WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
Coden USA: WJPRAP Impact Factor 8.63
Volume 15, Issue 13, 1007-1034. Research Article ISSN 2277–7105

DEVELOPMENT AND EVALUATION OF NATURAL SHAMPOO POWDER HAVING ANTIDRANDRUFF AND ANTIFUNGAL ACTIVITY

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India.

Article Received on 01 June 2026,
Article Revised on 22 June 2026,
Article Published on 01 July 2026,

https://doi.org/10.5281/zenodo.21031735

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How to cite this Article: Ms. Ragini Solanke[1]*, Khushi Rajesh Gupta[2], Harshit Udaybir Singh[3], Sanjana Santosh Gupta[4], Eesheeta Ajit Jadhav[5], Sejal Dhanaji Ghadge[6], Disha Sanjay Gupta[7]. (2026). Development And Evaluation Of Natural Shampoo Powder Having Antidrandruff And Antifungal Activity. World Journal of Pharmaceutical Research, 15(13), 1007–1034.
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ABSTRACT

The present study focuses on the development and evaluation of a natural polyherbal shampoo powder having anti-dandruff and antifungal activity. The formulation was prepared using herbal ingredients such as shikakai, Reetha, Amla, Neem, Tulsi, Fenugreek, Bhringraj, Kalonji, Orange peel, and rose petal powder, selected for their cleansing, conditioning, antimicrobial, and hair growth promoting properties. The shampoo powder was formulated by drying, grinding, sieving, and blending the herbal ingredients in suitable proportions. The prepared formulation was evaluated for organoleptic properties, powder characteristics, physicochemical parameters, phytochemical screening, foaming ability, washability, and stability. The results showed good foaming capacity, acceptable pH, easy washability, good stability, and no skin irritation. The prepared herbal shampoo powder can serve as a safe, economical, and eco-friendly alternative to synthetic shampoos.

KEYWORDS: Eco-Friendly Polyherbal Cosmetics, Antidandruff, Antifungal activity, Evaluation parameters.

INTRODUCTION

The personal care industry's fastest-growing sector is now cosmeceutical roughly 25 years. The term "cosmeceutical" was first used by Dr. Albert Kligman of the University of Pennsylvania to refer to a hybrid category of products that fall somewhere between

medications and cosmetics and have pharmaceutical therapeutic benefits but not always biological ones.[1]

A person's hair is an essential component of their appearance. People are using herbs for cleaning, beautifying and managing hair since the ancient era. As the Synthetic agents have taken up a significant portion of the market over time, but people are becoming more conscious of their detrimental effects on skin, hair, and eyes. These factors drew the society to herbal products because they are less costly and have few adverse effects. Hair cleansers or shampoos are used not only for cleansing purpose but also for imparting gloss to hair and to maintain their manageability and oiliness for hair.[2] Keratin is the primary component of hair. One amazing protein that resists deterioration is keratin. Although synthetic agents have dominated the formulation industries throughout the years, people are now drawn to natural goods because of their lower cost and less negative effects.[3]

DANDRUFF

Excessive shedding of dead skin cells from the scalp is a chronic disorder known as dandruff. Malassezia restricta and Malassezia globosa are the fungi that cause it. Malassezia, formerly known as Pityrosporum, is a yeast that causes scalp and skin infections. The excessive loss of dead skin cells from the scalp is the cause of dandruff. Males are more likely than females to get dandruff, which affects 5% of the population and often manifests between the ages of 20 and 30 after puberty. The scalp's skin regenerates roughly once every month. Dead cells are typically removed by the scalp in an almost imperceptible manner, but occasionally cell turnover increases abnormally quickly, causing dead cells to be shed as visible flakes known as dandruff. Overpopulation, a warm, humid environment, and poor personal hygiene promote the growth of *malassezia*.[1]

Causes Of Dandruff

The fungus Pityrosporum ovale, which is found naturally on the scalp and elsewhere sections of the skin. This fungus usually doesn't do any harm. However, the scalp will create more oil due to hormonal changes, stress, and weather variations, which will lead to the growth of the fungus P. ovale. The fungus's growth will cause itching of the scalp's skin cells, hair follicle loss, and so called dandruff. The development of enzymes known as lipases is now thought to be the precise process underlying the development of dandruff. These enzymes help the Malassezia fungus convert sebum to oleic acid. In those who are vulnerable, the oleic acid

then enters the epidermis and increases skin cell turnover. Dandruff flakes and occasionally itchiness result from this and redness.[1]

