Review Article

Int Jou Hea Bio Sci, 6(3), 2025, 17-23

International Journal of Health care and Biological Sciences

Content available at www.saap.org.in Online ISSN: 2582-7499

Open Access

ANTIFUNGAL AND ANTIDANDRUFF POTENTIAL OF MOUNTAIN KNOT GRASS IN HERBAL SHAMPOO FORMULATION

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Article History

Received on: 14-06-2025
Revised on: 02-07-2025
Accepted on: 25-08-2025

Abstract

Dandruff is a prevalent scalp condition commonly associated with fungal infections, particularly by Malassezia species, and is often managed using synthetic antifungal shampoos that may cause adverse effects with prolonged use. This study explores the antidandruff efficacy of a herbal shampoo formulated with Polygonum aviculare (mountain knot grass), a plant known for its antimicrobial, anti-inflammatory, and astringent properties. Methanolic and aqueous extracts of the plant were incorporated into shampoo formulations and evaluated for physicochemical properties, antifungal activity, and overall effectiveness against dandruff-causing fungi. The formulated shampoo exhibited favorable pH, foaming ability, and cleansing power, while also showing significant inhibitory activity against Malassezia furfur in vitro. Phytochemical screening confirmed the presence of flavonoids, tannins, saponins, and phenolic compounds, which are believed to contribute to the antidandruff effect. The results suggest that mountain knot grass-based shampoo is a promising natural alternative to conventional antidandruff products, offering both efficacy and safety.

Keywords: Dandruff, Polygonum aviculare, Herbal shampoo, Antifungal activity, Malassezia furfur, Phytochemicals.

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DOI: https://doi.org/10.46795/ijhcbs.v6i3.733

introduction

Dandruff is a common scalp condition characterized by flaky, dry skin that sheds from the scalp, often resulting in white or grayish flakes in the hair and on the shoulders. It's typically not a serious or contagious condition but can be embarrassing and uncomfortable. Hair shaft is made up of layers and they can get damaged when they come in contact with direct heat or unfavorable conditions Blow drying involves the use of heat for drying and styling the hair, which has an adverse impact on the hair if done wrongly, making them weak. Not only styling processes, like coloring, perming, straightening, etc., but environmental factors also have adverse impacts on hair and can change their properties, such as losing sheen and volume, making them dry and brittle, causing split ends and dandruff, etc. Environmental factors include sunlight (UV rays), pollution, humidity, wind, dry weather conditions, etc. Head wash helps in maintaining healthy and clean hair. The lack of care and poor-quality products also affect the health of the hair. Regular hair care with protectants can make the hair healthy, and help in regaining its shine and strength. Salons can provide hair care service. For this, a salon should be clean and disinfected, maintain a suitable temperature and lighting facility. It should follow the required safety standards.

Fig 01: Identification of Dandruff

Aerva lanata (L) is a tropical plant which is grown extensively in “India, Arabia, Africa, Sri Lanka, Philippines and Java”. It is a perennial weed belonging to the family Amaranthaceae. Aerva lanata is a traditional medicine which holds to cure a various disorder such as “helminthic, diabetes, inflammation, skin diseases, kidney stones, headache, cough, cholera, dysentery and diarrhea”.

Aerva lanata is extensively utilized by progressive scientific techniques which is reported to possess activities such as “diuresis, urolithiasis anti-inflammatory, antimicrobial, anti-diabetic, nephroprotective, hepatoprotective anthelminthic and antidiarrheal.

Hair anatomy

- Hair grows from hair follicles situated within the fatty layer of the scalp. Contrary to the popular belief that hair grows as single strands, hair follicles actually grow in groups of 1-4 hairs called “follicular units”.
- At the base of each hair follicle is a hair bulb where the growth mechanism for producing hair occurs. Hair follicles get their nourishment from the blood vessels within the dermis. The cells divide and develop to produce the hair shaft.
- While the hair is still developing underneath the epidermis, it maintains a soft form. Once the pushes past the epidermis, its outside layer hardens into keratin.

Structure of Hair

Hair is a simple structure that is made up of protein filaments called keratin. This is exactly the same protein from which the nail and outer skin layer is comprised. Hair act as a barrier to foreign particles.

