

Development, Characterization, and Evaluation of a Semi-Synthetic Anti-Dandruff Shampoo Formulation

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ABSTRACT

A common scalp ailment, dandruff is linked to microbial development, flaking, itching, and irritation. The creation and assessment of a semi-synthetic anti-dandruff shampoo with ketoconazole and herbal components—Amla, Reetha, Bhringraj, and Shikakai—was the main focus of this study. The goal was to create a safe and effective anti-dandruff shampoo by combining the cleaning, conditioning, and nourishing qualities of herbal extracts with the established antifungal activity of ketoconazole.

Ketoconazole and appropriate excipients were added to a shampoo base along with herbal extracts made from dried plant materials. Organoleptic and physicochemical characteristics of the shampoo were assessed, including color, odor, appearance, texture, pH, foam height, foam stability, wetting time, % solid content, dirt dispersion, washability, skin irritation, and stability. The outcomes showed adequate wetting qualities, a scalp-friendly pH, strong foaming ability, and an efficient washing action. Important bioactive components such as alkaloids, flavonoids, saponins, tannins, phenolics, glycosides, proteins, and terpenoids were found by phytochemical screening. Under various storage settings, the formulation remained stable and did not exhibit any evidence of skin irritation. For managing dandruff and taking care of hair, the shampoo was found to be safe, stable, and effective overall.

Keywords: Anti-dandruff shampoo, Ketoconazole, Semi-synthetic formulation, Herbal extracts, Antifungal activity, Shampoo evaluation.

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INTRODUCTION

Dandruff

Excessive shedding of dead skin cells from the scalp is a common symptom of dandruff. It is mostly brought on by fungi like *Malassezia restricta*, *Malassezia globosa*,

and *Malassezia furfur*, which are found on the scalp normally but can grow out of control in specific situations. These fungi cause noticeable white flakes on

the scalp, hair, and shoulders by interfering with the regular process of skin cell renewal.[1]

Because sebaceous glands become more active and produce more oil during this time, which creates an ideal habitat for fungal growth, dandruff typically develops between adolescence and middle age. Dandruff can create discomfort, humiliation, and cosmetic concerns in those who have it, but it is neither communicable nor fatal. Itching, irritation, and redness are common

symptoms of the illness, which can affect dry or oily scalps.[2] Skin flakes accumulate and shed quickly as a result of the fungus's production of enzymes that change the connection between dead skin cells. Mild hair loss may occasionally result from persistent scratching and discomfort.[3] White or yellowish flakes, itching, redness, dryness, and excessive oiliness of the scalp are common signs of dandruff. Maintaining good scalp hygiene and care is crucial to managing dandruff and stopping its recurrence.[4]

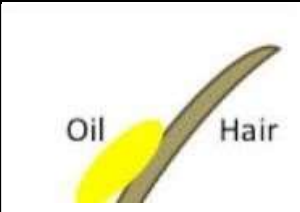
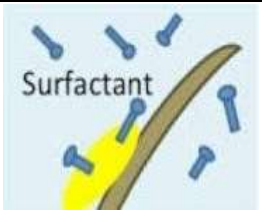
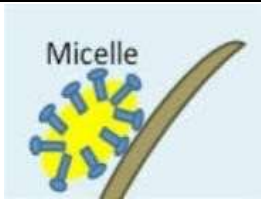
Medicated anti-dandruff shampoos with active chemicals including salicylic acid, selenium sulfide, and ketoconazole are the mainstay of treatment. These components help manage scalp irritation, inhibit fungal development, and remove dead skin cells. Natural therapies like coconut oil, aloe vera, and tea tree oil are used in addition to pharmaceutical shampoos to hydrate the scalp and lessen inflammation and itching.[5]

Scalp health can be further enhanced by avoiding overuse of hair styling products and by regularly cleaning the scalp. Because stress can exacerbate dandruff symptoms in certain people, stress management is also crucial. Beyond only cleaning, shampoo formulations also improve hair hygiene, heal scalp infections, lessen dryness, and help control dandruff-related hair loss. Because they combine cleansing activity with medicinal advantages, medicated and herbal shampoos are popular. [2,6]