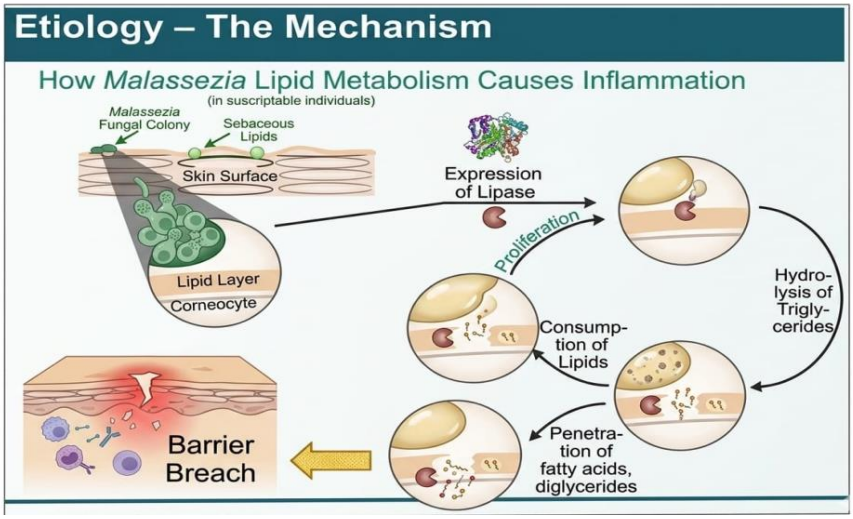


***Fig No.1*: Etiology of dandruff formation.[1]**

Dandruff can be treated using two Primary approches

There are two main methods for treating dandruff: chemical-based anti-dandruff shampoos and herbal-based anti-dandruff shampoos. To fight dandruff, a variety of shampoos and scalp treatments are currently on the market. Chemicals found in many of these products might cause unintended side effects such itching, irritation, hair loss, nausea, headaches, and increased scaling. Consequently, natural anti-dandruff plant components found in herbal formulations are being explored as potential substitutes for synthetic shampoos. Many herbs are utilized as potent natural antidandruff medicines in ancient Indian medicine. Orange peel, bhringraj, amla, ginger, reetha, hibiscus, shikakai, aloe vera, and curry leaves are a few of these. However, creating cosmetics with just natural ingredients is a 5 challenging process .It is difficult to formulate cosmetics using just natural basic materials. To guarantee efficacy and safety while preserving aesthetic qualities, substances must be carefully chosen and handled. The quality and effectiveness of natural components can differ, thus careful testing and quality control are required. Despite these challenges, the goal of this study was to create an environmentally friendly herbal shampoo with mostly natural ingredients.[4]

Antidandruff Shampoo Powder

Shampoos with anti-dandruff ingredients are primarily used to prevent or treat dandruff on the hair scalp. There are two marketed varieties of anti-dandruff shampoos.

A. Synthetic anti-dandruff shampoos (made with chemical components)

B. Plant-based herbal anti-dandruff shampoos.[1]

Synthetic Antidandruff Shampoo Powder

Anionic, cationic, and non-ionic surfactants are the primary surfactants found in synthetic shampoos. Both cationic and anionic surfactants have strong cleaning and foaming properties. However, they are "toxic," rarely used, and harmful to the eyes. Certain shampoos irritate the eyes and leave a haze on the cornea. Sodium, calcium, and magnesium salts are deposited on the hair shaft by the surfactants in hard water. Therefore, it has been discovered that these synthetic shampoos have adverse effects, such as drying out the hair. The hair is too dry to handle or comb after using these shampoos. Herbal shampoos will be helpful in preventing these issues.[5]

How Shampoo Works

Sebum is removed from the hair by shampoo. Hair follicles release an oil called sebum, which is easily absorbed by hair strands and creates a barrier. Hair's protein structure is shielded from harm by sebum, but this defense has a price. It often gathers flakes from the scalp, styling products, and grime. Surfactants eliminate the debris that is adhered to the hair shafts by stripping the sebum from them. Although surfactants are included in both shampoos and soaps, soap's strong affinity for oils causes it to remove excessive amounts when applied to hair. A different class of balanced surfactants is used in shampoo to prevent excessive oil removal from the hair.[6]

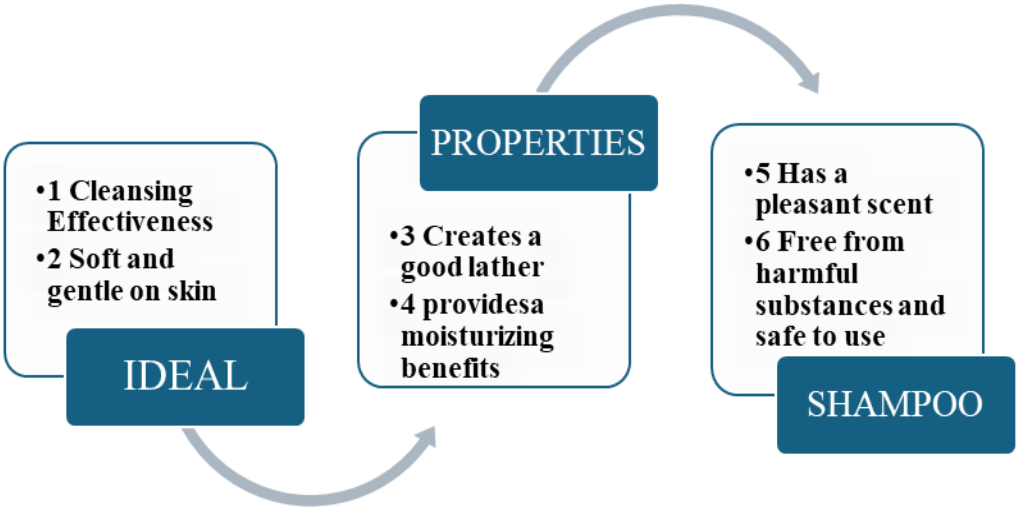
Advantage of herbal shampoo over chemical shampoo

These days, the most popular hair products are traditional herbal shampoos. because these products are thought to be safe and to have no negative effects. Chemical shampoos may seem to be improving the smoothness of hair throughout, but ultimately result in harming the roots and cause:

