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Research Article

Formulation and Evaluation of a Herbal Anti-Dandruff Shampoo

Mayuri Auti*[1], Sujit Hage[2], Jeevan Gawai[3]

[1,2,3] S.U college of pharmacy, SPPU, Pune, Maharashtra 411014

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ABSTRACT

Dandruff is a common scalp disorder primarily associated with the overgrowth of Malassezia species, excessive sebum production, and scalp inflammation. Synthetic anti-dandruff agents such as zinc pyrithione and ketoconazole are effective but may cause irritation and long-term scalp imbalance [1,2]. The present study aims to formulate and evaluate a herbal anti-dandruff shampoo using plant-based ingredients with antifungal, anti-inflammatory, and scalp-conditioning properties. Herbal formulations are gaining importance due to their better patient acceptability, reduced side effects, and eco-friendly nature.[3] Neem (Azadirachta indica), tea tree oil (Melaleuca alternifolia), aloe vera (Aloe barbadensis), and amla (Emblica officinalis) were selected based on their documented pharmacological activities. [4,5] The shampoo was evaluated for its physicochemical properties, stability, pH, foamability, cleansing efficiency, and antifungal activity. [6] Results suggest that the herbal formulation demonstrates satisfactory cleansing, acceptable stability, and promising antifungal potential, indicating its suitability as a natural alternative for dandruff management [5,6].

INTRODUCTION

Dandruff is a chronic scalp condition characterized by flaking, itching, and mild inflammation. It affects nearly 50% of the global population at some stage of life. The condition is closely linked to the proliferation of lipophilic yeast of the genus *Malassezia*, along with sebaceous gland activity and scalp barrier dysfunction. [7,8]

Conventional anti-dandruff shampoos contain synthetic antifungal agents such as ketoconazole, selenium sulfide, and zinc pyrithione. Although effective, these agents may cause scalp irritation, dryness, and potential resistance with prolonged use. Increasing consumer preference for natural and sustainable personal care products has led to growing interest in herbal formulations. [8,9]

Herbal shampoos offer multiple benefits, including reduced irritation, biodegradability, and multifunctional activity due to phytochemical constituents. This study focuses on the formulation

***Corresponding Author:** Mayuri Auti
Address: *S.U college of pharmacy, SPPU, Pune, Maharashtra 411014.*
Email ✉: hsujeet23@gmail.com
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and evaluation of a neem and tea tree-based herbal anti-dandruff shampoo. [9,10]

This study focuses on the formulation and evaluation of a neem (*Azadirachta indica*) and tea tree oil (*Melaleuca alternifolia*) based herbal anti-dandruff shampoo. Both ingredients are well known for their antimicrobial and scalp-soothing properties, making them suitable candidates for natural dandruff management. [10,11]

structure and may be absent in fine or lightly pigmented hair. [12,16]

Dandruff

- Dandruff is a chronic ailment where the scalp gets dry or greasy, causing white flakes of dead skin to form in the hair or on the shoulders. It is innocuous.[17,18]
- The condition can nevertheless cause cosmetic concerns and social embarrassment. Normally, scalp skin cells are continuously renewed and shed invisibly; however, in dandruff, this shedding process becomes accelerated.[17]
- Sebum produced by the scalp may cause dead skin cells to aggregate, leading to visible flakes on the hair and shoulders. Mild itching and scalp irritation are also common symptoms associated with dandruff [18,19]

Fig.2 Dandruff

Causes of dandruff

- Include dry skin
- Irritated or oily skin
- Insufficient shampooing
- Other skin disorders**:**
- Malassezia yeast-like fungus
- Hair product sensitivity (contact dermatitis) [18,19]

Classification of dandruff

1. Dry dandruff (pityriasis sicca)

Appearance: Small, dry, white or grey flakes. Scalp is dry, itchy, and not inflamed.

Common causes:

- Dry skin.
- Cold weather.
- Infrequent hair washing.
- Use of strong shampoos

Other features:

- Flakes readily fall from shoulders.
- Not related to oiliness or redness**.**

2. Oily dandruff (Pityriasi Steatoides)

Appearance: Larger, yellowish, oily flakes**.**

Scalp condition: Oily, Itchy, Irritated, and possibly.

