IJFANS INTERNATIONAL JOURNAL OF FOOD AND NUTRITIONAL SCIENCES
ISSN PRINT 2319 1775 Online 2320 7876
 Journal UGC CARE Listed (Group-I) Volume 14, Issue 05 2025

FORMULATION AND EVALUATION OF AN ALOE-BASED HERBAL HAIR SERUM FOR SCALP NOURISHMENT

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ABSTRACT

The study aimed to formulate and evaluate a polyherbal hair serum using *Aloe vera* gel as the base, combined with extracts of flaxseed, fenugreek, hibiscus, and *Nigella sativa*. These herbal ingredients were chosen for their hair-strengthening, growth-promoting, and scalp-nourishing properties. Lavender oil was added for fragrance and soothing effects. Five formulations (F1–F5) were prepared by varying extract concentrations and evaluated for physical appearance, pH, homogeneity, viscosity, and spreadability. All formulations showed a smooth texture, greenish color, uniform consistency, and acceptable pH for topical use. The optimized batch exhibited excellent homogeneity and desirable viscosity, indicating good stability and ease of application. The findings suggest that the developed aloe-based herbal serum offers a natural, safe, and effective alternative for promoting hair health and scalp nourishment.

Keywords : Nourishment, Serum, Trigonella foenum- graecum.

INTRODUCTION

Hair is a vital part of the human body, playing an important role in enhancing an individual's appearance and boosting self-confidence. Maintaining proper hair care is essential, as hair is one of the key features contributing to a person's beauty and overall personality. Hair is a keratin-based filament that emerges from the skin and is primarily made up of dead, keratinized cells. It is composed of three main components — the hair shaft (the visible part), the root (situated within the follicle), and the hair follicle (the structure in the skin responsible for hair growth). The scalp contains numerous hair follicles along with sebaceous glands, which help preserve the natural pH and moisture balance of the hair. The hair shaft has an average pH of approximately 3.6, while the scalp's pH is around 5.5. Hair grows in cycles, with most strands remaining in the growth phase at any given time. To support healthy hair growth and prevent hair problems, various herbal formulations, such as hair oils, shampoos, and serums, are widely used [1,2].

Hair serums are cosmetic products with a high concentration of active ingredients, formulated to deliver intensive nourishment to the hair and scalp while providing a non-greasy finish suitable for all hair types [3].

The word 'cosmetic' originates from the Greek term 'kosmesticos,' meaning 'to adorn.' As per the Drug & Cosmetic Act of 1940 and its 1944 rules, cosmetics are defined as any article intended to be applied to the human body for cleaning, beautifying, enhancing attractiveness, or altering appearance [4,5]."

ANATOMY OF HAIR[6]

Hair is composed of nearly 95% keratin, a fibrous, helical protein that also forms the structural basis of skin, nails, and other body appendages. The hair shaft is organized into three main layers:

- **Medulla:** The central core of the hair shaft, made up of a soft, oily, and non-structured material.
- **Cuticle:** The thin, outermost protective layer composed of flat, scale-like keratinized cells that help retain essential nutrients for hair growth.
- **Cortex:** The thickest and most significant layer, containing elongated keratin fibers that provide strength, flexibility, and resilience. The cells within the cortex are bound together by a lipid- and protein-rich intercellular substance that enhances the hair's cohesion and durability.

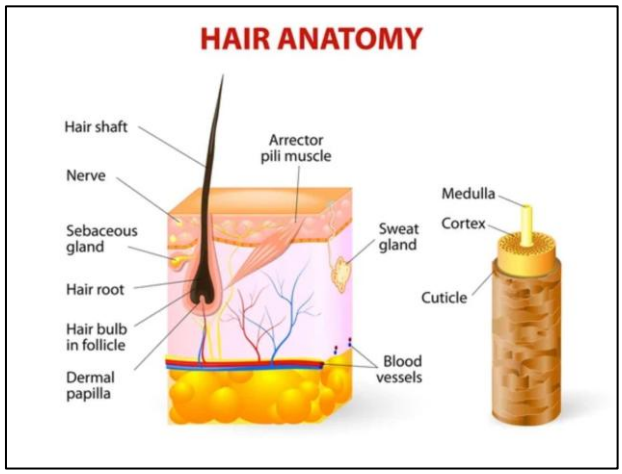


Figure : 1 Hair Anatomy

HAIR GROWTH CYCLE

Hair growth occurs through a continuous, cyclical process consisting of three primary stages: anagen, catagen, and telogen [7,8]. The anagen phase, also known as the growth phase, is the longest and most active stage, lasting approximately 2 to 7 years [7,8]. During this period, hair follicles actively generate precursor cells that develop into specialized hair cells, leading to visible strand elongation [8]. In a healthy scalp, about 85–90% of follicles are in this phase, producing hair at an average rate of roughly 1.2 cm (½ inch) per month [7]. Following this is the catagen phase—a short transitional stage lasting only a few weeks—during which cell division halts, and the lower part of the follicle begins to shrink and become inactive [7,8]. The final stage, telogen, lasts about 3 to 4 months and represents the resting phase of the hair cycle, where growth pauses but the existing hair remains attached to the follicle [8,7]. Eventually, the

