leading to visible flakes and discomfort. Beyond physical symptoms, dandruff significantly impacts scalp health and personal appearance, often resulting in psychological distress and reduced self-confidence. Conventional management primarily relies on synthetic antifungal shampoos containing agents such as zinc pyrithione, ketoconazole, selenium sulfide, salicylic acid, and coal tar, which are effective in suppressing Malassezia proliferation and reducing flaking; however, prolonged or excessive use of these formulations is frequently associated with undesirable effects, including scalp dryness, irritation, altered hair texture, and the potential development of microbial resistance. These limitations have driven increasing consumer interest in safer, natural, and eco-friendly alternatives, leading to the growing popularity of polyherbal shampoos as holistic solutions for long-term dandruff management. Polyherbal formulations combine multiple medicinal plants with complementary pharmacological activities, producing a synergistic therapeutic effect, and herbs commonly used in Indian and Ayurvedic medicine—such as *Azadirachta indica* (Neem), *Sapindus mukorossi* (Reetha), *Hibiscus rosa-sinensis* (Hibiscus), *Aloe vera*, *Ocimum basilicum*, and *Tagetes erecta*—exhibit well-documented antifungal, anti-inflammatory, antibacterial, antioxidant, and scalp-soothing properties. The presence of natural saponins, flavonoids, phenolics, essential oils, and mucilage in these plants not only helps reduce microbial load but also gently cleanses the scalp, maintains moisture balance, strengthens hair follicles, and improves overall scalp condition without causing harmful

side effects. Owing to their combined cleansing, antimicrobial, anti-inflammatory, and conditioning mechanisms, polyherbal shampoos represent a promising, sustainable, and effective natural approach for long-term dandruff control and maintenance of scalp health [1-3].



Fig. Dandruff

TYPES [4, 5]:

Oily Dandruff (Pityriasis Steatoides)-

Oily dandruff is a more severe form, clinically referred to as pityriasis steatoides, and is associated with excessive sebum production (seborrhea). It often results from an overactive scalp environment that promotes the proliferation of *Malassezia* species, a lipophilic yeast implicated in dandruff pathogenesis.

Clinical Features

- Presence of larger, yellowish, greasy flakes that stick to the scalp and hair shaft.
- Excessive oil causes flakes to clump together.
- Increased scalp odor due to sebum oxidation and microbial activity.
- The hair often feels greasy, heavy, and unclean.

Pathophysiology

- Hyperproduction of sebum creates a lipid-rich environment favorable for *Malassezia* growth.

- Malassezia metabolizes sebum triglycerides, releasing oleic acid, which irritates the scalp.
- This leads to inflammation, erythema, and more severe itching.
- Sticky scales form due to the combination of sebum, fungi, and corneocytes.

Symptom Severity

- Itching is more intense than in dry dandruff due to inflammatory changes.
- In some cases, it may lead to follicular blockage, causing hair weakness or shedding.

Distribution Pattern

Oily dandruff may extend beyond the scalp and is frequently observed:

- Behind the ears
- On the chest (sternal region)
- In the beard area
- Under the arms (axilla)
- In other seborrheic areas rich in sebaceous glands

Dry Dandruff (Pityriasis Simplex / Pityriasis Sicca)

Dry dandruff is characterized by the presence of small, dry, white flakes that are loosely attached to the scalp and easily fall onto the shoulders. This form is usually associated with reduced scalp moisture and insufficient sebum production, leading to dryness of the stratum corneum.

Clinical Features

- Appearance of tiny, white, powdery scales that are highly visible on the scalp and hair.
- Flakes detach easily because they are not held together by sebum.
- Minimal inflammation and comparatively lower itching than oily dandruff.
- Hair loss is typically not prominent in this type.

Pathophysiology

- Inadequate sebum production leads to insufficient lubrication of the scalp.
- Loss of natural moisture accelerates desquamation of corneocytes.
- Environmental factors such as cold weather, dry air, and harsh shampoos can worsen dryness.
- Poor hydration and nutritional deficiencies (e.g., essential fatty acids, zinc) may also contribute.

Distribution Pattern

- Dry flakes commonly originate from the central scalp region.
- Gradually spread towards the forehead, temporal regions (sides), and the nape of the neck.