Common Causes

Seborrheic dermatitis.

Overgrowth of Malassezia yeast

Hormone imbalances.

Other features:

Flakes adhere to the scalp and hair due to excess oil.

If not addressed, it may cause hair thinning.

Literature Review

1. Neem (*Azadirachta indica*)

Neem contains bioactive compounds such as nimbidin, azadirachtin, and quercetin. Studies have demonstrated its antifungal activity against *Malassezia furfur* and other dermatophytes. Neem also exhibits anti-inflammatory and antibacterial properties, making it suitable for scalp disorders [21,22]

Key facts

- **Scientific name:** *Azadirachta indica*
- **Family:** Meliaceae
- **Native range:** Indian subcontinent
- **Height:** Typically 15–20 m; may reach 35 m
- **Notable compounds:** Azadirachtin, nimbin, quercetin, salannin.[20,21]

Medicinal and chemical properties
All parts of the neem tree—leaves, bark, seeds, flowers, and roots—contain bioactive

phytochemicals such as azadirachtin, nimbolide, nimbin, and quercetin [21,24] These compounds have been studied for antimicrobial, antifungal, antiviral, anti-inflammatory, and antioxidant activities. Neem extracts are used in Ayurvedic and Unani medicine for skin disorders, infections, and dental care [22,25] Modern pharmacological research continues to explore their potential, though scientific evidence for many traditional claims remains under study [23,25]

Fig.3 Neem (*Azadirachta indica*)

2. Amla (*Emblica officinalis*)

Because of its high vitamin C, antioxidant, tannin, and flavonoid content, amla, also called Indian Gooseberry (Emblica officinalis or Phyllanthus emblica), is a highly prized ingredient in Ayurvedic medicine and natural hair care products. Because of these bioactive ingredients,

amla is a potent scalp rejuvenator that is essential for both preventing and treating dandruff.[26]

Key facts

- **Scientific name:** *Phyllanthus emblica*
- **Common names:** Amla, Indian gooseberry
- **Native range:** Indian subcontinent and Southeast Asia
- **Primary uses:** Food, medicine, cosmetics
- **Nutrient highlight:** Extremely rich in vitamin C[27

Nutritional and medicinal properties

The fruit is an exceptional source of vitamin C, polyphenols, and flavonoids. In Ayurveda, Amla is considered a "rasayana" or rejuvenating substance, supporting immunity, digestion, and longevity [26,28] Modern research supports its antioxidant, anti-inflammatory, and hypolipidemic effects, though clinical validation continues.[28]

Fig.4 Amla (*Emblica officinalis*)

3. REETHA (*Sapindus mukorossi)*

Reetha (Sapindus mukorossi), commonly known as soapnut or soapberry, belongs to the family Sapindaceae. It is traditionally used as a natural hair cleanser because of its high saponin content, which produces a mild foaming action.[27]

Reetha exhibits natural antifungal and antibacterial properties that help combat dandruff and maintain scalp hygiene. Its gentle cleansing action removes dirt and excess oil without stripping natural moisture from the scalp. [27,29]

Key Facts

- **Scientific name:** *Sapindus mukorossi.*
- **Family:** Sapindaceae.
- **Native range:** India, Nepal, China.
- **Common names:** Reetha, Ritha, Aritha, Indian soapberry.
- **Primary compound:** Saponins – natural surfactants.[29]

Uses and Applications

In Ayurveda, reetha is used in herbal hair preparations for its cleansing, antimicrobial, and anti-inflammatory properties. It is also used in eco-friendly detergents and sulfate-free cosmetic products.[29]

Its medicinal applications include the treatment of scalp infections, dandruff, and mild skin disorders. Reetha promotes healthy, shiny hair while maintaining the scalp's natural oil balance [27,29]

Health and Cosmetic Benefits

Rich in saponins, Reetha gently removes oil and dirt without stripping natural moisture. It promotes shiny, strong hair and relieves dandruff and scalp infections. Medicinally, it has been used to alleviate respiratory issues, migraines, skin conditions like eczema and psoriasis, and to balance kapha dosha in Ayurvedic practice. Its anti-inflammatory properties extend to soothing joint and muscle discomfort.[29]