All things considered, dandruff is a persistent but treatable scalp ailment that affects a sizable portion of the global population. Dandruff symptoms can be effectively controlled and healthy hair and scalp conditions maintained with proper diagnosis, consistent use of appropriate shampoos, scalp hygiene, and healthy lifestyle behaviors. [7]

Action of Shampoo

Table 1: Action of Shampoo [3,8]

Before	Shampooing	Mode of action	Rinse
			
Skin	Skin	Skin	Skin
Oil and dirt are attached to the skin and hair	The surfactant lowers the surface tension of the water	The surfactant creates micelles around the dirt and oil that are removed from the skin and hair	The micelles with the oil, dirt and surfactant are eliminated with the water during rinse

MATERIAL AND METHODS

Ketoconazole was obtained as a gift sample from NR Life Care, Bharuch, Gujarat, India. The excipients and other chemicals required for formulation development and evaluation were supplied by the Rungta Institute of Pharmaceutical Sciences, Bhilai, Chhattisgarh, India. All chemicals used in the study were of analytical reagent grade and were utilized as received.

Pre-formulation

Physical characteristics of ketoconazole:

Ketoconazole is broad-spectrum antifungal drug belonging to the imidazole class of antifungal agents. In its pure state, Ketoconazole is commonly obtained in powder form, and its physical characteristics are important for identification, quality control and formulation development in pharmaceutical formulations. [5,11]

Table:3. Physical characteristics

Sr. No.	Properties	Observation
01	Colour	White crystalline powder
02	Odor	Odourless
03	Texture	Fine crystalline texture
04	Test	Slightly bitter
05	Melting point	148-152°C
06	Stability	Stable under normal temperature

pH Test:

Ketoconazole: The pH of ketoconazole solution is determined to understand the acidic or basic nature of the drug. The pH influences drug stability, solubility, and compatibility with formulation ingredients. [6,11]

Observation: Ketoconazole solutions generally show a slightly acidic pH.

3. Solubility Test:

Solubility studies are conducted to determine the ability of ketoconazole to dissolve in different solvents. Solubility is a crucial factor influencing drug absorption, bioavailability, and formulation design. [6,12]

Table 4: Solubility Study

Solvent	Observation	Solubility Result
Distilled Water	Drug undissolved, turbid mixture	Partially insoluble
Ethanol	Drug dissolve completely	Freely soluble
Chloroform	Dissolve completely	Soluble
Methanol	Completely soluble	Freely Soluble
HCL	Dissolve completely	Freely soluble
NaOH	Poor dissolution	Slightly soluble

UV spectroscopy is used to determine the absorption characteristics of ketoconazole and to identify the

UV Spectroscopy:

maximum wavelength of absorption ($\lambda_{\max}$). [13] UV spectroscopy is based on the absorption of ultraviolet radiation by molecules, causing electronic transitions in

the molecule. Ketoconazole shows maximum absorption at around 225–230 nm.

