



# Formulation And Evaluation of Herbal Antidandruff Shampoo by Using Azadirachta Indica, Aloe Barbadensis Miller and Tea Tree Oil

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## KEYWORDS

Herbal shampoo, Azadirachta indica, Aloe barbadensis miller, Tea tree oil, Antidandruff, Antifungal activity, Physicochemical evaluation, Stability studies

## ABSTRACT:

An herbal anti-dandruff shampoo formulated with tea tree oil, aloe vera, and neem—three ingredients selected for their antifungal, antibacterial, and conditioning properties—is the subject of this study. The shampoo's regulated pH and user-friendly qualities were ensured by combining botanical extracts with surfactants, stabilisers, and preservatives during formulation. We compared it to popular commercial shampoos like Dove, Sun Silk, and Head & Shoulders based on its physicochemical features, which included viscosity, foam volume, surface tension, detergency, and filth dispersion, among others. The created shampoos outperformed commercial options in terms of foam and debris dispersion, surface tension reduction, and overall cleaning performance. When tested against *Candida albicans*, the F4 formulation—which has higher concentrations of neem and tea tree oil—showed significant inhibitory zones, comparable to those of other anti-dandruff shampoos. Experiments measuring stability over 90 days confirmed that the formulations maintained their physical properties and pH within acceptable ranges. A combination of medicinal benefits and minimal side effects, herbal shampoo compositions provide a secure and efficient substitute for synthetic shampoos.

## 1 Introduction:

Preventing the development of dandruff flakes is the main goal of anti-dandruff products. The cosmetic issue of dandruff is significant in both industrialized and poor countries. The two species of fungi that cause dandruff are *Malassezia restricta* and *Malassezia globosa*. This happens when a large number of the scalp's epidermal cells die off. The scalp's skin regenerates about once every thirty days.

The scalp normally gently sheds dead cells; however, there are instances where the cell turnover rate is accelerated to a point where visible flakes, generally known as dandruff, are shed. [1]

Many people use shampoos because they are convenient hair care items that clean the scalp and hair. There are a lot of uses for shampoo; some of them include lubricating, conditioning, strengthening muscles, preventing static electricity, and treating diseases. In the end, it all comes down to whether or not the final shampoo formula is suitable for long-term usage in a medical setting. A natural anionic surfactant with

antibacterial and preservation characteristics, neem was used in the manufactured herbal anti-dandruff shampoo, which made it superior to the commercial herbal shampoo.

Ayurveda, Siddha, and homoeopathy are just a few of the many herbal treatments that have long made substantial use of the medicinal herbs aloe vera and neem. A major social problem in India and around the world, dandruff is a major hair problem. In a chronic, non-inflammatory state, dandruff causes the scalp to scale excessively and is a common dermatological problem. The dandruff-causing fungus *Malassezia globosa* and *Malassezia restricta* are the culprits. An infection of the skin can be caused by the yeast *Malassezia*, which is also known as *Pityrosporum*. [2] in The cosmetics industry is the largest user of shampoos. In the past, people would use soap cakes to wash their hair; however, nowadays, most people use shampoos, regardless of gender. If you apply a shampoo when the conditions are right, it will remove excess oil and dead skin cells from your hair. A shampoo is essentially a surfactant in a liquid, solid, or powder form. No matter



how hard the water is or what kind of grease or dirt is on the hair, a good shampoo should be able to make enough lather to remove it. People tend to prefer shampoos that have a lot of foam, though.

## 1.1 Types of dandruff

### (a) Dry dandruff

Excessive accumulation of tiny, white, greyish, or ash-colored scales on the scalp is the hallmark of dry dandruff, which is caused by Pityriasis simplex. The visible scales on the scalp are caused by the split cells of the keratinized layer, which have a renewal cycle that is pathologically squeezed. Extreme hair thinning is not an outcome of this type of dandruff. [3, 4]

### (b) Oily dandruff

As an additional form of dandruff, pityriasis steatoides can also be called greasy dandruff. Variegated sebum production causes it to manifest on scalp skin. The majority of its victims are preteen and adolescent males. The scalp skin becomes irritated to varied degrees, and there are also oily, filthy-yellow scales that can develop into ulcers. Various degrees of pruritis are often seen alongside these lesions. Loss of hair is prevalent. Androgenetic alopecia will also be exacerbated by it. [5, 6]