Fig.5 Reetha (Sapindus mukorossi)

4. TULSI (Ocimum sanctum)

Tulsi, commonly known as Holy Basil (*Ocimum sanctum* or *Ocimum tenuiflorum*), is an important medicinal herb in Ayurveda. It contains phytochemicals such as eugenol, ursolic acid, flavonoids, and tannins that contribute to its therapeutic properties.[28]

Tulsi possesses antifungal, antibacterial, anti-inflammatory, and antioxidant activities, making it highly effective in reducing dandruff and maintaining scalp health. It also helps soothe irritation and supports a balanced scalp environment.[28,39]

Key facts

- **Scientific name:** *Ocimum tenuiflorum* (syn. *O. sanctum*).
- **Family:** Lamiaceae (mint family).
- **Native range:** Indian subcontinent and Southeast Asia.
- **Height:** 30 cm – 1 m.
- **Primary uses:** Medicinal, culinary, and religious.[30]

Cultivation and care

Tulsi thrives in warm, sunny conditions and moist, well-drained soil rich in organic matter. It can be grown outdoors in frost-free areas or indoors on sunny windowsills. Regular watering, light pruning, and occasional liquid fertilization encourage bushy growth. It propagates readily from cuttings or seeds, which germinate within two weeks.

Traditional and medicinal uses

In Ayurvedic medicine, tulsi is regarded as an adaptogenic herb that helps the body resist stress. Leaf extracts are used for respiratory disorders, digestive problems, and skin infections.[30] Modern pharmacological studies indicate that tulsi exhibits immunomodulatory, antimicrobial, and antioxidant activities, supporting its use in herbal cosmetic formulations.[27]

Fig.6 Tulsi (Ocimum sanctum)

5. Fenugreek (Trigonella foenum-graecum)

Often utilized in traditional Ayurvedic hair and scalp care formulations, fenugreek, also known as Trigonella foenum-graecum, is a medicinal plant. Fenugreek, which is high in proteins, flavonoids, saponins, and mucilage, has anti-inflammatory, antibacterial, and moisturizing qualities that help fight dandruff and promote healthy scalp function.[26]. Fenugreek is a multipurpose component having antifungal, anti-inflammatory, moisturizing, and nutritional qualities that is used in herbal anti-dandruff shampoos. It calms the scalp, improves the general health of the scalp and hair, and lessens the symptoms of dandruff. Its presence in natural hair care formulas promotes both therapeutic effect and aesthetic appeal [26,27]

Key facts

- **Scientific name:** *Trigonella foenum-graecum.*
- **Family:** Fabaceae (legume family).
- **Native range:** Mediterranean, Western Asia, South Asia.
- **Common uses:** Spice, herbal supplement, fodder crop.
- **Active compounds:** Diosgenin, saponins, alkaloids.[27]

Medicinal and nutritional significance

Traditionally, fenugreek has been used to support digestion, stimulate milk production, and manage blood sugar levels.[27] The seeds are rich in fiber, protein, and bioactive compounds such as diosgenin, which has estrogenic properties. Modern research explores its potential benefits for metabolic and inflammatory conditions, though evidence remains mixed.[26]

Fig.7 Fenugreek (Trigonella foenum-graecum)

6. SHIKAKAI (*Aacia concinna*)

Shikakai (*Acacia concinna*) is a traditional Ayurvedic herb widely used as a natural hair cleanser. It contains natural saponins that gently cleanse the scalp while preserving natural oils.[29]

Shikakai exhibits antibacterial, antifungal, and anti-inflammatory properties that help reduce dandruff and maintain healthy scalp conditions. It also improves hair texture and reduces hair breakage [29,30]

Key facts

- **Scientific name**: *Acacia concinna* (syn. *Senegalia rugata*)
- **Family**: Fabaceae (legume family)
- **Native range**: Tropical Asia (India, Myanmar, Thailand)
- **Plant type**: Woody climbing shrub, 1–10 m tall.
- **Traditional use**: Natural hair cleanser and Ayurvedic medicine.[30]

Traditional and medicinal uses

The pods and bark of shikakai are traditionally used in Ayurvedic hair preparations for cleansing and conditioning purposes. It is often combined with amla and reetha in herbal shampoos.[30]