Associated Symptoms

- Tightness or dryness of the scalp.
- Mild itching.
- Absence of inflammation or greasy scales.

Table: Medicinal Plants Commonly Used in Anti-Dandruff Formulations

Sr. No.	Plant Name	Botanical Name	Family	Synonym	Part used	Key Antidandruff Properties
1.	Neem	Azadirachta indica	Meliaceae	Melia azadirachta	Leaves, bark, oil	Strong antifungal (acts against Malassezia), antibacterial, anti-



						inflammatory, cleanses scalp
2.	Tulsi	Ocimum sanctum	Lamiaceae	Holy Basil	Leaves	Antifungal, antimicrobial, reduces itching, balances scalp microbiome
3.	Marua	Oscimum Basillicum	Lamiaceae	Sweet Basil	Leaves	Potent antifungal (against Malassezia), antioxidant, anti-inflammatory
4.	Marigold	Tagetes Erecta	Asteraceae	Genda	Flower, Leaves	Antifungal, antimicrobial, wound-healing, reduces scalp irritation
5.	Amla	Phyllanthus emblica	Phyllanthaceae	Emblica Officinalis	Fruit	Antifungal, antioxidant, reduces itching, promotes scalp health
6.	Jamun	Syzygium Cumini	Myrtaceae	Eugenia jambolana	Leaves, seeds	Antimicrobial, antifungal, reduces scalp irritation
7.	shikakai	Acacia concinna	Fabaceae	Karnikara	Pod, Leaves	Mild cleanser, antifungal, reduces irritation
8.	Reetha	Sapindus mukorossi	Sapindaceae	Reethaphal	Fruit, pericarp	Natural cleanser, antimicrobial, removes excess oil & flakes
9.	Aloe vera	Aloe barbadensis miller	Asphodelaceae	Indian Aloe	Gel	Anti-inflammatory, antifungal, hydrating, anti-itch
10.	Curry leaf	Murraya koenigii	Rutaceae	Bergera koenigii	Leaves	Antifungal, antioxidant, improves scalp health
11.	Ginger	Zingiber officinale	Zingiberaceae	Adrak	Rhizome	Antimicrobial, improves circulation, reduces scalp infection
12.	Moringa	<i>Moringa oliefera</i>	Moringaceae	Saijna	Leaves	Prevents scalp infection, anti-inflammatory property
13.	peepal	<i>Ficus Religiosa</i>	Moraceae	Peepul	Leaves	Hair Follicle Regeneration, Promote Hair Growth
14.	Fenugreek	Trigonella foenum	Leguminosae	Methi	seeds	Provides hair shining
15.	Hibiscus	Hibiscus rosa-sinensis	Malvaceae	China Rose	Flower, Leaves	Moisturizing, soothing, antimicrobial, reduces dryness
16.	Bhringraj	Eclipta alba	Asteraceae	False Daisy	Whole plant	Antifungal, anti-inflammatory, strengthens hair follicles

17.	Cassia	Cassia Auriculata	Fabaceae	Tanner's cassia	Leaves	Antifungal, antioxidant, Natural cleanser
18.	Garlic	Allium sativum	Amaryllidaceae	Lehsun	Bulb	Antifungal, antimicrobial, improves scalp conditions
19.	Ashwagandha	Withania somnifera	Solanaceae	Punir	Stem	Anti-inflammatory, antimicrobial, detoxifying for scalp
20.	Onion	Allium cepa	Amaryllidaceae	Pyaj	Bulb	Antimicrobial, Anti-dandruff, Hair growth promoting

PATHOPHYSIOLOGY OF DANDRUFF ^[6-8]:

Dandruff is a chronic scalp condition marked by visible flaking, itching, and irritation. It is widely regarded as a non-inflammatory form of seborrheic dermatitis and results from a complex interplay of excess sebum secretion, Malassezia yeast activity, and host-related susceptibility factors, including impaired barrier function and subclinical inflammation. These interconnected mechanisms together contribute to the onset and progression of dandruff.

1. Sebum Production and Lipid Metabolism

Sebum plays a crucial role in maintaining scalp hydration and supporting the natural microbiota. Produced by the sebaceous glands, it forms a lipid-rich protective layer essential for maintaining scalp homeostasis.