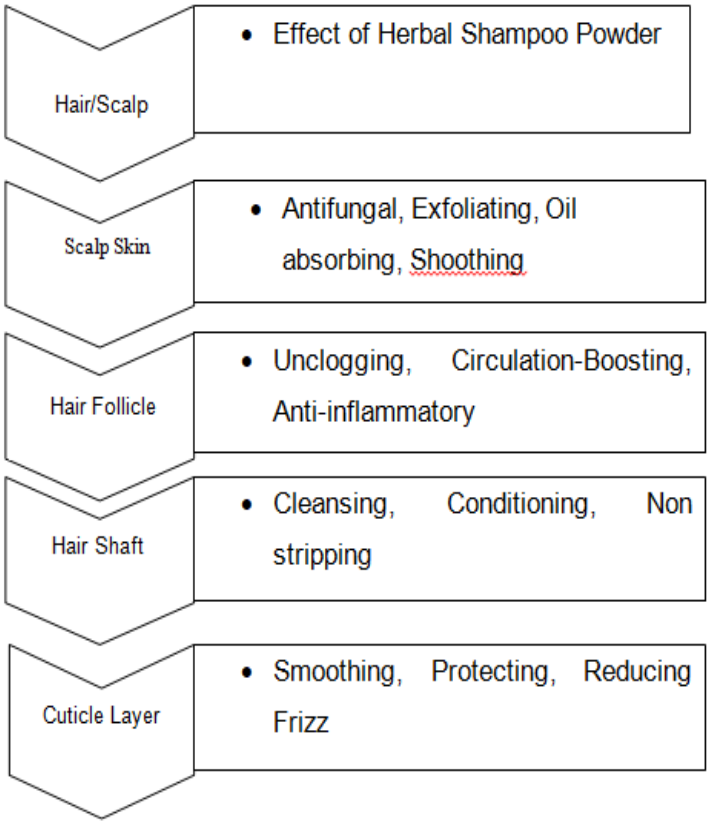
- Itching and dryness of the scalp
- Hair graying and premature aging
- Excessive hair loss and split ends.

The best solution to all of these issues is to use a herbal shampoo, which will compensate for the nutrient loss and reverse the harm.[1]

IDEAL PROPERTIES OF SHAMPOO



MECHANISM



ACTION OF SHAMPOOS ON HAIRS

Shampoo mainly clears hair by getting rid of three kinds of dirt: Insoluble particles, soluble soils and oily sebum. The surfactants in shampoo lower the surface tension of water, letting it reach and take away these soils. Soluble soils mix up with water and wash away easily. Oily sebum is removed through a process called roll up, where the surfactants lift the oil from the

hair. Insoluble particles are pushed away because of the electrostatic attraction between the hair, the dirt, and the surfactant molecules. While washing, the detergent forms small structures called micelles that wraps the oil. These micelles then break apart in water, carrying away the oil from the hair.

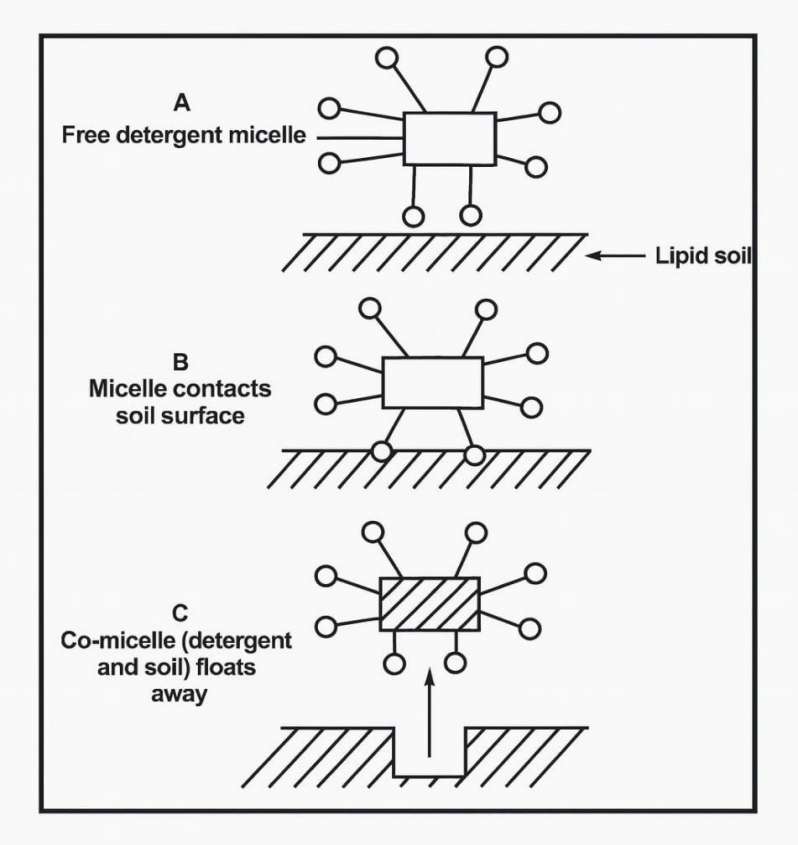


Fig No. 2: The Process of Soil Removal. [7]

LITERATURE REVIEW

Sachin Gholve et al. (2015) formulated and evaluated a polyherbal antidandruff powder shampoo containing neem, tulsi, shikakai, reetha, methi, aloe vera, amla, henna, and brahmi. The study reported good foaming ability, acceptable pH, good cleansing action, and effective antidandruff activity without causing irritation to the skin or eyes. The formulation also improved hair softness and manageability.

Sonali S. Gadge et al. (2023) formulated and evaluated a polyherbal anti-dandruff shampoo containing Shikakai, Reetha, Neem, Aloe vera, Hibiscus, Fenugreek, Onion juice, Sidar powder, and Curry leaves. The formulation was evaluated for pH, foam stability, dirt dispersion, antimicrobial activity, and skin irritation.The study concluded that formulation F1 showed the best anti-dandruff activity against Malassezia furfur, good foam stability,

acceptable pH, and no skin irritation. The authors reported that herbal shampoos are safer and more cost-effective compared to synthetic shampoos.

Wani Snehal et al. (2014) Sandip Institute of Pharmaceutical Science conducted a study on the preparation and evaluation of antidandruff polyherbal powder shampoo. The formulation contained herbal ingredients such as neem, shikakai, reetha, tulsi, fenugreek, aloe vera, hibiscus, henna, amla, and brahmi. The study reported that the herbal shampoo showed good foaming ability, acceptable pH, easy washability, good cleansing action, and no skin or eye irritation. The formulation was found to be stable and effective against dandruff-causing microorganisms. The authors concluded that polyherbal powder shampoo is a safe and effective alternative to synthetic shampoos.