Irritation, allergies, hair breakage, and skin and hair discoloration are some of the negative reactions that may occur after using shampoos that include a lot of synthetic components [7]. If anything, herbal shampoos have shown promising results in the fight against dandruff. Natural plant oils and extracts used in herbal shampoos are often gentler on the skin and less likely to cause the kinds of side effects associated with synthetic chemicals. Seborrhoeic dermatitis (SD) is a common etiology of dandruff, which manifests as a dry, itchy scalp. Because of how common it is, it affects almost half of the world's adult population.

It could be difficult to pinpoint the exact cause of your itchy, flaking scalp because of all the factors that might lead to dandruff. [8]

The bioactive properties of plant extracts have been the subject of substantial research. More and more, people are looking for natural ways to make sure their food is safe to eat.

An emphasis on using plant extracts instead of synthetic antioxidants has emerged in response to rising environmental concerns.

Because of their antimicrobial and antioxidant properties, bioactive neem, aloe vera, and tea tree oils stand out in the medical and scientific fields.

Melaleuca alternifolia is the plant from which tea tree oil is extracted. The common names for this tree are tea tree and narrow-leaf paperbark. In Australia, where the plant was originally from, its antibacterial properties have been used for many years [9].

For thousands of years, medicinal systems like Ayurveda, Siddha, and Homoeopathy have relied on the healing properties of plants like aloe vera and neem.

Growing to a height of 14 meters, tea trees are evergreen shrubs or trees with a fibrous bark that do best in warm climates. This plant is a member of the myrtle family and the Melaleuca genus. Most plant extracts are extracted via steam distillation. Terpenes, especially monoterpenes, are the principal active ingredients in tea tree oil [10].

You may find tea tree oil, which is typically used topically as an antibacterial, in health food stores and doesn't require a prescription. It is a component of various cosmetics and is also available as an essential oil. To cleanse hair and promote a scalp free of dandruff, you can use a herbal shampoo, which is a cosmetic product made from traditional medical plants. You can use them to get rid of dandruff, grease, filth, and other environmental toxins. Scaling, itching, and redness are symptoms of dandruff, a chronic disorder that occurs when the scalp's epidermal cells shed. You should stay away from some shampoos since they irritate the eyes. Botanical extracts and essential oils are among the herbal items offered by the sector. Herbal ingredients that are commonly used in

Antimicrobial resistance and the negative impacts of harsh chemicals used to sanitize food processing plants make it imperative that the food business always has access to better antimicrobials. So, it's crucial to find naturally occurring antibacterial compounds that don't have any negative side effects. [11].

This paper describes a novel shampoo recipe that combats dandruff and fungal infections with the use of



tea tree oil, aloe vera, and neem. We tested the manufactured shampoos thoroughly for a number of quality indicators. There was a comparison between the produced shampoos and four shampoos that are sold in India. Commercial shampoos, Neem, Aloe vera, and tea tree oils, as well as a fungus strain called *Candida albicans*, were tested for their anti-dandruff effectiveness using antimicrobial activity [12].

### 1.2 Limitations of Synthetic Treatments:

Even though common antifungal shampoos like selenium sulfide, zinc pyrithione, and ketoconazole 1-2% work well, they can cause some unpleasant side effects like allergic reactions, changes in hair texture, and irritation to the scalp. Some people just can't handle these for long lengths of time. Users have reported that the effectiveness of ketoconazole shampoo has decreased with time, which has raised concerns about overuse and resistance.[13,14]

### 1.3 Herbal Rational: [15-16]

#### ➤ **Neem:**

*Azadirachta indica* has been employed in Ayurvedic medicine for scalp and hair care owing to its antifungal,

antibacterial, anti-inflammatory, and antioxidant properties. Neem extracts have demonstrated inhibitory zones against pathogenic fungus, equivalent to or beyond conventional antifungal drugs in vitro.

#### ➤ **Aloe vera (*Aloe barbadensis miller*)**

Aloe vera, recognised for its anti-inflammatory, moisturising, and antifungal properties, is commonly employed to alleviate scalp irritation and restore skin pH equilibrium. Particular investigations indicate that aloe vera extract can suppress clotrimazole-resistant *Malassezia furfur* strains in vitro, with efficacy rising with concentration; nevertheless, more clinical validation is required.