However, when sebum production increases beyond normal levels—a condition influenced by hormonal activity (especially androgens), stress, or genetic predisposition—the scalp becomes highly conducive to microbial proliferation. The lipophilic yeast *Malassezia* spp., which depends on external lipids for survival, uses these triglycerides as a nutrient source. Excess sebum thus sets the stage for microbial imbalance and increases susceptibility to dandruff.

2. Role of Malassezia Species in Dandruff Development

Among the various species of the genus *Malassezia*, *M. globosa* and *M. restricta* are most frequently associated with dandruff. These species secrete lipases that break down triglycerides present in sebum, producing free fatty acids, particularly oleic acid.

Oleic acid easily penetrates the weakened stratum corneum, leading to:

- Irritation
- Barrier disruption
- Increased transepidermal water loss
- Accelerated turnover of keratinocytes

This rapid shedding of corneocytes leads to the formation of white or yellowish scales characteristic of dandruff.

3. Barrier Dysfunction and Immune Response

The penetration of free fatty acids and metabolic by-products of *Malassezia* results in structural deterioration of the scalp barrier. This triggers the release of inflammatory mediators such as:

- Interleukin-1 α (IL-1 α)
- Tumor necrosis factor-alpha (TNF- α)

- Other cytokines associated with epidermal stress

Even though dandruff is considered a mild condition, these inflammatory responses create subclinical dermatitis, giving rise to symptoms like itching, redness, and discomfort. Continuous barrier impairment also makes the scalp more reactive to environmental irritants and chemicals.

4. Skin Microbiome Imbalance

Recent microbiome-based studies show that dandruff-affected scalp exhibits altered microbial diversity. While *Malassezia* dominates the fungal community, the bacterial population—commonly *Staphylococcus* spp. and *Propionibacterium* spp.—gets disrupted.

This dysbiosis contributes to:

- Increased inflammation
- Impaired barrier repair
- Reduced resilience of the scalp ecosystem

An imbalanced microbiome weakens the scalp's natural defense mechanisms, making it more prone to recurring dandruff episodes.

5. Genetic, Hormonal, and Environmental Influences

Dandruff severity varies widely among individuals due to intrinsic and extrinsic factors. Several studies indicate that:

- Genetic susceptibility can influence sebaceous gland activity and skin barrier strength.
- Hormonal fluctuations, especially elevated androgen levels, stimulate excess sebum production.

- Environmental conditions like humidity, temperature changes, pollution, and seasonal climate shifts can aggravate dandruff.
- Lifestyle-related factors, including stress, poor hair hygiene, and inappropriate cosmetic use, further modulate dandruff recurrence.

These variables collectively determine how frequently and severely an individual may experience dandruff.

6. Relevance to Polyherbal Anti-Dandruff Formulation Development

Since dandruff is multifactorial, a successful treatment must target multiple mechanisms simultaneously. Conventional antidandruff agents (ketoconazole, zinc pyrithione, selenium sulfide) act mainly against fungi but may cause adverse effects with prolonged use.

In contrast, polyherbal formulations provide a multi-targeted approach due to the diverse phytochemicals present in medicinal plants.

Polyherbal formulations offer:

- Antifungal action → inhibits *Malassezia* proliferation
- Anti-inflammatory effects → reduces cytokine-mediated irritation
- Sebum-regulating activity → restores scalp oil balance
- Barrier-enhancing functions → improves scalp hydration and barrier repair
- Microbiota-balancing activity → supports healthy scalp ecology

Phytoconstituents such as flavonoids, alkaloids, phenolics, tannins, saponins, terpenoids, and essential oils act synergistically to address the core pathways of dandruff pathogenesis. This multi-dimensional therapeutic potential makes



polyherbal shampoos a promising, safer alternative for long-term dandruff management.



RECENT RESEARCH AND CLINICAL STUDIES:

1. Mane et al. (2025) presented a comprehensive review on the formulation and evaluation of a polyherbal anti-dandruff shampoo incorporating *Aegle marmelos*, *Aloe vera*, and *Acacia concinna* (Shikakai). The study highlights the growing demand for herbal hair-care formulations as safer alternatives to synthetic shampoos, which are often associated with scalp irritation and long-term hair damage.