Satyanarayana et al. formulated and evaluated a polyherbal shampoo powder containing amla, reetha, shikakai, neem, tulsi, hibiscus, bhringraj, and curry leaves. The study aimed to prepare a safe and effective herbal shampoo powder with cleansing and conditioning properties. Six formulations (F1–F6) were prepared and evaluated for organoleptic properties, pH, foamability, wetting time, dirt dispersion, moisture content, and stability. The study concluded that all formulations showed good cleansing ability, good foaming capacity, acceptable pH, and no skin or eye irritation. The prepared shampoo powders also made hair soft and manageable.

Prachi S. Mandave et al. (2025) prepared three formulations of polyherbal powdered shampoo containing Hibiscus, Amla, Reetha, Shikakai, Flaxseed, Henna, Rosemary, and Rose petals. Formulation F1 showed balanced cleansing, conditioning, and scalp nourishment with pH 6 and good foaming properties.

Prerna Dabhade, Akanksha Punekar, and Dr. Amol Gayke developed an herbal anti-dandruff shampoo powder containing rosemary, methi, hibiscus, neem, ashwagandha, reetha, amla, cinnamon, kalonji, and rose powder. Their study reported a suitable pH of 5.75, good washability, acceptable foaming capacity, low moisture content, and excellent scalp compatibility, making the formulation a promising natural alternative to synthetic shampoos.

Firoj A. Tamboli et al. (2021), herbal shampoo powders are safer and more effective alternatives to synthetic shampoos. Their study formulated a polyherbal shampoo using ingredients like shikakai, reetha, neem, hibiscus, aloe vera, and bhringraj. The formulation

showed good cleansing action, suitable pH, good foaming ability, stability, and no skin irritation. The authors concluded that the herbal shampoo powder is effective for hair cleansing, conditioning, and dandruff control with fewer side effects.

Mane Swati Mahadev et al. reported the formulation and evaluation of dry herbal shampoo powder using ingredients such as Shikakai, Reetha, Tulsi, Neem, Henna, and Amla. The study showed good foaming ability, cleansing action, acceptable pH, and stability, proving the effectiveness of herbal shampoo powder for hair care.

Shubham Singh and Shashikant Maury, a polyherbal antidandruff powder shampoo containing pomegranate seed and guava leaves showed significant antidandruff, antifungal, and conditioning properties. The formulation included natural ingredients such as neem, hibiscus, aloe vera, amla, tulsi, and brahmi, which helped in reducing dandruff, scalp irritation, and hair fall. The study concluded that herbal shampoos are safer, economical, and produce fewer side effects compared to synthetic shampoos.

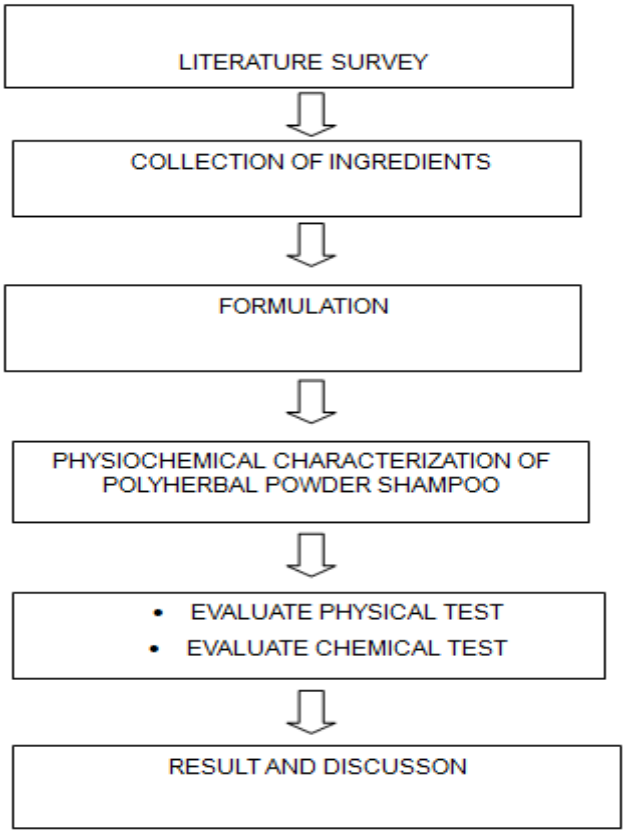
Prajakta Ashok Halnor et al. (2024) prepared and evaluated a herbal anti-dandruff shampoo using natural ingredients such as Shikakai, Reetha, Neem, and Aloe vera. The study focused on evaluating parameters like pH, viscosity, foam stability, and cleansing.

AIM: To develop and evaluate natural shampoo powder having anti-dandruff and antifungal activity.

OBJECTIVES

- To clean hair and scalp naturally.
- To evaluate the quality and effectiveness of the formulation.
- To remove dandruff and excess oil.
- To promote healthy hair growth.
- To provide soft, shiny, and manageable hair.
- To maintain healthy scalp condition.
- To avoid harmful chemical ingredients.
- To prepare a safe and economical shampoo.

PLAN OF WORK



PLANT PROFILE

1] Reetha

20m Height, gray smooth bark and pinnate Leaves.

Leaves- 5-10 pairs with Large drupes

Trunk- Straight/Cylindrical

Category- Detergent / Foaming property[8]

Biological Source: Obtained from plant of Dried Fruits of Sapindus Mukorossi Gaertn.

Family: Sapindaceae.[5]

Synonyms: Soapberry, Washnut, Soapnut.

Fig. No. 3: ReethaPowder.