A hair is composed of columns of dead, keratinized cells welded together. The shaft is a Superficial portion of the hair, which projects from the surface of the skin. The shaft of straight Hair is rounded in a cross-section, that of wavy hair is oval and that of wooly hair is elliptical or Kidney-shaped. The root is the portion of the hair deep into the surface that penetrates the dermis And sometimes into the subcutaneous layer. The shaft and root both, hair structure can be divided into two part

1.Hair root

2.Hair shaft

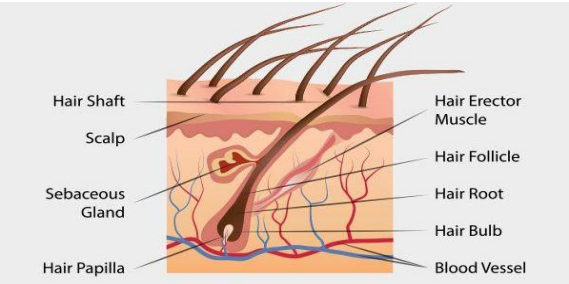

Fig 02: Hair Anatomy

1. Hair Root

a. hair follicle

This is the living part of the hair. The hair follicle is the Sac or tube that surounds the hair root and extends into the dermis.The follicle is surounded by an inner and ouler shceath that proltects and molds the growing hair shaft.

b. hair bulb

It is the lowest part of your hair strand, which lies inside the follicle. The club-shape of the hair bulb helps it to get locked by the dermal papilla.

c. dermal papilla

It is the conc-shaped clevation which is present at the base of your hair follicle. It fits into the hair bulb and holds it. Dermal papilla is connected with the blood vessels.

d. Matrix:

The matrix surrounds the dermal papillae and contains all the active cells needed for hair growth and for the development of the different parts of the hair, particularly the outer root sheath, the inner root sheath and the hair shaft. Combined, the matrix and the dermal papillae make up the hair bulb.

Outer root sheath

The outer root sheath, or trichelemma, is the outermost part of the hair and is keratinized. It covers the entire hair follicle inside the dermis and the transitions through to the epidermis, providing the hair follicle with an opening from which to surface from.

Inner root sheath

Inner root sheath is comprised of three parts: the Henley layer, Huxley layer, and cuticle. The Henley’s and Huxley’s layers are capsular layers that anchor onto each other with the purpose of stabilizing the hair. The cuticle, which is the innermost part that it closest to the hair shaft, is made from dead hardened cells and give the hair shaft added protection. This, together with the capsular layers that make up the Henley’s and Huxley’s layers, secures the hair and allows it to grow in length.

D.Melanocyte Cells

Melanocyle cells are located in the germinal matrix.It produce the pigmenthat gives colour to the hair.

Hair is fomed by cells in germinal matrix which undergo mitosis or cell division.

E.Arrector Pili Muscle

It is an involuntary muscle present at the base of the hair folicle. We get gooscbumps when arrector pili contrcts.

F.Sebaceous Glands

These are the oil glands that are connecled to the hair follicles. "Scbaceous glands secrete scbum for your hair.

2. Hair shaft:

The hair shaft is the solitary part of the hair follicle that fully exits the surface of the skin.

The hair shaft is made up of three layers: the medulla, cortex, and the cuticle.

- The medulla is described as an unsystematic and unstructured area located in the innermost region of the hair shaft and is not always present.
- The cortex, in contrast to the medulla, is highly structured and organized. The cortex is made up of keratin and is responsible for giving hair its strength and durability, as well as its water uptake. The cortex also contains melanin and determines the color of hair based on the

number, distribution and types of melanin granules present.

- The cuticle is the hair's outer protective layer and is connected to the internal root sheath. It is a complex structure with a single molecular layer of lipids that helps hair repel water.

Hair physiology

Hair growth cycle

Hair grows from the follicle, or root, underneath the skin. The hair is 'fed' by blood vessels at the Base of the follicle, which give it the nourishment it needs to grow. Between starting to grow and Falling out years later, each hair passes through four stages: anagen, catagen, telogen and exogen. Another stage kenogen, has been recently realised. Every hair is at a different stage of the growth cycle. Over time, the length of the anagen stage decreases. Therefore, the hair may become weaker and thinner after each cycle. That is why it is important to ensure diet rich in Specific nutrients to maintain normal, healthy hair growth. If hairs enter the resting phase too Early, excess shedding and noticeable thinning of the hair can occur [14]. The hair growth happens in a cyclical process in hair follicles.