Role in hair and skin care

Shikakai's low pH makes it gentle on hair and scalp, cleansing without stripping natural oils. It strengthens follicles, enhances shine, and reduces breakage. [29]Combined with amla and reetha (soapnut), it forms a classic herbal hair-care trio in South Asia. In modern cosmetics, it appears in shampoos, conditioners, and masks as a natural, sulfate-free cleanser.[30]

Fig.8 Shikakai (Aacia concinna)

7. Hibiscus (*Hibiscus rosa-sinensis*)

Hibiscus rosa-sinensis belongs to the family Malvaceae and is commonly used in herbal hair-care preparations. The flowers and leaves contain amino acids, flavonoids, and antioxidants beneficial for scalp and hair health.[28]

Hibiscus promotes hair growth, strengthens hair roots, improves scalp circulation, and reduces dandruff. Its soothing and antimicrobial properties also help relieve scalp irritation [28,30]

Key facts

- **Scientific name:** *Hibiscus rosa-sinensis*
- **Family:** Malvaceae
- **Common names:** Chinese hibiscus, shoeblackplant, tropical hibiscus
- **Native range:** East and Southeast Asia
- **Bloom colors:** Red, pink, orange, yellow, white, and multicolored.[30]

Cultivation And Care

Hibiscus thrives in warm, humid conditions with full sunlight and well-drained soil. It is frost-sensitive and grows outdoors in tropical to subtropical regions or indoors as a container plant elsewhere [5] Regular watering, pruning, and fertilization encourage prolific flowering.[3]

Fig.9 Hibiscus (Hibiscus rosa-sinensis)

8. GUAR GUM

Guar gum is a natural polysaccharide obtained from the endosperm of guar seeds (*Cyamopsis tetragonoloba*). It is widely used in pharmaceutical and cosmetic formulations because of its thickening, stabilizing, and emulsifying properties.[29]

Guar gum is a water-soluble, biodegradable, and non-toxic polymer composed mainly of galactomannan. It appears as a white to yellowish-white powder and is effective even at low concentrations [29,30]

In herbal shampoos, guar gum improves viscosity, stability, and texture of the formulation. Its conditioning effect enhances the spreadability and consistency of cosmetic products.[30]

Fig.10 Guar Gum

Materials and Methods.

1. Materials.

Table.1[37,38,39,40]

Ingredients	Uses
Neem leaf powder	Anti-fungal, Antibacterial
Hibiscus petals powder	Hair fall control, Reduce Dryness
Shikakai powder	Anti-dandruff, Hair softness
Reetha powder	Natural cleansing agent, Foaming agent
Tulsi Powder	Antimicrobial, Anti-inflammatory
Amla Powder	Promotes hair growth' Strengthens hair roots
Fenugreek Powder	Nourishes scalp Reduces hair fall
Rose Oil	Pleasant fragrance
Glycerine	Moisturizing, Prevents dryness
Sodium Benzoate	Preservative Increases shelf life
Sodium Bicarbonate	pH adjustment, Scalp-friendly pH
Guar Gum	Improves viscosity
Shampoo Base	Foaming
Water	Vehicle/Solvent

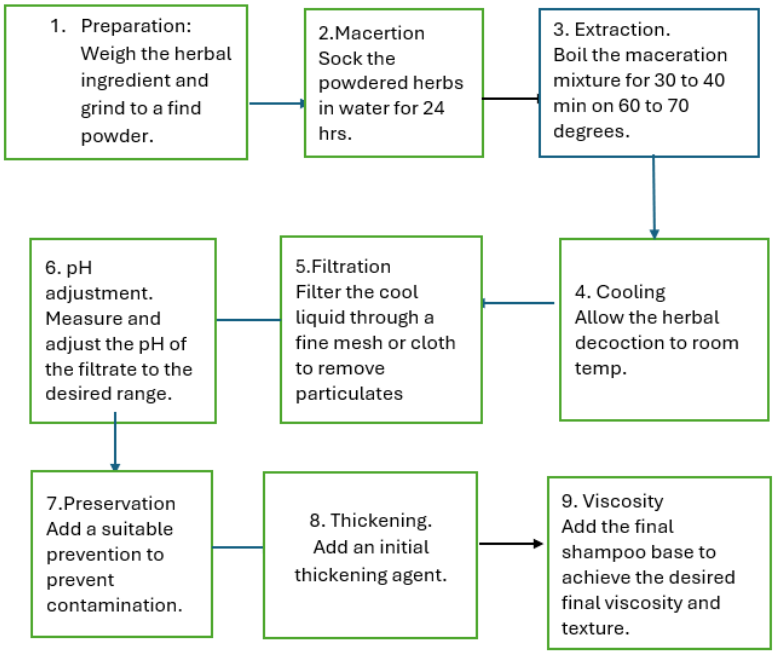
2. Preparation Formulation.