TAXONOMY

- **Kingdom:** Plantae
- **Order:** Sapindales
- **Genus:** Sapindus
- **Species:** Sapindus mukorossi[9]
- **Phyllum:** Tracheophyta
- **Class:** Sapindaceae[10]

Chemical constituents: Sapindoside A,B and C Flavonoids, Phenolic acids, Terpenoids

Uses: Removes flakes of cells on the scalp, stop hair fall. Shows anti-inflammatory, antioxidant and antibacterial properties. Shows Cooling effect and excellent Cleansing effect on the skin, prevent the skin, prevent the scalp from drying.[10]

2] Shikakai

Acacia concinna is a thorny spreading shrub or tree.Bark-light grey.

Leaves-Oblong 4-10 mm long forms 7-11 pairs of

Branches each with 17-37 pairs of Leaflets

Fruits –From Feb to March

Senegalia rugata used for hair care.

Fig No 4: ShikakaiPowder.

Biological Source: Obtained from Dried seeds of Acacia rugate and Dried pods of Acacia concinna.

Family: Mimosaceae

Synonyms: Acacia Concinna[11]

Taxonomy

- **Kingdom:** Plantae
- **Order:** Fabales
- **Genus:** Senegalia
- **Species:** Acacia Concinna, S. rugata
- **Class:** Magnoliopsida[8]
- **Division:** Magnoliophyta
- **Sub-Family:** Caesalpinioideae
- **Clade-** Mimosoid clade

Chemical constituents: Lupeol,spinasterol, accacic acid, lactone, and the natural sugar glucose,arabinose and rhamnose.

Uses: Foam base & Antidandruff provide nourishment to hairs[12]

3] Meethi

Biological Source: Dried ripe seeds of Trigonella Foenum graecum.

Family: Fabaceae

Synonyms: Fenugreek, Greek hay[13]

Fig No. 5: Meethi Powder.

Taxonomy

- **Kingdom:** Plantae
- **Order:** Fabales
- **Genus:** Trigonella
- **Species:** T.Foenum-graceum
- **Division:** Magnoliophyta

- **Class:** Magnoliopsida
- **Sub-Family:** Faboideae
- **Clade:** Magnolia

Chemical constituents: Nitotinic acid, retinol, luteolin, quercetin, carbohydrates, proteins , lipids, alkaloids, Falvonoids, fibers saponin, steroidal Saponin, Vitamins, minerals, Nitrogen compound.

Uses: soothes scalp inflammation, rich source of vit A,K & C and known for its medical quality such as antidiabetic.Conditioning and Nourishment of hair.[12]

4]Neem

Strengthening hair follicles and reducing hair fall.

Biological Source: Fresh or Dried Leaves nad seeds oild of Azadirachta indica j.juss (melia indica or M.azadirchata linn) and Dried ripe fruits of Embelica Officinalis.

Family: Ephorbiaceae.

Synonyms: Neem, Margasa, Azadirachta.[11]

Fig No. 6: Neem Powder.

Taxonomy

- **Kingdom:** Plantae
- **Order:** Rutales
- **Genus:** Azadirachta
- **Species:** A.indica
- **Division:** Magnoliophyta
- **Class:** Magnoliopsida
- **Sub-Family:** Meliaideae

Chemical constituents: unsaturated Fatty acids, oleic acids ,steric acids, salanin, Azadirachtin, Meliantriol, Nimbidin, Nimbolide etc.[12]

Uses: Antispetic, anti-inflammatory, antioxidant, antibacterial and healing property.Fight scalp infection, Prevent the hair dryness and Flakings of hairs, lice, dandruff and itching.Clears the clogged pores and improves hair Growth.Hair growth promoter, show antifungal property and treatment of dandruff. Regenerative property which reduces hair fall.[6]

5] Amla

Medium sized deciduous plant Height 8-18m

Crooked trunk and Spreading branches

Fruits- spherical/light greenish, yellow, quite smooth and hard in appearance.

Taste- Bitter, sour, astringent.[6]

Biological Source: Obtained from Dried ripe fruits of Embelica Officinalis.

Family: Euphorbiaceae.

Synonyms: Indian gooseberry, Embelic myrobalans.[11]

Fig. No. 7: Amla Powder.

Taxonomy

- **Kingdom:** Plantae
- **Order:** Malpighiales
- **Genus:**Phyllanthus
- **Species:** P. Embelica
- **Class:** Magnolipsida
- **Sub-Family:** Meliaideae

- **Phylum:** Tracheophyta

Chemical constituents: Emblicanin Aand B, Chebulinic acid, ascorbic acid, ellagic acid, emblicanine A, Gallic acid, Phyllantine, Tannins, Phosphorous iron, Calcium.[12]

Uses: Hair Growth Promoter,Darkening of hairs, hair tonics, improve hair pigmentation, strengthens the scalp and and hair, Prevent or treat dandruff or fungal and bacterial scalp infection.[6]

6] Orange Peel Powder

Biological Source: Obtained from Dried outer peel of the fruit citrus sinensis

Family: Rutaceae

Synonyms: Citrus aurantium linn.[6]

Fig No. 8: Orange peel Powder.

Taxonomy

- **Kingdom:** Plantae
- **Division:** Angiosperms
- **Order:** Sapindales
- **Genus:** Citrus
- **Species:** Citrus aurantium
- **Family:** Rutaceae

Chemical constituents: Pectin,cellulose,hemicelluloses, galacturonic acid, arabinose, galactose, limonene, citral vitc, Aurantimarin, isohesperidin etc.[12]

Uses: Excellent condition for hair, controls dandruff and improves the blood circulation level, less hairfall, lusturous hair. Imparts a refreshing Fragrance to the shampoo, shows exfoliating properties.[6]

7] Kalonji Powder

Biological Source: Consist of dried seeds of plant Nigella sativa Linn.

Family: Leguminosae

Synonyms: Small Fennel, Nigella seeds, Black cumin, Fitch[13]

Fig No.9: Kalonji Powde.