#### ➤ **Tea Tree Oil**

Green tea is fortified with polyphenols and antioxidants that help diminish sebum production and promote scalp health, alleviating flaking and irritation. Tea tree oil, derived from *Melaleuca alternifolia*, has 30–40% terpinen-4-ol, a powerful antibacterial and anti-inflammatory agent effective against fungus and bacteria. It can impair microbial cell membranes, inhibiting scalp yeast multiplication.



Figure: 1 Leaves of Neem, Aloe vera and tea tree oil

## 2. Material and Methods

### ➤ **Materials**

The aloe Vera and Neem extract is extracted by soxhlet extraction process, the tea tree oil is procured from the local market and the other excipients like, SLS, EDTA ,

Tara Gum, Polysorbate 80, Methyl paraben, are the gift sample from Belco pharma, Bahadurgarh Haryana.



## 2.1 Formulation anti-dandruff, antifungal shampoo

Before adding tara gum and glycerin to adjust the shampoo's viscosity, the herbal anti-dandruff shampoo's formulation began with dissolving sodium lauryl sulphate in 50–60 mL of filtered water while stirring constantly. Following this, preservative methyl paraben (dissolved in warm water) and chelating agent sodium EDTA were added. To make the oil phase, neem extract, tea tree oil, aloe vera gel, and polysorbate 80 were mixed in a separate container. To obtain a homogenous mixture, the oil phase was slowly mixed with the water phase while constant agitation was maintained. A sodium hydroxide solution was employed to modify the formulation's pH to 5.5-6.5. Fragrances were added to enhance the product's appeal to consumers. Before placing the mixture into a clean storage container, the volume was brought to 100 mL using filtered water. To achieve homogeneity and prevent excessive foaming, the formulation was gently spun.

**Table: 1** Composition of Herbal shampoo containing Neem, Aloe Vera and Tea Tree oil

Component	F1	F2	F3	F4
Neem Extract (%)	1.0	1.5	2.0	2.5
Tea Tree Oil (%)	1.0	1.5	2.0	2.5
Aloe Vera Extract / Gel (%)	5	5	5	5
Sodium Lauryl Sulfate (%)	5	10	15	20
Tara Gum (mg)	2	2	2	2
Glycerin (mL)	1	1	1	1
PolySorbate 80(mg)	5	5	5	5
Methyl Paraben (mg)	0.1	0.1	0.1	0.1
Sodium EDTA (g)	0.15	0.15	0.15	0.15
Sodium Hydroxide	q.s.	q.s.	q.s.	q.s.

Perfume / Fragrance	q.s.	q.s.	q.s.	q.s.
Water (q.s. to 100 mL total)	—	—	—	—

## 2.2 Evaluation of shampoo [17]

### ➤ Organoleptic Properties

The formulated anti-dandruff shampoos were assessed against commercially available anti-dandruff shampoos by sensory assessment. The shampoos were inspected for color, clarity, odor, and texture.

### ➤ Determination of pH

The pH levels of formulated shampoos and commercially available chosen shampoos were measured using a digital pH meter at a controlled temperature of  $25 \pm 0.2^\circ\text{C}$ .

### ➤ Viscosity Measurements

A Brookfield viscometer (BDV-8S) with an L3 spindle was used to test the viscosity of shampoos at rotation rates of 1.5, 3, 6, 12, 30, and 60 RPM. Three separate measurements of viscosity were made at room temperature ( $25 \pm 0.2^\circ\text{C}$ ).