The authors emphasized the therapeutic relevance of individual herbal components. *Aegle marmelos* contributes significant antifungal and anti-inflammatory activity, aiding in the management of dandruff-causing microbial flora. *Aloe vera* acts as a natural moisturizer and soothing agent, reducing scalp dryness, itching, and irritation, while also supporting hair growth. *Acacia concinna*, a traditional natural cleanser, functions as a mild surfactant, providing effective cleansing and foam formation without stripping natural oils from the scalp.

The review further discusses standard formulation strategies and evaluation parameters, including pH, viscosity, foam stability, wetting time, dirt dispersion, and stability studies, all of which are critical for ensuring product safety, efficacy, and consumer acceptability. Additionally, the antidandruff efficacy of the formulation is attributed to the synergistic action of the herbal constituents against dandruff-associated fungal species.

Overall, the authors conclude that the polyherbal shampoo formulation demonstrates promising antidandruff potential, scalp compatibility, and cosmetic acceptability, supporting its suitability as a natural, eco-friendly alternative to conventional synthetic shampoos. This review provides valuable insights for future research and development of herbal antidandruff formulations.

2. Ghatge et al. (2025) described the formulation and systematic evaluation of a polyherbal shampoo using medicinal plant extracts to achieve effective cleansing with improved hair and scalp compatibility. The formulation was assessed for physicochemical parameters including pH, viscosity, foam stability, dirt dispersion, and wetting time, confirming good stability and cosmetic acceptability. The study highlights the potential of polyherbal shampoos as safe and eco-friendly alternatives to conventional synthetic formulations.

3. Newar et al. (2025) formulated and evaluated polyherbal shampoos containing *Phyllanthus emblica* (Amla), orange peel, lemon juice, and *Sapindus mukorossi* (Reetha) as a natural detergent. The formulations were assessed for physicochemical and performance parameters, including pH, viscosity, wetting time, detergency, foaming ability, and conditioning action. The shampoos exhibited skin-compatible pH, good rheological behavior, satisfactory detergency, and

conditioning effects comparable to marketed products. The study highlights polyherbal shampoos as stable and safer alternatives to synthetic surfactant-based formulations.

ADVANTAGES OF POLYHERBAL ANTIDANDRUFF SHAMPOO ^[9 - 12]:

Polyherbal shampoos offer several therapeutic, cosmetic, and safety-related benefits compared to conventional synthetic formulations. These advantages arise from the combined action of multiple plant extracts, each contributing unique phytochemicals with antifungal, anti-inflammatory, cleansing, and conditioning properties. The key advantages are described below.

1. Multimodal Therapeutic Action

Polyherbal shampoos contain a combination of herbs that exhibit antifungal, antibacterial, anti-inflammatory, antioxidant, and seboreregulating properties.

This multimodal action targets all major causes of dandruff, such as:

- Malassezia fungal overgrowth
- Scalp inflammation and redness
- Excessive sebum secretion
- Oxidative stress
- Impaired scalp barrier function

Thus, polyherbal formulations provide comprehensive and long-term dandruff management.

2. Synergistic Effect of Multiple Herbs

When multiple herbs are combined, their bioactive compounds act synergistically, enhancing overall effectiveness.

For example:

- One herb may provide strong antifungal activity
- Another may reduce inflammation
- Another may condition and moisturize

This synergy results in superior therapeutic outcomes compared to single-herb or synthetic formulations.

3. Gentle and Scalp-Friendly

Herbal extracts are rich in natural emollients, mucilage, and soothing phytochemicals, making polyherbal shampoos:

- Mild and non-irritating
- Suitable for sensitive scalps
- pH-balanced
- Less likely to cause dryness or allergic reactions

Even when synthetic surfactants (like SLS) are present, herbs reduce their harsh effects, improving scalp compatibility.

4. Nourishing and Conditioning Properties

Polyherbal shampoos naturally contain:

- Vitamins (A, C, E, B-complex)
- Minerals
- Essential oils
- Proteins
- Antioxidants

These nourish the scalp and hair, leading to:

- Stronger roots and reduced hair fall
- Better hair texture and shine
- Improved moisture balance
- Smoother, softer hair



Thus, users get both therapeutic and cosmetic benefits in one formulation.

5. Anti-Inflammatory and Soothing Effects

Many herbs such as Aloe vera, Neem, Marigold, and Basil contain flavonoids, terpenoids, and tannins with strong soothing effects. They help:

- Reduce itching and irritation
- Calm inflamed scalp skin
- Promote healing of microlesions
- Prevent further scalp damage

This improves user comfort and supports long-term scalp health.