Taxonomy

- **Kingdom:** Plantae
- **Division:** Angiosperms
- **Order:** Rosales
- **Genus:** psoralea
- **Species:** Corylifolia linn
- **subfamily:** Papilionaceae
- **class:** Dicotyledoneae

Chemical constituents: Essential oils 0.05% , a non volatile terpenoid oil, a dark brown resin & 0.6% coumarin compounds

Uses: Used for Hair Growth.Improves Scalp health, Reduce Dryness, improves blood circulation, prevent premature greying, reduce hairfall.[12]

8] Tulsi

Category: Antimicrobial agent.

Biological Source: Consist of Fresh or Dried Leaves
of Ocimum species like Ocimum Sanctum L.
and Ocimum Basilicum L.Tulsi

Family: Labiateal

Synonyms: Ocimum tenuiflorum.[11]

Fig No. 10: Tulsi Powder.

Taxonomy

- **Kingdom:** Plantae
- **Division:** Magnoliophyta
- **Order:** Lamiales
- **Genus:** Ocimum
- **Species:** O. tenuiflorum
- **Class:** Magnoliopsida

Chemical constituents: Eugenol, Rosmarinic acid, Apigenin, /Myretenal, Luteolin, Carnosic acid, Beta sitosterol

Uses: Rejuvenating the hair Follicles and strengthening of the roots.

Antibacterial, Antidrandruff ingredient, scalp dryness reduces, Stimulates blood circulation, Promote hair growth.[11]

9] Bhringraj Powder

Biological Source: Obtained from entire herb of Ecilipta-alba

Family: Asteraceae

Synonyms: Keshranjana, Keshraja, Markava, Bhunga.[11]

Fig No. 11: Bhrinraj powder.

Taxonomy

- **Kingdom:** Plantae
- **Division:** Tracheophyta
- **Order:** Asterales
- **Genus:** Eclipta L**.**
- **Species:** Eclipta prostrata L
- **Class:** Magnoliopsida.[10]

Chemical constituents: Principal Constituents of Eclipta alba are coumes and tan derivatives like wedoloacetone etc.

Uses: Increases Heamoglobin level, reduce kapha. Reduce greying of hars, improves hair growth.Make Hair Lusturous.[6]

10] Rose Petal Powder

Biological Source: Rose is Woodly Perennial Flowering Plant of the Genus Rosa and Consist of Fresh or dried flowers of the plant Rosa rugosa.

Family: Rosaceace.

Synonyms: Bloom, Blossom.

Fig No. 12: Rose Powder.

Taxonomy

- **Kingdom:** Plantae
- **Order:** Rosales
- **Genus:** Rosa
- **Species:** Rosa rugos.
- **Chemical constituents:** Citronellol, Geraniol, Nerol, Phenyl ethyl alcohol.

Uses: Fragrance, Conditioners, Ease your Pain, Soothe and Nourish pain, Antidrandruff agent.[8]

FORMULATION TABLE

Table 1: Formulation of shampoo powder.

Sr. No	Ingredients	Quantity (50gm)	Role of Ingredients.[14]
1.	Shikakai powder	7.5gm	Foam Base, Mild Cleanser, Anti Dandruff
2.	Reetha powder	5gm	Natural Faoming agent (Contains saponin)
3.	Amla powder	7.5gm	Hair Growth Promoter,Strengthens hair
4.	Neem powder	2.5gm	Anti-microbial,Anti dandruff
5.	Tulsi Powder	5gm	Antifungal, Improves Scalp health
6.	Meethi(Fenugreek)	5gm	Conditioning and Nourishment of Hair
7.	Bhrinraj powder	2.5gm	Promotes Hair growth, Reduce Hair fall
8.	Kalonji powder	7.5gm	Improves Hair texture, Reduce Hair fall
9.	Orange peel powder	2.5gm	Cleansing agent, Antioxidant
10.	Rose petal powder	5gm	Natural Fragrance , Soothing effect

Fig No. 13: Final Formulation Shampoo powder.

PREPARATION PROCEDURE OF POLYHERBAL SHAMPOO POWDER

The steps listed below are used in order to formulate herbal shampoo powder.

1. Drying: After being dried in the shade, each ingredient is ground.

2. Weighing: Each of the herbal powders needed to make shampoo was weighed separately.

3. Size reduction: Using a hand-driven mixer, each crude ingredient was reduced in size after being gathered.

4. Mixing: To create a uniform fine powder, all of these fine ingredients were completely combined using a stainless steel spatula.

5. Sieving: To obtain an adequate amount of fine powder, this fine powder was next run through sieve number 125.

6. Packing and labeling: After that, it was appropriately packed and labeled.[3]

EVALUATION PARAMETER OF POLYHERBAL POWDER SHAMPOO

A) ORGANOLEPTIC PROPERTY

An organoleptic assessment was conducted based on characteristics such as color, texture, taste, and odor. Vision and tactile feeling were used to assess color and texture, respectively. A team of five taste and odor-sensitive individuals was assembled for the purpose of evaluating flavor and odor, and random sampling was carried out.[10]

B) GENERAL POWDER CHARACTERISTICS

Evaluation of the parameters that may impact the preparation's external qualities, such as flow characteristics, appearance, packaging requirements, etc., is part of general powder characteristics. This section evaluates the following characteristics: bulk density, angle of repose, and powder form. Three distinct levels the top, medium, and lower levels were used to collect samples for each of these assessments.

1. Particle size Determination

Particle size was measured using I.P. Standard sieves and mechanical shaking for ten minutes. Particle size is a criterion that may influence a number of characteristics, including spreadibility and grittiness.[15]

2. Angle of repose

The flow properties of a powder are influenced by the angle of repose.