### ➤ Solid Contents Determination

The loss-on-drying method was used to calculate the solid content percentage. In short, freshly cleaned, dry, and pre-weighed Petri dishes were filled with 5 g of each shampoo formulation, and the final weight was noted. After that, Petri dishes were placed in a convection oven that was set to  $50^\circ\text{C}$  for an hour, or until the shampoos were totally dry. The following formula was used to estimate the solid content after drying, and the dried Petri dishes were weighed once again. [18]

$$\text{Solid content \%} = \frac{W_0 - W_1}{W_0}$$

Where,  $W_0$  is the initial weight of the sample

While  $W_1$  is the weight of solid contents

### ➤ Surface Tension Determination

Using a stalagmometer, surface tension was determined by diluting each shampoo by 10% in distilled water at room temperature ( $25 \pm 0.2^\circ\text{C}$ ). Using the following formula, the surface tension of shampoos was measured three times:



## ➤ **Foam Volume**

As previously stated in a study, the shaking cylinder method was utilized to test the foam volume of the made shampoos and the marketed shampoos. To put it briefly, 50 mL of a 10% shampoo solution was put into a 250 mL graduated cylinder and shaken ten times. After shaking for 1, 2, 3, and 4 minutes, the total volume of foam was quickly measured using the cylinder's graduation the process was performed three times.

## ➤ **Wetting Time**

The wetting periods of the shampoos were measured by dropping 50 mL of 1% aqueous shampoo solution over 1g of wool yarn in a 100 mL beaker. The wool yarn's beginning to float at the surface of the shampoo solution and its beginning to sink were carefully timed using a timer. At least three replicates' mean findings and standard error were provided. [20]

## ➤ **Detergency Power**

Each shampoo's detergency power (DP) was determined by soaking five grams of wool yarn in grease, weighing it, and then adding 100 milliliters of a 1% aqueous shampoo solution to a 250 milliliter flask. Next, the flask was placed in a water bath that was programmed to shake at 35°C for four minutes at a speed of fifty agitations per minute. After removing the solution from the flask, the wool yarn was left to dry. Following drying, the wool yarn was measured for its detergency power using the following formula. in [21]

In this case, C is the weight of the grease before it is removed from the shampoo solution and T is its weight after removal.

## ➤ **Stability Studies**

Shampoos were stored in an incubator for two months at 45°C and 75% relative humidity in order to assess their

## **3 Result and discussion**

### ➤ **Physical Properties:**

The developed herbal anti-dandruff shampoo exhibited a smooth and uniform consistency, distinguished by a subtle greenish hue from neem and aloe extracts, accompanied by a pleasant herbal smell from tea tree oil and supplementary scent. It exhibited an opaque to

## ➤ **Dirt Dispersion**

Visual evaluations revealed that the foam contained light, moderate, strong, and no Indian ink. Shampoos were deemed low quality if they left the color in the foam. Ten milliliters of distilled water, two drops of shampoo, and one drop of Indian ink were combined in a test tube, which was then stoppered and gently shaken ten times.[19].

## ➤ **Antimicrobial Activity of Shampoos**

The agar well diffusion method was used to assess the antibacterial activity of both commercial and created shampoos against a *Candida albicans* culture. In brief, sterile Petri dishes were filled with Sabouraud Dextrose Agar (SDA) medium that had been produced. Using a sterile cork borer, a 4 mm diameter hole was punched into each Petri dish after the medium had set. After that, a sterile glass spreader was used to distribute the 3 mL of *Candida albicans* culture. A parafilm seal was applied to the Petri dishes as soon as 150 µL of shampoo was put into the perforations, and the lids were replaced immediately thereafter. An incubator was used to keep the sealed Petri plates at 37°C for 24 hours. After one day, the inhibition zones were calculated by averaging and standardizing the results of three separate trials. We compared the inhibitory zones of shampoo formulations including Neem, Aloe vera, and tea tree oil using solutions of these oils at different concentrations. The marketed shampoos' antifungal properties were further evaluated using this. [22,23]

stability. The physical appearance of the shampoos was regularly evaluated at 1, 4, 7, 15, 30, and 60 days.

slightly clear appearance, indicating sufficient integration of the components without phase separation or sedimentation. Upon application, it produced stable, gentle foam with moderate cleansing efficacy, providing a relaxing, non-greasy feel on the scalp and hair. The texture was smooth and viscous, enabling easy application and spreadability while maintaining consumer-friendly sensory appeal.