6. Safe, Biocompatible, and Eco-Friendly

Most ingredients used in polyherbal shampoos are:

- Plant-derived
- Biodegradable
- Non-toxic
- Environmentally safe

Surfactants like Cocamidopropyl betaine (CAPB), derived from coconut oil, also improve sustainability. These formulations appeal to consumers seeking natural, clean, and green personal care products.

7. Holistic Hair and Scalp Care

Polyherbal shampoos not only treat dandruff but also provide broader benefits such as:

- Improved blood circulation
- Hair strengthening
- Reduced dryness
- Enhanced scalp hydration
- Prevention of dandruff recurrence

This holistic approach makes them ideal for both therapeutic use and daily hair care.

8. Cost-Effective and Easily Formulated

Polyherbal shampoos are economical because:

- Herbal raw materials are widely available
- Formulation does not require expensive synthetic chemicals
- Herbal extracts often act as natural preservatives and conditioners
- Physicochemical stability can be maintained with simple formulation techniques

This makes them suitable for large-scale production and affordable pricing.

LIMITATIONS OF POLYHERBAL ANTIDANDRUFF SHAMPOO ^[12 - 20]:

- **Variability in Herbal Raw Materials:** The quality and potency of herbal ingredients can vary depending on factors like plant age, season, soil conditions, and extraction methods. This variability can affect the consistency and therapeutic performance of the shampoo.
- **Standardization Challenges:** Compared to synthetic drugs, herbal extracts contain multiple active phytochemicals. Ensuring uniform concentration of these compounds in every batch is difficult, making standardization a major limitation.
- **Risk of Allergic Reactions:** Despite being “natural,” some herbs may cause irritation, itching, or allergic dermatitis in sensitive individuals. Identifying the exact allergen becomes challenging when multiple herbs are combined.



- **Stability Issues:** Herbal ingredients can degrade over time due to light, heat, and microbial contamination. Maintaining product stability, color, consistency, and fragrance for long storage durations is difficult.
- **Possible Interactions Between Ingredients:** When many herbs are mixed, their chemical components may interact. These interactions can sometimes reduce efficacy or lead to unexpected side effects.
- **Higher Microbial Contamination Risk:** Plant-based materials may naturally contain microbes. Extra preservatives or sterilization steps are required to ensure safety, which increases processing time and cost.
- **Limited Clinical Evidence:** Although herbs are traditionally used, strong clinical trials proving safety and efficacy of polyherbal combinations are limited. This restricts universal acceptance in dermatology.
- **Formulation Complexity:** Creating an ideal balance of surfactants, conditioning agents, and herbal extracts is difficult. Some extracts may not dissolve well, may alter pH, or may react with other components.
- **Color and Odor Challenges:** Herbal extracts often have strong natural colors and odors that may not be appealing to all consumers. Additional fragrance or color correction is required.
- **Shorter Shelf Life:** Compared to synthetic shampoos, polyherbal formulations generally have a shorter shelf life unless preserved carefully, which may increase manufacturing cost.

CONCLUSION:

Polyherbal anti-dandruff shampoos are increasingly recognized as safe and effective natural alternatives to conventional chemical-based formulations. These shampoos contain synergistic combinations of medicinal plant extracts possessing antifungal, antibacterial, anti-inflammatory, and keratolytic activities. Through their multifaceted mechanisms, herbal constituents target the primary causes of dandruff, including *Malassezia* overgrowth, excessive sebum production, and scalp inflammation, while simultaneously nourishing the scalp and strengthening hair. Compared to synthetic agents, which are often associated with adverse effects such as scalp irritation, dryness, and hair damage, polyherbal shampoos are generally milder and better suited for long-term use. Commonly incorporated herbs such as neem, tulsi, aloe vera, fenugreek, and reetha contribute to effective cleansing, soothing, and conditioning actions. However, challenges related to standardization, batch-to-batch consistency, and product stability remain. Future research should focus on large-scale clinical validation, formulation optimization, and the development of natural preservatives to enhance shelf life. With continued scientific support, polyherbal anti-dandruff shampoos hold strong potential as sustainable solutions for dandruff management and overall scalp health.

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