The fix glass funnel method, which maintains a 2 cm gap between the graph paper and the bottom of a powder, was used to determine it. The flow continued until the heap's top touched the funnel's bottom tip.[8]

The formula is $\theta = tan{-}1\ (hr)$.

Table No. 2: Angle of repose.[16]

Angle of repose (θ)	Type of flow
<25	Excellent
25-30	Good
30-40	Passable
>40	Very poor

Funnel method

A funnel is positioned six centimeters above a horizontal base to collect the necessary quality of dried powder. On the horizontal plane, the powder was permitted to flow and accumulate on top of the paper. The formula can be used to compute the angle of repose (θ) based on the powder's height and radius.[17]

3. Bulk density

The ratio of a powder's mass to its bulk volume is known as bulk density. A 50 ml measuring cylinder is filled to the 50 ml mark with the necessary quantity of dried powder. The cylinder is then dropped at intervals of two seconds from a height of one inch onto a hard wood surface. The powder's volume is measured. The powder is then weighed.To obtain average results, this is repeated.[18]

$$\text{Bulk Density} = \frac{\text{The herbal powder shampoo's mass}}{\text{The herbal powder shampoo's volume}}$$

4. Tapped density

The higher bulk density obtained by mechanically tapping a container holding the powder sample is known as the "tapped density." Following the initial measurement of the powder's volume or mass, the measuring cylinder or vessel is mechanically tapped for one minute, during which time observations of the volume or mass are taken until very little more change is seen. The unit of measurement was grams per cubic centimeter (g/cm3) [11]

$$\text{Tapped density} = \frac{\text{weight of powder}}{\text{Tapped volume of powder}}$$

5. Haussner's ratio

The Hausner's ratio is a measure of how easily powder flows. Good flow is indicated by a Hausner's ratio of less than 1.25.[16]

$$\text{Hausner's ratio} = \frac{\text{Tapped Density}}{\text{Bulk Density}}$$

Table No. 3: Hausner's ratio.[16]

Hausner's ratio	property
0.1-1.25	Free flowing
1.25-1.6	Cohesive powder

6. Carr's index

Carr's index is one of the most important measures for characterizing the properties of powders and granules. It can be computed using the following formula, and the table displays the Carr's Index category.[16]

$$\text{Carr's Index (I)} = \frac{\text{Tapped density (TD) - Bulk density (BD) x 100}}{\text{Tapped density (TD)}}$$

Table No. 4: Carr's Index[16]

% Compressibility Index	Properties
5-12	Free Flowing
12-19	Good
19-21	Fair
23-31	Poor
33-38	Very Poor
> 40	Extremely Poor

C) PHYSIOCHEMICAL PROPERTY

1. pH

An electrical tool for determining a liquid's pH is called a pH meter. An electronic meter that detects and displays the pH reading is coupled to a particular measuring probe in a standard pH meter.Ten milliliters of water were used to dissolve one gram of each herbal shampoo powder formulation. A pH meter was used to measure their pH.[14]

2. Washability

After applying formulations to the skin, the degree and ease of washing with water were personally assessed.[17]

3. Solubility

The ability of a substance to dissolve in a solvent is known as its solubility. After precisely weighing one gram of the powder, it is put into a beaker with 100 milliliters of water. To improve the solubility, this was well shook and heated. After cooling and filtering, the residue is weighed and recorded.[10]

Table No. 5: Solubilty Classification[16]

Descriptive Term	Relative Quantity of Solvent Required
Very Soluble	Less than 1 parts
Freely Soluble	1 to 10 parts
Soluble	10 to 30 parts

Sparingly Soluble	30 to 100 parts
Slightly Soluble	100 to 1000 parts
Very Slightly Soluble	1000 to 10,000 parts
Practically Insoluble	More than 10,000 parts

4. Loss On Drying

The mass loss, expressed in current m/m, is known as loss on drying. After precisely weighing two grams of the powder, it was placed on a dry petri dish. Over calcium chloride crystals, the petri dish is kept in a desiccator for two days. Then, in order to determine the weight loss during drying, the powder was taken and precisely weighed.[8]

5. Skin/ eye irritation test

According to testing on skin and eye irritation, the herbal shampoo powder has no negative effects on the skin or eyes. The lack of artificial surfactants is the cause of this. The majority of synthetic surfactants cause corneal irritation and eyelid inflammation. However, all of the elements in this herbal shampoo powder composition come from natural sources. Therefore, it has no negative effects on the skin or eyes.[18]

Skin Irritation Test

After washing, the skin was treated with a prepared polyherbal anti-dandruff shampoo for five minutes to check for skin irritation or inflammation.[19]

6. Moisture Content Determination

Ten grams of each polyherbal shampoo powder were weighed in a tare evaporating dish and stored at 105 in a hot air oven. Repeated the drying process until a consistent weight loss was noted after 30 minutes. For every sample, the moisture content was determined.[20]

$$\text{Moisture Content\%} = \frac{\text{Initial weight-Final weight x100}}{\text{Initial weight}}$$

7. Foaming Capacity

Foam stability test was used to assess the foaming ability of herbal shampoo powder. Specifically, two grams of shampoo 50 ml water mixed with powder in one Graduated cylinder. The mixture was shaken aggressively for a predetermined time to produce foam. The height of the foam was immediately noted, and then at a predetermined period to evaluate the foam Stability. Foaming capacity was determined using Calculating initial volume and retention of foam with time.

$$\text{Foaming Capacity} = \frac{\text{Foam volume at time (t) x100}}{\text{Initial Foam Volume}}$$

8. Wetting Agent

The canvas was cut into 1-inch discs with an average weight of 0.44 g. Disk floated on a 1% w/v shampoo solution and the stopwatch started. The time required for the disc to start sinking is rigidly marked and noted as wetting time.[9]

9. Dirt Dispersion

Ten milliliters of distilled water were put to a big test tube along with two drops of 1% each shampoo powder. After adding one drop of India ink, the test tube was sealed and shaken ten times. The foam's ink content was classified as None, Light, Moderate, or Heavy.