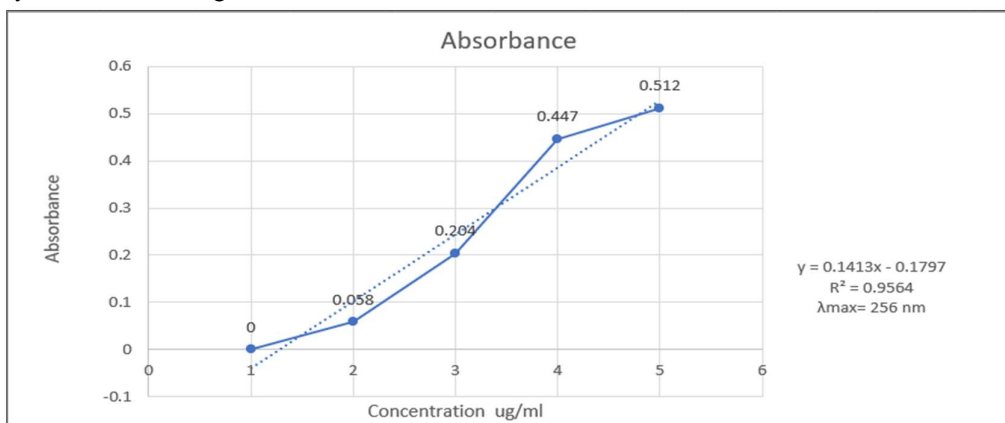
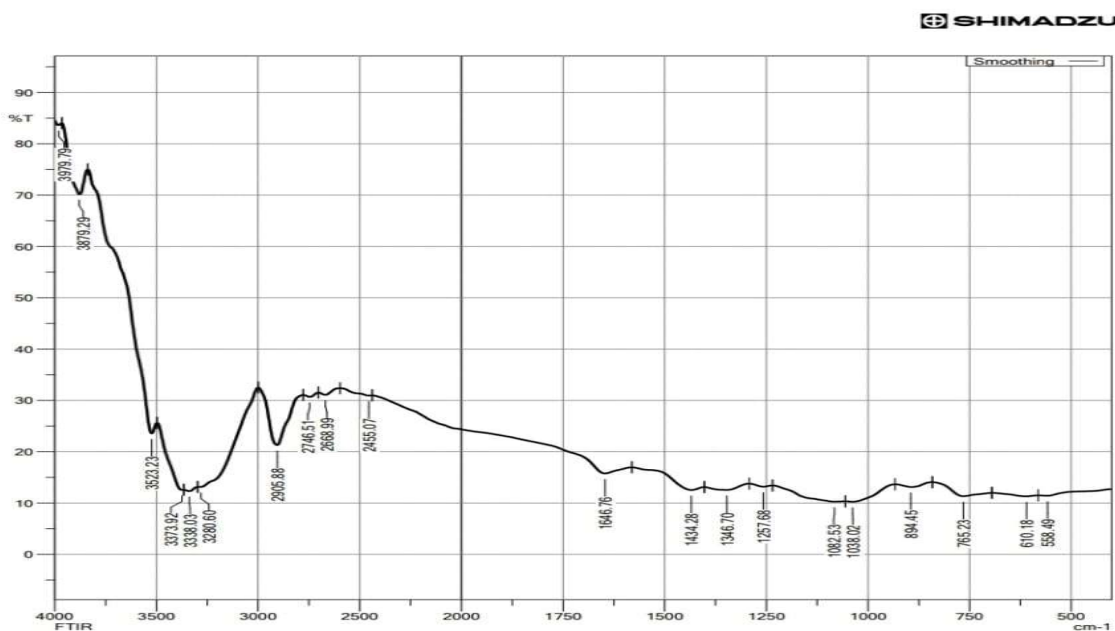


Fig-1: Calibration curve of ketoconazole

FTIR Spectroscopy Study:

Fourier Transform Infrared Spectroscopy (FTIR) is used to identify the functional groups present in the drug molecule and to check the compatibility of the drug with excipients. The FTIR spectrum provides information about the chemical structure and stability of

ketoconazole. [14] FTIR spectroscopy works on the principle that molecules absorb infrared radiation at specific wavelengths, corresponding to the vibrations of chemical bonds such as C–H, N–H, O–H, and C=O. Each compound produces a unique infrared spectrum, which acts as a molecular fingerprint.



Wavenumber (cm ⁻¹)	Functional Group Assignment
3400–3450	O–H stretching (imidazole)
3100–3150	Aromatic C–H stretching
2950–2850	Aliphatic C–H stretching
1650–1600	C=O / C=C stretching
1580–1500	Aromatic C=C stretching
1250–1200	C–O–C stretching
1120–1080	C–O stretching
820–800	C–Cl stretching

Fig-2. FTIR Analysis of Ketoconazole

Phytochemical Test for Herbal Extraction: [6,11,12]