The cycle consists of four phases:

Anagen (hair growth)
Catagen (transition)
Telogen (Resting)
Exogen (hair shedding)

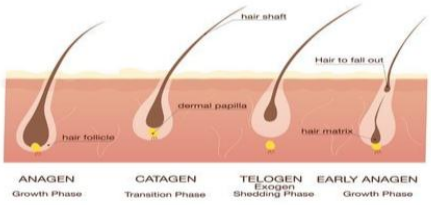

Fig 03: Hair Growth Cycle

Anagan phase

The anagen or growing phase is the first part of the hair growth cycle. During this Phase, cells of the bulb divide rapidly, resulting in new hair growth. 80-90% of Hair follicles are in the anagen Phase at any given time. The anagen phase lasts for 2-7 years. The length of the anagen phase Determines. The maximum hair length. For example, people with very long hair have a very Long anagen phase. Eyelashes, eyebrows, and body hair have shorter growth phases.Than for the hair on head, which is why they are much shorter than scalp hair. There are many Factors that influence the length of the anagen phase, including Genetics, nutrition, age and Overall health.

Catagen phase

The catagen or transition phase follows the anagen phase. This short, transitional Phase lasts for Only 2-3 weeks. During the catagen phase, the hair stops growing and detaches itself from the Blood supply. The hair becomes club hair.

Telogen phase

The telogen or resting phase follows the catagen phase. During the telogen phase, the club hair rests while a new hair begins to grow beneath it. This new hair eventually takes the place of the Club hair. The telogen phase lasts for 3 months, and 10-15% of all hair is in this phase at any one time.

Exigent Phase

The exogen or shedding phase is the last part of the hair cycle. During the Exogen phase, the Resting club hair detaches and falls out. Every hair eventually sheds, and it's completely normal To lose 50 to 100 hair each day. After the exogen phase, the follicle then returns to the anagen Phase and the cycle Repeats [15].

Hair and scalp conditions and diseases

Common hair and scalp conditions

Hair loss: -

It can be spotted when clumps of hair are visible in the drain after a head wash, in the hair brush after combing, or visible thinning of the hair.

Lice infestation: -

Lice thrive by sucking blood from the scalp, causing itching.

Dandruff: -

It is the shedding of dead skin from the scalp. Many associate it with self-esteem

Hair and Scalp Diseases

ALOPECIA AREATA

It is the loss of hair in patches that can be as big as a coin.

Psoriasis

It is seen in the form of dry and scaly skin of the scalp. It can spread to the entire scalp and other areas, such as behind the ears, neck or forehead.

Lichen planus

These are rashes occurring due to immune responses, allergies, stress or genetic disorders.

Dandruff

Dandruff is the major cosmetic problem & great public concern both in developed developing Countries. The word dandruff is combination of "ten "meaning Letter and meaning 'dirty Dandruff is a chronic scalp condition leading to scaling itching redness of by shedding epidermal Cell. Scalp sheds dead cells in nearly invisible way but sometimes shed as visible flakes called Dandruff. In physiological spectrum of sealing about 487500 cell/smart released after detergent Treatment. Many herbal shampoos available in market contains herhal ingredients such as plant Extracts and essential oil Tulsi, Henna, Neem, Lemon, shikakai are commonly used plants in Shampoo formulation of which some how anti-dandruff activity, The goal of using shampoo is to Remove the unwanted build up in between the hair without stripping out so much sebum as to Make hair unmanageable Shampoo is generally made by combining surfactant, most often Sodium lauryl sulphate with a co-surfactant, most

often propyl in water. Synthetic shampoo may Cause side effects so keeping this in view an Herbal anti-dandruff shampoo has been formulated And evaluated scientifically. In Indian system of medicine, various plants its parts have been usedfor treatment of dandruff such as Tulsi, Henna, Neem, Lemon, shikakai. Traditionally, single plants have been used &there was no scientific report available regarding totally all ingredients are natural regarding usage of such combination that we have conceived.

Type of dandruff

I) Dry Skin dandruff
II) Oily skin dandruff
III) Fungus related dandruff

i) Dry skin dandruff:-

It is also called as pityriasis simplex characterize by excessive formulation of minute scales which accumulate on the scalp area. In this type of dandruff there is no excessive hair loss. The inflammation on the skin no observed. The scales are first found in middle of the scalp and then spread of frontal, parietal and occupational areas.