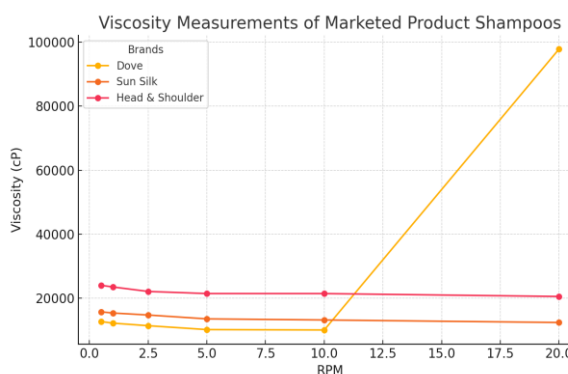
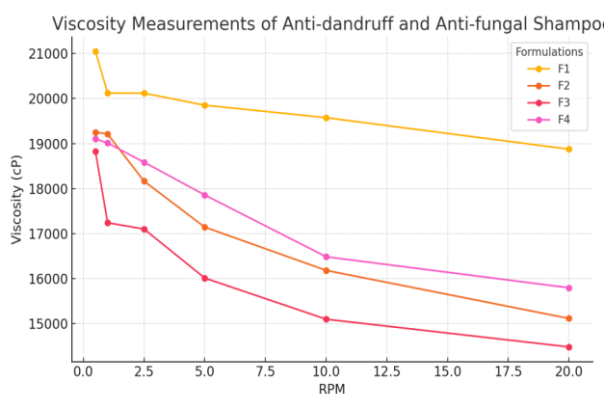
**Table: 2** Physical Properties of anti-dandruff shampoo

Organoleptic Properties	F1	F2	F3	F4	Marketed Sample		
					Dove	Sun Silk	Head & Shoulder
Texture	Gel Type	-	-	-	Gel Type	-	-
pH	5.4	5.6	5.5	5.8	7.3 ± 0.2	4.8 ± 0.1	7.3 ± 0.13
Colour	greenish tint	greenish tint	greenish tint	greenish tint	White	Pink	White
Odour	herbal aroma	herbal aroma	herbal aroma	herbal aroma	Pleasant	-	-

**3.1 Viscosity determination:**

**Table: 3** Viscosity Measurements of anti-dandruff and anti-fungal Shampoo and Marketed products

RPM	F1	F2	F3	F4	Marketed Products			
					RPM	Dove	Sun Silk	Head & Shoulder
0.5	21045	19252	18821	19102	0.5	12752	15784	24058
1	20121	19211	17241	19011	1	12248	15417	23544
2.5	20118	18165	17102	18586	2.5	11458	14795	22144
5	19852	17145	16014	17858	5	10245	13587	21487
10	19574	16184	15100	16486	10	10124	13245	21478
20	18875	15117	14485	15798	20	97765	12458	20578



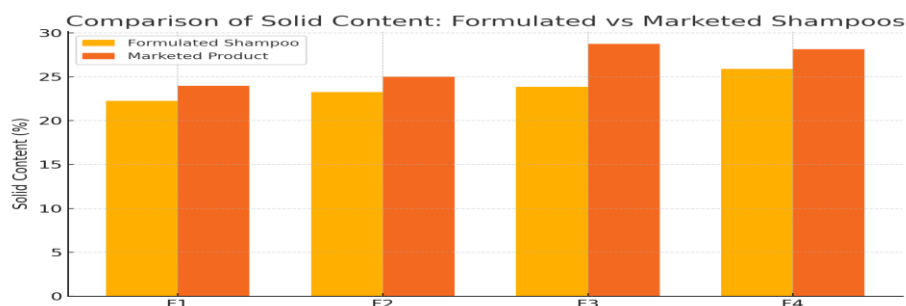
**Figure: 2** Graph 2(a) Graph 2 (b) Viscosity measurements of (a) prepared antifungal shampoo, (b) various marketed products



### 3.2 Presence of solid matter content

For high-quality anti-dandruff shampoos, a solid content range of 20 to 30% is advised. This makes it easy to wash and remove from the hair. The solid ingredients in the commercially available anti-dandruff shampoos and the produced Neem, Aloe Vera and tea tree oil shampoos are