Table. 3[37,38,39,40]

Ingredients	Batch 1	Batch2	Batch3
Neem leaf powder	4 gm	4.5gm	4gm
Hibiscus petals powder	1.5gm	2gm	2.5gm
Shikakai powder	5gm	6gm	6gm
Reetha powder	8gm	8.5gm	9gm
Tulsi Powder	2gm	2.5gm	2.5gm
Amla Powder	4gm	4gm	4gm
Fenugreek Powder	2gm	2gm	2gm
Rose Oil	0.5ml	0.5ml	0.5ml

3. Method of Preparation

Table. 3[37,38,39,40]



Evaluation Parameters

1. Physical Appearance

The physical appearance of the herbal shampoo was evaluated to assess its overall visual and sensory qualities. Parameters such as colour, fragrance, clarity, texture, consistency, and uniformity were carefully observed. The formulation was also checked for the presence of any unwanted particles, sedimentation, or phase separation. A well-formulated herbal shampoo

should have an attractive appearance, a pleasant smell, a smooth texture, and a consistent composition without any visible impurities.

2. pH Determination

Measured using a calibrated digital pH meter. Ideal scalp-friendly range: 5 to 6. The pH of shampoo is determined to ensure compatibility with the scalp and hair. Herbal shampoos generally require a pH close to neutral or slightly acidic to avoid irritation and maintain hair health.

3. Foam Height and Stability

The cylinder shake method was used to assess foaming ability and stability over 5 minutes. The foam height and foam stability test was performed to assess the foaming ability and stability of the herbal shampoo. A shampoo solution was shaken in a graduated cylinder, and the foam produced was measured immediately and after a fixed time interval. Good foam formation and stability indicate effective cleansing performance and better product quality.

4. Viscosity

Measured using a Brookfield viscometer. The viscosity test was conducted to determine the thickness and flow property of the herbal shampoo formulation. Viscosity affects the ease of application, spreadability, and overall consumer acceptability of the product. The viscosity of the shampoo was measured using a viscometer at room temperature. An ideal shampoo should possess moderate viscosity for convenient handling and application.

5. Dirt Dispersion Test

The dirt dispersion test was performed to assess the cleansing efficiency of the herbal shampoo. In this method, a small amount of shampoo was added to water along with a drop of dirt or ink solution, and the mixture was shaken. The distribution of dirt was then observed to determine how effectively the shampoo removes impurities. A good shampoo should keep the dirt dispersed in the water rather than in the foam, indicating better cleansing action.

6. Stability Studies

The prepared shampoo samples were stored under different temperature conditions, including room temperature, refrigerated conditions, and elevated temperature (40°C ± 2°C), for a period of 1–3 months. During the study, the formulations were regularly examined for any changes in color, odor, pH, consistency, and phase separation to evaluate their stability.

7. Skin Irritation Test

The skin irritation test was carried out to evaluate the safety and suitability of the herbal shampoo for topical application. A small quantity of the shampoo was applied to a specific area of the skin and observed for any signs of irritation, such as redness, itching, swelling, or discomfort after a certain period of time. The absence of any adverse reaction indicates that the shampoo is safe and non-irritating to the skin.

8. Wetting Test

The wetting test is performed to check how effectively a shampoo can spread over a surface and reduce the surface tension of water. This test helps in determining the cleansing performance and efficiency of the shampoo formulation.