S.N.	Phytochemical Test	Observation
1.	Test for Alkaloids: Dragen dorff's test is used to detect alkaloids in plant extracts. About 2 mL of extract is acidified with dilute hydrochloric acid and treated with Dragen dorff's reagent.	Formation of an orange, reddish-brown, or brick-red precipitate
2.	Test for Flavonoid: The alkaline reagent test detects flavonoids in plant extracts. Add a few drops of 10% sodium hydroxide to 2–3 mL of extract; a yellow colour develops. On adding dilute hydrochloric acid.	Formation of a yellow colour
3.	Test for Tannins: The ferric chloride test is used to identify tannins in plant extracts. Add a few drops of 5% ferric chloride solution to 2–3 mL of extract and mix gently.	The appearance of a blue-black colour or a greenish-black colour
4.	Test for Phenolic Compound: The ferric chloride test is used to detect phenolic compounds in plant extracts. Add 2–3 drops of 5% ferric chloride solution to 2–3 mL of extract and mix gently.	Formation of deep blue colour
5.	Test for proteins: The Biuret test is used to detect proteins in plant extracts. Add 1 mL of 10% sodium hydroxide and 2–3 drops of 1% copper sulphate to 2–3 mL of extract.	Violet or purple coloration develops

6.	Test for Terpenoids: The ferric chloride test is used to detect phenolic compounds in plant extracts. Add 2–3 drops of 5% ferric chloride solution to 2–3 mL of extract and mix gently.	Reddish-brown coloration at the interface.
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Preparation of Semi-synthetic Anti-dandruff Shampoo

Method of Extraction

The first step in the preparation is the extraction of active constituents from the selected medicinal plants such as Amla, Reetha, Shikakai, and Bhringraj. These herbs are first collected in dried form and cleaned thoroughly to remove dust, dirt, and other impurities that may affect the quality and stability of the shampoo. After cleaning, the herbs are shade-dried to preserve heat-sensitive phytoconstituents and remove excess moisture. The dried herbs are then powdered separately using a grinder to obtain coarse powder, which enhances solvent penetration and improves extraction efficiency. Equal quantities of the powdered herbs are mixed uniformly and soaked in distilled water, usually five to ten times the weight of the powder. The mixture is gently heated for about thirty to forty-five minutes with continuous stirring to extract active constituents such as saponins, tannins, flavonoids, antioxidants, vitamins, and alkaloids into the aqueous medium. After heating, the mixture is cooled and filtered using muslin cloth or Whatman filter paper to obtain a clear herbal extract containing the active phytoconstituents. [4,7,15]

Preparation of Shampoo Base:

The next step involves the preparation of the shampoo base. A suitable surfactant such as Sodium Lauryl Sulphate (SLS) is dissolved in distilled water with continuous stirring. Surfactants are responsible for cleansing and foam formation by reducing surface tension and removing dirt and excess oil from the scalp and hair. After complete dissolution of the surfactant, a

thickening agent such as Hydroxypropyl Methylcellulose (HPMC) is added gradually to obtain the desired viscosity and consistency. Continuous gentle stirring is maintained to avoid lump formation and excessive foaming.[12]

Preparation of ketoconazole Solution:

Ketoconazole, the antifungal drug, is then accurately weighed and dissolved in a small quantity of propylene glycol because of its poor water solubility. Propylene glycol acts as a solubilizing agent and helps achieve uniform dispersion of the drug. The dissolved ketoconazole is added slowly into the shampoo base with continuous stirring to prevent precipitation and ensure uniform distribution. [15,16]

Addition of Herbal Extract and Excipients:

After incorporation of ketoconazole, the prepared herbal extract is added gradually into the shampoo base and mixed thoroughly using a magnetic stirrer until a homogeneous formulation is obtained. The combination of ketoconazole with herbal ingredients provides synergistic benefits by offering antifungal activity along with nourishment and conditioning effects. The pH of the formulation is then adjusted to a slightly acidic range of 5.5 to 6.5 using citric acid or sodium hydroxide solution to maintain scalp compatibility and reduce irritation. Preservatives, fragrance, colouring agents, and conditioning agents are added to improve stability, appearance, odour, and hair manageability. Finally, the shampoo is filtered to remove undissolved particles and filled into clean, dry, sterilized containers. [15,16,17]

Following ingredients are used in the formulation of semi synthetic anti dandruff shampoo.