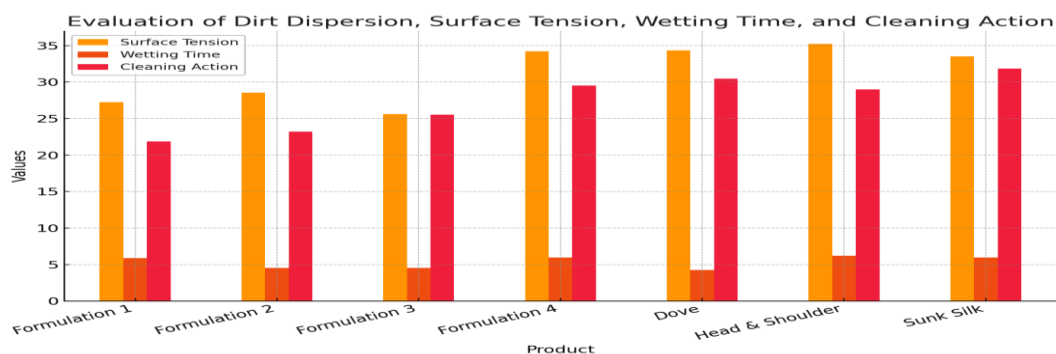
shown in above figure. All of the Neem Aloe Vera and tea tree oil shampoos were regarded as excellent due to their limited selection of solid ingredients. Nonetheless, Dove, Sun Silk, and Head & Shoulder are marketed shampoos with good substance that fall within an ideal range.



**Figure: 3** Percentage of solid content present in formulated Herbal shampoo & marketed product

**Table: 4** Evaluation of dirt dispersion, surface tension, wetting time and cleaning action with marketing product

Formulation/Marketed Products	Dirt Dispersion	Surface tension	Wetting Time	Cleaning Action
1	Medium	27.23±0.2	5.87±0.08	21.85±0.1
2	Light	28.54±0.12	4.54±0.11	23.21±0.21
3	Light	25.63±0.12	4.52±0.15	25.52±0.12
4	None	34.21±0.33	5.96±0.14	29.52±0.1
Dove	None	34.32±1.1	4.25±0.50	30.48±0.21
Head & Shoulder	None	35.24±0.14	6.21±0.03	28.98±0.17
Sunk Silk	None	33.52±0.32	5.97±0.57	31.85±0.15



**Figure: 4** Comparison of dirt dispersion, surface tension, wetting time and cleaning action with marketing product

Good anti-dandruff shampoos often have 20-30% solid components, which makes them simple to wash out,

according to the evaluation of filth dispersion, surface tension, wetting time, and detergency. Among them,



you'll find shampoos infused with neem, aloe vera, and tea tree oil; they're on par with popular brands like Head & Shoulders, Sun Silk, and Dove. By drastically lowering the surface tension of water—with values ranging from 25.63 to 34.32 dyn/cm, which is significantly lower than pure water—all of the shampoos showed excellent cleansing properties. The detergency