Fig 04: Dry Skin Dandruff on the Scalp

ii) Oil related dandruff

Oil related dandruff happen when there is an accumulation of sebum oil on the scalp. It is mostly Found in young men following puberty. Inflammation of varied intensity developed on the scalp Along with oily scales of dirty yellow colour. Hair fall is mostly found in this condition. The Most common site affected by this type of dandruff is scalp, behind the ears, over breast bone Armpits. Oume high amount of serum oil secretion leading to the condition flakes. Stress & Anxiety level cause champs all dead skin. And dirt forming itchy flakes. Stress and anxity level Cause high amount of sebum oil secretion leading to the condition.

Fig 05: Oil related dandruff on the Scalp

iii) Fungal dandruff

Fungal dandruff Fungal is a natural component found on skin and scalp. This fungus survives on excessive oil.

Fig 06: Fungal dandruff

Pathophysiology of dandruff

The patho physiology of dandruff involves a complex interplay between Malassezia yeasts, sebaceous gland activity, immune responses, skin barrier integrity, genetic and environmental factors.

Malassezia, a genus of lipophilic yeasts, plays a central role in triggering the inflammatory and hyper proliferative responses seen in and dandruff. Malassezia spp. are particularly abundant in seborrheic areas due to their preference for lipid-rich environments and are more prevalent in individuals with dandruff or compared to those without these conditions. The metabolites produced by Malassezia can induce keratinocytes to release proinflammatory cytokines, thereby prolonging the inflammatory process Excessive sebum production creates an environment conducive to Malassezia growth. The interplay between sebaceous secretions and scalp microflora is crucial in the pathogenesis and dandruff.

Dandruff - seborrhoeic dermatitis link

The spectrum of dandruff is difficult to define because it blurs with seborrhoeic dermatitis and some other scaly conditions. The inflammation and extension of scaling outside the scalp exclude the diagnosis of dandruff from seborrhoeic dermatitis. However, many reports suggest a clear link between the two clinical entities - the mildest form of the clinical presentation of seborrhoeic dermatitis as dandruff, where the inflammation is minimal and remain subclinical. Histological examination reveals the scattered presence of lymphoid cells and squirting capillaries in the papillary dermis with hints of spongiosis and focal parakeratosis.

Conceptually, dandruff is a dander and represents nothing more than physiologic scaling. Hence it is believed that physiological scaling process requires more of cosmetic management. The response to treatment is commonly swift, but transient. On the contrary, seborrhoeic dermatitis is obviously more inflammatory in nature extending outside the limit of the scalp surface.

Diagnosis:

The itching and flaking of dandruff can almost always be controlled. For mild dandruff, first try regular cleansing

with a gentle shampoo to reduce oil and skin cell buildup. If that doesn't help, try a medicated dandruff shampoo. Some people can tolerate using a medicated shampoo two to three times a week, with regular shampooing on other days if needed. People with drier hair would benefit from less frequent shampooing and a moisturizing conditioner for the hair or scalp.

Hair and scalp products, both medicated and non medicated, are available as solutions, foams, gels, sprays, ointments and oils. You may need to try more than one product to find the routine that works for you. And you'll likely need repeated or long-term treatment. If you develop itching or stinging from any product, stop using it. If you develop an allergic reaction — such as a rash, hives or difficulty breathing — seek immediate medical attention.

Shampoo

A Shampoo is a preparation of a surfactant in a
Suitable form -liquids, solid or powder-which when
Used under the specified conditions will

- Remove surface grease
- Dirt and
- Skin debris

From the hair shaft and scalp without adversely affecting the user.

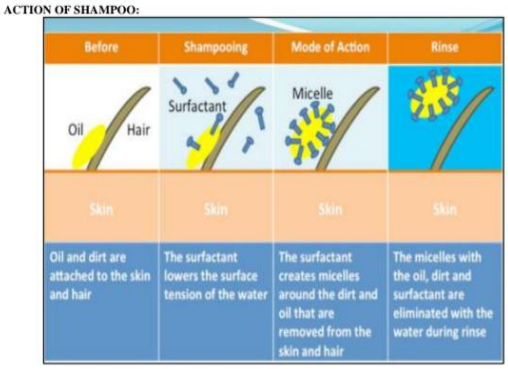

Fig 06: Action of Shamppo

Dandruff shampoos are classified according to the medication they contain. Some are available in stronger formulations by prescription.

Pyrithione zinc shampoos (Derma Zinc, Head & Shoulders, others). These contain the antibacterial and antifungal agent zinc Pyrithione. Tar- based shampoos (Neutrogena T/Gel, Scalp 18 Coal Tar Shampoo, others). Coal tar slows how quickly skin cells on your scalp die and flake off. If you have light- colored hair, this type of shampoo may cause discoloration. It can also make the scalp more sensitive to sunlight. Shampoos containing salicylic acid (Jason Dandruff Relief Treatment Shampoo, Baker P&S, others). These products help eliminate scaling. Selenium sulphide shampoos (Head & Shoulders Intensive, Selsun Blue, others).