Table-2: Formulation of Shampoo for 100 ml [5,9,10]

Sr. No.	Ingredients	Category	Quantity taken
1.	Ketoconazole	Anti-dandruff active drug	2g
2.	Amla	Hair nourishing agent	5ml
3.	Shikakai	Natural conditioner	5ml
4.	Reetha	Natural cleanser	5ml
5.	Bhringraj	Hair growth promotor	5ml
6.	Sodium lauryl sulphate (SLS)	Surfactant	20ml
7.	Propylene glycol	Solvent/ Humectant	5ml
8.	HPMC (Hydroxy propyl methyl cellulose)	Thickening agent	1gm
9.	Methyl paraben	Preservatives	0.2gm
10.	Citric acid	pH adjuster	q.s.
11.	Rose water	Fragrance	q.s.
12.	Distilled water	Vehicle	Up to 100 ml

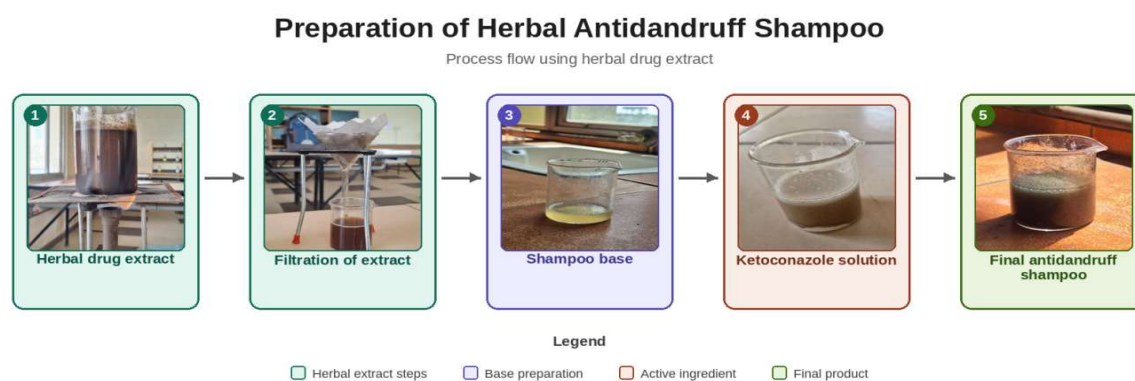


Fig 3. Preparation of Herbal Antidandruff Shampoo

Evaluation Parameters for Semi-Synthetic Anti-Dandruff Shampoo

Physical Appearance/ Visual Inspection

By utilizing sensory organs like eyes or nose, the examination of the semi-synthetic antidandruff shampoo

is performed under this evaluation, and it includes macroscopic characteristics of the drug or product, such as colour, odour, and taste. The texture and appearance are also included under macroscopic features. [11,18]

Table-5: Physical characteristics

Sr. No.	Properties	Observation
01	Colour	Greenish black
02	Odor	Pleasant herbal odour
03	Texture	Smooth, homogeneous and viscous
04	Appearance	Slightly opaque
05	Stability	Stable under normal temperature

pH Determination

The pH of the prepared semi-synthetic anti-dandruff shampoo was determined using a digital pH meter. About 10 ml of shampoo was diluted with 90 ml of distilled water to prepare a 10% shampoo solution. The pH meter was first calibrated using standard buffer solutions of pH 4 and pH 7. The electrode was then immersed into the shampoo solution and the reading was recorded at room temperature. The measurement was carried out in triplicate and the average value was calculated. A shampoo with pH between 5 and 7 is considered suitable for scalp and hair because it minimizes irritation and maintains scalp balance. [11,18,19]

Viscosity Test

The viscosity of the shampoo influences its ability to spread evenly across the scalp, ensuring proper coverage and contact with the hair and skin. Viscosity of semi-synthetic shampoo was measured using a viscometer. 10 ml of shampoo is placed in a beaker, and a spindle is immersed in it for approximately 5 minutes. Subsequently, a measurement is obtained. By evaluating viscosity, manufacturers can optimize the formulation of semi-synthetic anti-dandruff shampoos to deliver a smooth, easy-to-use product that effectively addresses dandruff concerns while providing a pleasant washing experience for consumers. [11,19]