#### Foam volume:

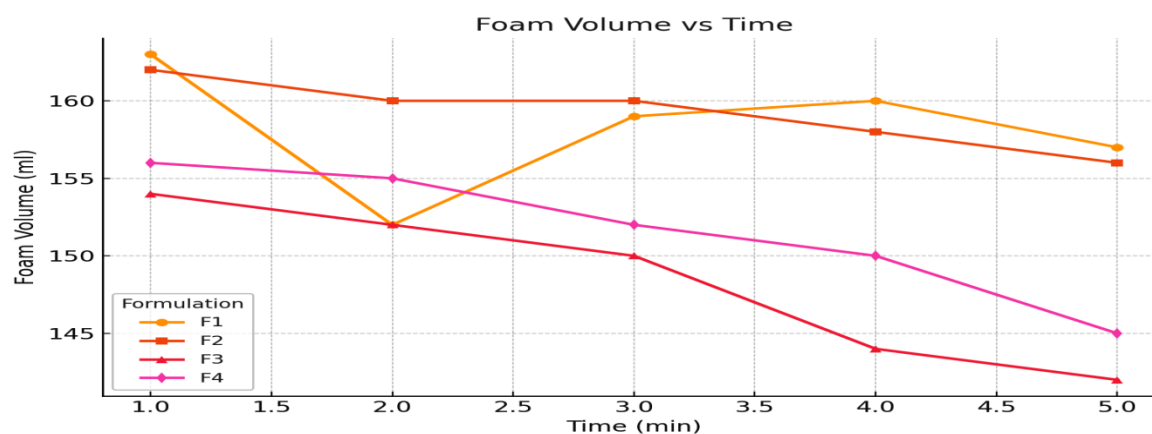


Figure 5 Representation of foam volume of formulated shampoo

#### Antifungal activity of shampoo:

Table 5 compares the zone of inhibition (ZOI) values of commercial antidandruff shampoos with those of the suggested herbal shampoos (F1-F4). F4 exhibited the biggest zone of inhibition ( $35.85 \pm 0.3$  mm) among the formulations, which can be attributed to the enhanced antibacterial and antifungal effects caused by the greater quantities of neem extract, aloe vera, and tea tree oil. According to the zone of inhibition (ZOI) values, the antibacterial activity of the shampoos was enhanced by using a higher concentration of active herbal components.

Despite the fact that commercial formulations such as Head & Shoulders ( $41.12 \pm 2.0$  mm), Sunk Silk ( $39.7 \pm 0.11$  mm), and Dove ( $39.41 \pm 2.2$  mm) have a larger Zone of Inhibition (ZOI), F4's herbal formulation demonstrates substantial antimicrobial effectiveness (without the use of artificial chemicals). This proves that dandruff treatments with herbs may be less harmful and more effective.

analysis confirmed that the produced formulations were almost identical in cleaning performance, since the formulated shampoos had a cleaning action of 21.85-30.48 percent, which was comparable to that of commercially available shampoos, which had a cleaning action of 28.98-31.85% percent.

Table: 5 Comparison of ZOI of Neem, Aloe Vera shampoo with marketed product

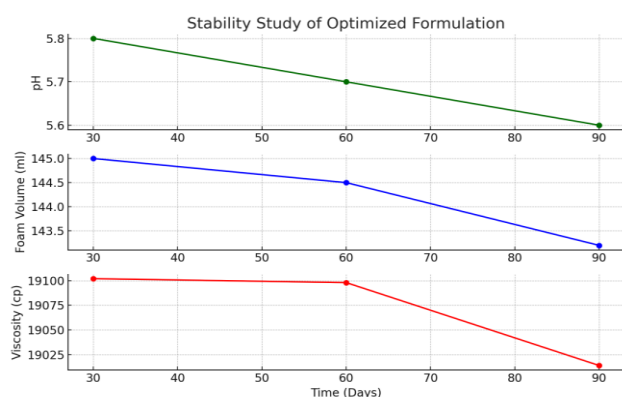
Formulated Shampoo	ZOI (mm)	Marketed Sample	ZOI(mm)
F1	$25.21 \pm 1.1$	Head & Shoulder	$41.12 \pm 2.0$
F2	$30.01 \pm 0.5$	Sunk Silk	$39.7 \pm 0.11$
F3	$30.85 \pm 0.2$	Dove	$39.41 \pm 2.2$
F4	$35.85 \pm 0.3$	-	-

#### Stability Studies:

Finally, the capacity of Neem, Aloe Vera and tea tree oil shampoos to withstand temperatures as high as  $40^{\circ}\text{C}$  (75% RH) The shampoos' physical characteristics, pH levels, viscosity, surface tension, dirt dispersion, and foam volume are displayed in the following table following 30, 60, and 90 days of storage at each temperature. Although there was a slight shift ( $p > 0.05$ ) in all parameters at storage settings, the stability data under various conditions indicate that there was no change in physical appearance. Since the pH change was



negligible over the 90-day stability testing period, we can say that all of the formulations were sufficiently stable



**Figure: 5** stability study of various parameters for 90 days

#### Conclusion:

The current study shown that tea tree oil, neem, and aloe vera shampoo could be effectively made in varying amounts to offer antifungal and antidandruff properties. The shampoos had good pH, viscosity, wetting time, antifungal activity, cleaning and deterring action, and dirt dispersion. Furthermore, the designed and commercialised shampoos had comparable properties. In conclusion, when compared to other products, neem, aloe vera, and tea tree oil have shown the best antifungal and antidandruff efficacy. These may be mixed to make anti-dandruff shampoos in varying quantities, and various skin and hair types may benefit from different amounts. More study is required to ascertain the efficacy of formulated shampoos in human volunteers with different skin and hair types.

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