Principle

A good shampoo contains surfactants that decrease the surface tension of water, making it easier for the liquid to penetrate and wet a material rapidly. In this method, a canvas disc is placed on the

shampoo solution, and the time required for the disc to sink is measured. Faster sinking of the disc indicates better wetting and cleansing ability of the shampoo.

Results and Discussion.

1. Physical Appearance

The physical appearance of the herbal shampoo was evaluated to assess its overall visual and sensory qualities. Parameters such as colour is brown, fragrance is mild , clarity is less, texture, consistency, and uniformity were carefully observed. The formulation was also checked for the presence of any unwanted particles, sedimentation, or phase separation. A well-formulated herbal shampoo should have an attractive appearance, a pleasant smell, a smooth texture, and a consistent composition without any visible impurities.

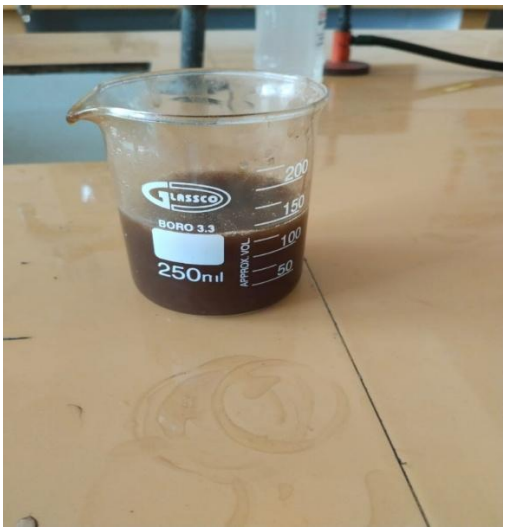


Fig.11 Physical Appearance

1. pH Determination

Measured using a calibrated digital pH meter. Ideal scalp-friendly range: 5 to 6. The pH of shampoo is determined to ensure compatibility with the scalp and hair. Herbal shampoos typically require a pH level close to neutral or slightly acidic to prevent irritation and promote hair health.

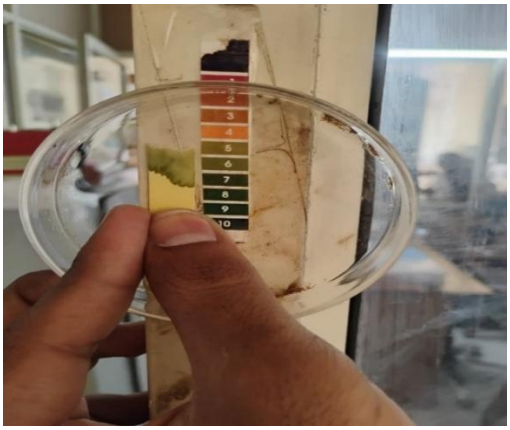


Fig.12 1. pH Determination

3. Foam Height and Stability.

The shampoo formulation produced a good amount of foam on shaking with water, showing effective cleansing properties due to the presence of surfactants. The foam was uniform and remained stable for a reasonable time with minimal reduction in volume. These results indicate that the shampoo has satisfactory foaming ability and good foam stability, making it suitable for regular hair cleaning.

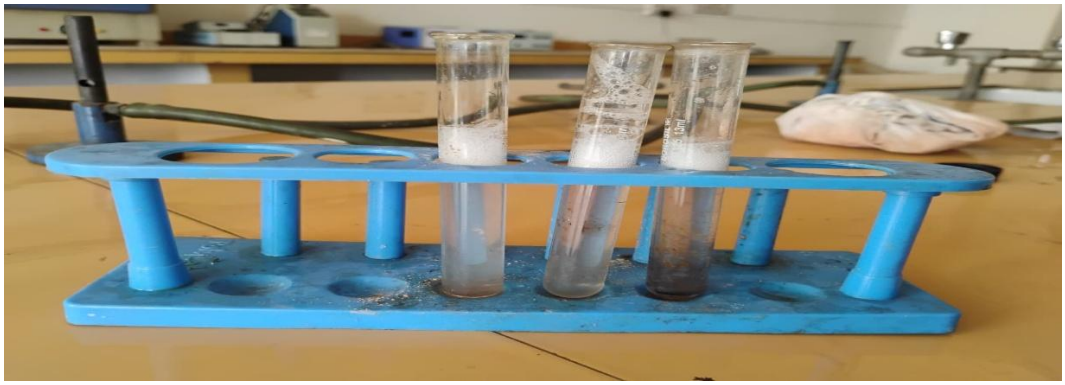


Fig 12 Foam Height and Stability

4. Viscosity

The shampoo formulation showed appropriate viscosity with a smooth and uniform consistency. It was neither too thick nor too watery, indicating good flow properties and ease of application. The results suggest that the formulation possesses acceptable viscosity suitable for convenient use and handling. The spindle range is 62, and speed is 10 rpm and result was 1263cP.