Foam Height and Foam Stability Test

The foaming ability and foam stability of the shampoo were evaluated by the cylinder shake method. In this

method, 50 ml of 1% shampoo solution was transferred into a 250 ml graduated cylinder. The cylinder was covered by hand and shaken vigorously ten times to generate foam. Immediately after shaking, the total volume of foam produced was measured and recorded as the foaming ability of the shampoo. To determine foam stability, the foam volume was further recorded at 1-minute intervals for up to 4 minutes. The decrease in foam volume with time indicates the stability of the foam. This method provides a simple and effective evaluation of the foaming characteristics of shampoo formulations. [19,20]

Dirt Dispersion Test

The dirt dispersion test is used to evaluate the cleansing ability of shampoo and to determine whether dirt remains in the foam or disperses in water. In this method, two drops of shampoo were added to a large test tube containing 10 ml of distilled water. One drop of India ink was then added to represent dirt particles. The test tube was tightly stoppered and shaken ten times to produce foam. After shaking, the amount of ink present in the foam was visually observed and recorded as none, light, moderate, or heavy. A good quality shampoo shows little or no ink in the foam because dirt should remain in the water portion rather than the foam. [21,22]

Wetting Time Test

The wetting time test was performed to evaluate the ability of the semi-synthetic anti-dandruff shampoo to wet the surface effectively. A piece of canvas paper was cut into a square shape of 2-inch length. The shampoo solution was prepared using (1% v/v) dilution with distilled water. The canvas paper was carefully placed on the surface of the shampoo solution, and the time required for the disc to completely sink was measured using a stopwatch. The duration taken by the disc to absorb water and sink was recorded as the wetting time. [19,23]

Percentage of Solid Content

A clean dry evaporating dish was weighed and added 5gm semi-synthetic antidandruff shampoo to the evaporating dish. To the weight about the dish and semi-synthetic anti-dandruff shampoo. The exact weight of the semi-synthetic anti-dandruff shampoo was calculated and put on the evaporating dish with semi-synthetic anti-dandruff shampoo was placed on the hot plate until liquid portion was evaporated. The weight of the semi-synthetic anti-dandruff shampoo after drying was calculated. [19,21,24]

Skin Irritation Test

Skin irritation can be verified by applying some amount of product to the skin and checking after some minutes for local irritation or inflammatory reactions. Common techniques include patch testing or skin irritation scoring systems. For semi-synthetic anti-dandruff shampoos, which often contain botanical extracts and chemical ingredients, it's essential to assess their compatibility with different skin types, including sensitive skin. By conducting skin irritation evaluations, manufacturers can identify any adverse reactions such as redness, itching, or inflammation, and formulate the shampoo to minimize the risk of irritation while maintaining its efficacy in treating dandruff. Ultimately, thorough skin irritation evaluation ensures that semi-synthetic anti-dandruff shampoos are safe and gentle for regular use, providing relief from dandruff without compromising skin health. [21,25]

Washability Test

The washability test is performed to evaluate how easily the semi-synthetic anti-dandruff shampoo can be removed from hair or skin surface using water. Good washability indicates better cleansing action and user acceptability. [27,28]

Stability Study

Stability study is performed to determine the ability of the shampoo formulation to maintain its physical appearance, viscosity and pH during storage under different environmental conditions. The study helps to estimate the shelf life and storage condition of the formulation.

formulation was stored for some time under different temperatures (25°C to 40°C) and humidity conditions for 3 months and the change in the physical properties was observed. [26]

Table- 6: Stability Test

Sr. No.	Stability test	Observation
1.	Change in Colour	No change
2.	Change in Odour	No change
3.	Change in pH	No change
4.	Change in Texture	No change
5.	Change in Smoothness	No change
6.	Change in Viscosity	No change

RESULT AND DISCUSSION

The pre-formulation evaluation of ketoconazole confirmed its suitability for pharmaceutical formulation development. The drug was obtained as a white crystalline powder with an odourless nature and fine crystalline texture. It exhibited a slightly bitter taste and a melting point ranging from 148–152°C, indicating good purity and conformity with reported standards. The drug was found to be stable under normal temperature conditions, suggesting adequate physical stability during storage and handling.