10. Stability Study

Over the course of four weeks, the formulation's stability was assessed by keeping it between 25 and 30°C.The formulation was routinely examined for alterations in appearance and physical stability during this period. Throughout the month, these assessments were carried out to make sure that any changes or problems with the consistency or integrity of the formulation were identified and evaluated.[4]

11. Extractive values

Determination of alcohol-soluble Extractive: In a closed flask, 5 g of each air-dried herbal shampoo powder was weighed, macerated with 100 ml of alcohol of the designated strength for 24 hours, shaken frequently for six hours, and then left to stand for eighteen hours. After filtering and taking care to prevent solvent loss, 25 milliliters of the filtrate were evaporated to dryness in a shallow dish with a flat bottom, dried at 105 degrees Celsius to a consistent weight, and then weighed. In relation to the air-dried medication, the proportion of alcohol-soluble extractive was computed.

Determination of water-soluble extractive: followed the instructions for determining the alcohol-soluble extractive, substituting ethanol with chloroform water. For every sample, the proportion of water-soluble extractive was determined.[17]

12. Ash value

Total Ash Content

The inorganic contents that are typical of a herb are determined by calculating the ash value. A silicon dish that had been previously lit was filled with about 2 grams of powdered medication, which was then weighed. The temperature was raised by progressively raising the heat until it reached a red hue. Ash is cooled and weighed after it has finished burning.[8]

$$\text{Total Ash (\%)} = \frac{\text{Weight of Ash} \times 100}{\text{Initial Weight of Sample.}}$$

13. Nature Of Hair After Wash

By gathering volunteer replies, one can determine the nature of hair after washing.

14. Cleaning Action

After adding 5 g of wool yarn or cotton ball to a flask with 200 ml of water and 1 g of each herbal shampoo powder formulation, the mixture was shaken for 4 minutes. After removing the solution, the sample was removed, dried, and weighed.[14]

The following formula was used to determine how much grease was removed:

$DP = 100\ (1-T/C)$.

15. Preliminary Phytochemical Screening

A. ALKALOIDS TEST[DRAGENDORFF'S TEST]: Dissolve 0.85 g of bismuth subnitrate in 10 ml glacial acetic acid. Add 40 ml distilled water and mix properly to prepare Solution A. In another beaker, dissolve 8 g potassium iodide in 20 ml distilled water to prepare Solution B. Mix Solution A and Solution B slowly with continuous stirring. Store the prepared Dragendorff's reagent in an amber-colored bottle away from light.

B. FLAVONOID TEST [SHINODA TEST]: Five to ten drops of diluted HCl and a little amount of Zn or Mg were added to a test tube holding 0.5 milliliters of the sample's alcoholic extract. The mixture was then brought to a boil for a few minutes. Flavonoids were recognized by a reddish pink or filthy brown appearance.

C. SAPONINS TEST [FOAM TEST]: A test tube with roughly 50 milliliters of the sample's aqueous extract was filled with a drop of sodium bicarbonate. After giving the mixture a good shake, it was left for three minutes. The presence of saponins was demonstrated by the formation of a honeycomb-like foam.

D. PHENOL TEST [FERRIC CHLORIDE TEST]: Two milliliters of distilled water and a few drops of 10% aqueous ferric chloride solution were added to one milliliter of the sample's alcoholic solution. The presence of phenol was revealed by the formation of a blue-green color.

E. TEST FOR TANNINS [LEAD ACETATE TEST]: A few drops of a 1% lead acetate solution were added to a test tube that held roughly 5 ml of an aqueous extract. Tannins were present when a yellow or red precipitate formed.[8]

SR NO.	TEST	OBSERVATION	INFERENCE
1.	**DRAGENDORFF'S TEST**	Formation of Reddish Brown Colour	**PRESENT**
2.	**SHINODA TEST**	Formation of Dark Brown Colour	**PRESENT**
3.	**FOAM TEST**	Occurrence of Foam	**PRESENT**
4.	**FERRIC CHLORIDE TEST**	Formation of Black- Purple Colour	**PRESENT**
5.	**LEAD ACETATE TEST**	Formation of Bulky white colour	**PRESENT**

RESULTS AND DISCUSSION

Sr No.	Evaluation Parameters	OBSERVATION	
1	Organoleptic evaluation	Colour	Brown
		Odour	Characteristic
		Texture	Fine Smooth
		Apperance	Smooth and Fine Powder
2	Powder characteristic	Particle Size	0.177
		Angle of Repose	31
		Bulk density	1.2 g/cm
		Tapped density	2.5 g/cm
3	Physiochemical evaluation	pH	5.41
		Moisture content	9.01 g remain out of
		Total Ash value	33.33 g/cm
		stability	Stable at Room Temperature
4	Skin Irritation test		No Harmful Effect on skin
5	Faoming		Good Foaming
6	Dirt Dispersion		Moderate
7	Extractive Value		12.15%w/w
8	Loss on drying		1.26 %w/w
9	Wash ability		Easily Washable
10.	Solubility		Soluble in water

CONCLUSION

The developed polyherbal shampoo powder was successfully formulated and evaluated for its anti-dandruff and antifungal properties. The formulation exhibited satisfactory physicochemical characteristics such as good foaming ability, suitable pH, smooth texture, easy washability, acceptable moisture content, and stability at room temperature. The presence of various phytoconstituents like alkaloids, flavonoids, saponins, tannins, phenols, and terpenoids contributed to its therapeutic effectiveness. The formulation showed no harmful effects on the skin. Overall, the herbal shampoo powder proved to be a safe, effective, economical, and natural alternative to synthetic shampoos for maintaining healthy hair and scalp conditions.

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