These contain an antifungal agent. Use these products as directed and rinse well after shampooing, as they can discolor the hair and scalp.

Ketoconazole shampoos (Nizoral Anti-Dandruff).

This shampoo is intended to kill dandruff-causing fungi that live on your scalp.

Fluocinolone shampoos (Capex, Derma-Smoothe/FS, others). These products contain a corticosteroid to help control itching, flaking and irritation

Mountain Knot Grass

Fig 07: Mountain knot grass

Distribution

The plant grows as a common weed in fields, wastelands, and hills up to 3000 feet above sea level throughout India's plains. Additionally, it can be found in the Philippines, Java, Sri Lanka, Egypt, Tropical Africa, and Arabia. Particularly in Tamil Nadu, Andhra Pradesh, and Karnataka states in India.

Fig 08: Distribution Mountain knot grass

Morphology

The Perennial Shrub of Aerva lanata (Mountain Knot grass) is a shrub with woody root and soft spikes like flowers, with oval leaf of 0.5-1.5 in length arranged alternatively. The two lobes of whitish flowers with red bases are 0.1 m long alongside with pink, green and white flowers. This self-pollinating, bisexual plant is cultivated above 90-meter sea level and grown only around tropical climatic conditions23. It has subsessile head of axillary with spike length of 6-13 mm long forming globose like structures and long membranous perianth of 1.5 m long with oblong sepals, sometimes apiculate and two stigmas [0.85 mm diameter] polished, black seed24.Class: Magnoliopsida

Taxonomical classification

Subkingdom: Viridaeplantae Infra
Kingdom: Streptophyta
Phylum: Mangoliophyta
Subclass: Caryophyllidae Super
Order: Caryophyllanae
Order: Caryophyllales

Family: Amaranthaceae
Division: Tracheophyta
Subdivision: Spermatophyta
Infra division: Angiospermae
Genes: Aerva
Species:Lanata (Goyal et al., 2011).

Plant material

In September, leaves of Aerva lanata Juss were harvested from Naganakallu, Kartagi (tq) and preserved in paper bags for about 30 days, shielded from sunlight. Following the drying period, the leaves were ground into a powder using a mortar. The resulting powder was then subjected to extraction using a Soxhlet apparatus to isolate phytochemical components. The solution obtained from the extraction was collected in a conical flask and allowed to undergo solvent evaporation. The resulting residue underwent characterization through various analytical techniques, including HPLC, TLC, Mass spectra analysis

c	Petrolium Ether	Benzene	Ethyl Acetate	Methanol	Ethanol
Alkaloids	+	+	+	+	+
Anthroquinones	-	+	-	+	+
Catachin	-	+	+	+	+
Coumarin	-	+	+	+	+
Flovonoids	-	+	+	+	+
Phenols	-	-	-	+	+
Quinones	+	+	+	+	+
Saponins	-	-	-	+	+
Steroids	-	+	+	-	+
Tannins	-	-	-	+	+
Terpenoids	-	+	+	+	+
Glycosides	-	-	-	-	-
Xanthoprotein	-	+	+	-	+
Sugar	+	+	+	+	+
Fixed oil	-	-	-	-	-

Fig 09: Plant Materials

Conclusion

The present study demonstrates that Polygonum avicularia (mountain knot grass) possesses significant antidandruff potential, particularly when formulated into a shampoo. The plant extracts, especially the methanolic extract, exhibited notable antifungal activity against Malassezia furfur, a primary causative agent of dandruff. Phytochemical analysis revealed the presence of bioactive constituents such as flavonoids, tannins, and phenolics, which are likely responsible for the antifungal and scalp-soothing properties observed. The formulated herbal shampoo showed good cleansing ability, acceptable pH, and effective reduction of dandruff symptoms without causing scalp irritation. These findings suggest that mountain knot grass could serve as a natural, safe, and effective alternative to synthetic antidandruff agents in hair care products. Further in vivo studies and clinical trials are recommended to validate its long term efficacy and safety.

Funding

Nil

Conflict of Interest

Not Declared

Acknowledgement

Not Declared

Inform Consent and ethical statement

Not Applicable

Authors Contribution

All authors are contributed equally.

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