The pH of the drug solution was determined to be 5.45, indicating a slightly acidic nature. Solubility studies revealed that ketoconazole possesses poor aqueous solubility, while being freely soluble in ethanol, soluble in methanol, chloroform, and dilute acids, and slightly soluble in ether. These findings highlight the need for

suitable formulation strategies to improve its dissolution and bioavailability.

UV spectroscopic analysis showed a characteristic absorption maximum (λ_{max}) at 256 nm, which was used for quantitative drug estimation. FTIR analysis confirmed the presence of the characteristic functional groups of ketoconazole without any significant deviations, thereby verifying the identity, purity, and structural integrity of the drug. Overall, the preformulation results demonstrated that ketoconazole possesses suitable physicochemical characteristics for further formulation and development studies.

Table-7 Pre-formulation Studies of Ketoconazole

Sr. No.	Test	Result
1.	Physical characteristics	
a.	Colour	White crystalline powder
b.	Odor	Odourless
c.	Texture	Fine crystalline texture
d.	Taste	Slightly bitter
e.	Melting point	148-152°C
f.	Stability	Stable under normal temperature
2.	pH determination	5.45
3.	Solubility	poor solubility in water, freely soluble in ethanol, soluble in methanol, chloroform and dilute acids, and slightly soluble in ether.
4.	UV Spectroscopy	λ max = 256 nm
5.	FTIR	The FTIR spectrum confirms the presence of characteristic functional groups of ketoconazole, indicating the purity and identity of the drug.

Preliminary phytochemical screening of Amla (*Phyllanthus emblica*), Shikakai (*Acacia concinna*), Reetha (*Sapindus mukorossi*), and Bhringraj (*Eclipta alba*) revealed the presence of various bioactive constituents, including alkaloids, flavonoids, tannins, phenolic compounds, proteins, and terpenoids. Among the tested herbs, Amla showed a high abundance of tannins and phenolic compounds, while Shikakai and Reetha exhibited moderate levels of these phytoconstituents. Bhringraj demonstrated comparatively lower concentrations of tannins, phenolic

compounds, and terpenoids. The presence of flavonoids, tannins, and phenolic compounds suggests strong antioxidant activity, whereas alkaloids and terpenoids may contribute antimicrobial and anti-inflammatory properties. These phytochemicals are known to promote scalp health, strengthen hair follicles, and protect against oxidative damage. Therefore, the combined phytochemical profile of these herbal extracts supports their potential use in the development of effective herbal hair care formulations.

Table-8 Result of Phytochemical Test of Herbal extract:

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S. No.	Phytochemical Constituents	Amla (<i>Phyllanthus emblica</i>)	Shikakai (<i>Acacia concinna</i>)	Reetha (<i>Sapindus mukorossi</i>)	Bhringraj (<i>Eclipta alba</i>)
1	Alkaloids	Present (+)	Present (+)	Present (+)	Present (+)
2	Flavonoids	Present (+)	Present (+)	Present (+)	Present (+)
3	Tannins	Highly Present (+++)	Present (++)	Present (++)	Moderately Present (+)
4	Phenolic Compounds	Highly Present (+++)	Present (++)	Present (++)	Moderately Present (+)
5	Proteins	Present (+)	Present (+)	Present (+)	Present (+)
6	Terpenoids	Present (++)	Present (++)	Present (++)	Moderately Present (+)