Fig.13Viscosity

5. Skin Irritation Test

The shampoo formulation did not produce any redness, itching, swelling, or irritation on the applied area of skin. The formulation was found to be mild and safe for topical application. These results indicate that the shampoo possesses good skin compatibility and is suitable for regular use. Before applying the shampoo skin is little bit dirty after 5 min of washing skin will become clear and no irritation is found.

Skin Irritation Test

6. Wetting Test

The shampoo formulation showed good wetting ability by allowing the canvas disc to sink within a short period of time. This indicates effective reduction of surface tension and satisfactory cleansing performance of the formulation.

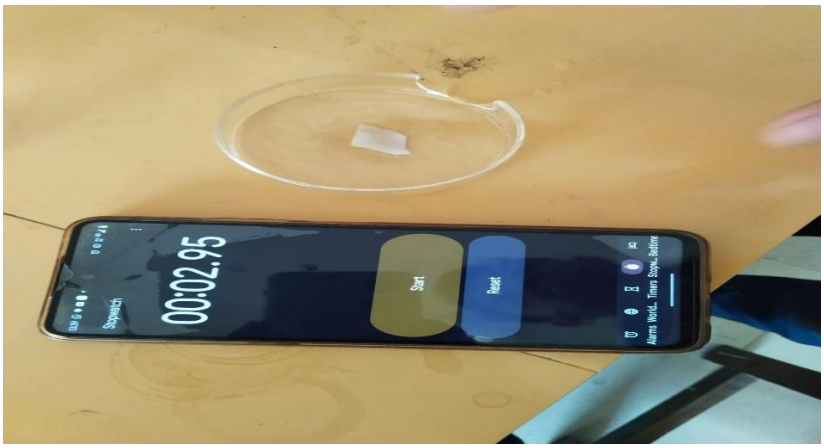


Fig 16 Wetting Test

CONCLUSION

The formulated herbal anti-dandruff shampoo containing neem, tea tree oil, aloe vera, and amla showed promising physicochemical stability and antifungal activity. The combination of plant-based actives offers a safer and potentially effective alternative to synthetic anti-dandruff agents. Further clinical evaluation on human volunteers is recommended to validate long-term efficacy and safety.

Future Scope

- Clinical trial on 30–50 volunteers
- Comparative study with commercial anti-dandruff shampoos
- Microbiome analysis of scalp flora.

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31. A broad review on Azadirachta indica highlights its antimicrobial, antifungal, anti-inflammatory, and antioxidant activities, which are the main reasons it's used in personal care products.
32. Neem extracts contain concentrated bioactive compounds (like flavonoids and limonoids), often more studied for efficacy than whole plant powder in cosmetic science.
33. A shampoo formulated with neem (typically using extract) proved highly effective in vitro against head lice, showing better results than a standard chemical (permethrin) in killing lice.
34. Another clinical trial showed neem seed extract shampoo was effective against lice with no significant irritation in human subjects, suggesting safety and therapeutic action.
35. Neem extracts (different solvent extracts) show ethanolic extracts tend to have stronger antimicrobial and antioxidant activity than simple aqueous or raw plant material, because the solvent concentrates bioactive compounds.
36. Anti-furfurative comparison of Kesh Kanti-Herbal Shampoos and synthetic shampoos against Malassezia furfur for dandruff management.
37. Formulation and Evaluation of herbal shampoo using neem, amla and reetha extract.
38. Formulation and evaluation herbal neem anti dandruff shampoo.
39. Formulation and Evaluation Antidandruff Herbal Shampoo.
40. In vitro anti-Malassezia activity of plant-based shampoo ingredients.

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