The formulated herbal shampoo was evaluated for various physicochemical and performance parameters. The formulation exhibited a greenish-black color, pleasant herbal odor, smooth and homogeneous viscous texture, and a slightly opaque appearance, indicating good aesthetic characteristics. The pH of the shampoo was found to be 5.82, which is suitable for scalp application and minimizes the risk of irritation. The viscosity was recorded as 1299.2 cP, suggesting acceptable consistency and ease of application. The shampoo demonstrated good foaming ability with stable foam formation and exhibited effective cleansing properties in the dirt dispersion test. The wetting time was found to be 73 seconds, indicating satisfactory surface-active properties. The percentage solid content was 31%, which falls within the acceptable range for

ensuring good consistency and performance. The formulation was found to be non-irritant during the skin irritation study, confirming its safety for topical use. Stability studies conducted over a period of three months showed no significant changes in physical appearance or performance characteristics, indicating good physical and chemical stability. Furthermore, the washability test revealed efficient rinsing properties with a washability time of 34 seconds. Overall, the evaluation results suggest that the developed herbal shampoo possesses desirable physicochemical properties, good cleansing efficiency, safety, and stability, making it a promising formulation for hair care applications.

Table-9 Result of Evaluation Parameters:

Sr. No.	Evaluation Parameters	Result
1.	Physical Appearance	
a.	Colour	Greenish Black
b.	Odor	Pleasant herbal odour
c.	Texture	Smooth, homogeneous and viscus
d.	Appearance	Slightly opaque
e.	Stability	Stable under normal temperature
2.	pH Determination	5.82

3.	Viscosity Test	1299.2
4.	Foam Height and Foam Stability Test	Good foam formation and foam remained stable for prolonged period with minimal collapse.
5.	Dirt Dispersion Test	Good cleansing property
6.	Wetting Time Test	The shampoo showed good wetting ability and effective surface-active properties. Time= 73sec.
7.	Percentage of Solid Content	The percentage of solid content was within acceptable range, good consistency and performance. % of Solid content= 31%
8.	Skin Irritation Test	Non-irritant and safe for topical use on the scalp and skin.
9.	Stability Study	Formulation remained stable throughout the study period, indicating good physical and chemical stability. Time period for 3 months.
10.	Washability Test	Formulation exhibit good washability and rising properties. Washability time= 34sec.

DISCUSSION:

The present study successfully developed and evaluated a herbal shampoo formulation containing Amla, Shikakai, Reetha, and Bhringraj extracts. Preliminary phytochemical screening confirmed the presence of alkaloids, flavonoids, tannins, phenolic compounds, proteins, and terpenoids in the herbal ingredients. Amla exhibited a higher concentration of tannins and phenolic compounds, indicating strong antioxidant potential, while Shikakai and Reetha contributed cleansing and conditioning properties. Bhringraj, known for its hair growth-promoting activity, complemented the formulation with its beneficial phytoconstituents.

The formulated shampoo exhibited desirable physicochemical characteristics, including a greenish-black appearance, pleasant herbal odor, smooth homogeneous texture, and good stability under normal storage conditions. The pH value (5.82) was found to be within the acceptable range for scalp application, ensuring compatibility with the natural pH of hair and minimizing irritation. The viscosity value (1299.2 cP) indicated appropriate consistency for easy application and handling. Performance evaluation demonstrated

good foam formation and stability, effective dirt dispersion, satisfactory wetting ability (73 sec), and excellent washability (34 sec), suggesting efficient cleansing action. The percentage solid content (31%) was within the recommended range, ensuring adequate shampoo consistency and consumer acceptability. Furthermore, the formulation was found to be non-irritant during skin irritation studies and remained physically and chemically stable throughout the three-month stability study period. These findings collectively indicate that the synergistic combination of herbal extracts contributed to the development of a safe, stable, and effective herbal shampoo formulation with desirable cosmetic and functional properties.

CONCLUSION:

The present investigation demonstrated the successful formulation and evaluation of a herbal shampoo containing Amla, Shikakai, Reetha, and Bhringraj extracts. Phytochemical analysis confirmed the presence of several bioactive constituents responsible for antioxidant, cleansing, conditioning, and hair growth-promoting activities. The developed shampoo exhibited

satisfactory physicochemical properties, including suitable pH, viscosity, foam stability, wetting ability, washability, and solid content. The formulation was found to be non-irritant and remained stable during the three-month stability study. Overall, the results suggest that the developed herbal shampoo is a promising natural hair care product with good cleansing efficiency, safety, stability, and consumer acceptability, and may serve as an effective alternative to synthetic shampoo formulations.

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