old hair is shed, allowing the follicle to return to the anagen phase and start producing new hair [7,8]. Typically, individuals lose between 50 and 100 hairs daily as part of this normal renewal process [7]. Noticeable hair thinning occurs when fewer follicles re-enter the growth stage. This recurring cycle is vital for maintaining the natural balance of hair shedding and regeneration, supporting overall scalp health throughout life.

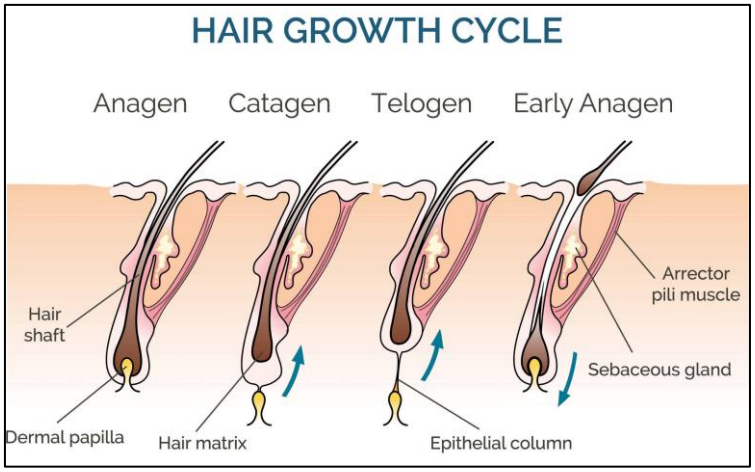


Figure : 2 Hair growth cycle

CAUSES OF HAIR LOSS [9,10]

Various life circumstances such as illness, emotional stress, inadequate protein intake from restrictive dieting, and hormonal fluctuations associated with pregnancy, puberty, or menopause can contribute to hair loss. Additionally, certain medical disorders, including thyroid imbalances, iron deficiency anaemia, and syphilis, are known to trigger hair shedding. Although thyroid function tests and general laboratory investigations, such as complete blood counts, often show normal results in individuals experiencing common forms of hair loss, it remains essential to rule out underlying, treatable conditions as potential causes.

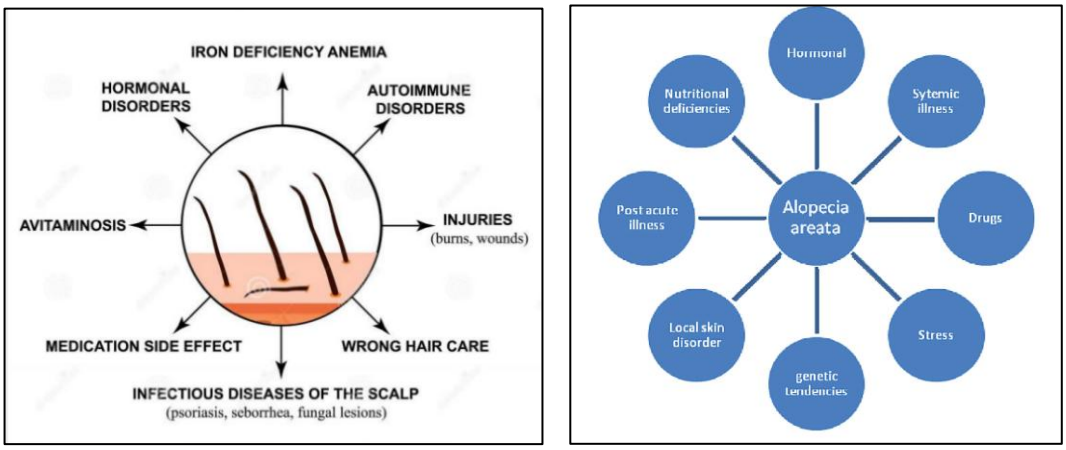


Figure : 3 Causes of hair loss

PURPOSE OF HAIR SERUM[11]

Hair serums are specifically formulated for application on damp hair, where regular use helps to minimize tangling, nourish the hair shaft, and smoothen rough strands. Their slightly acidic pH aids in sealing the cuticle layer, helping hair fibers stay intact and reducing breakage. In

addition, these formulations often include moisturizing and growth-enhancing ingredients that strengthen the hair, enhance shine, and shield it from environmental damage.

Hair serums are primarily designed to combat frizz, dryness, and dullness while enhancing manageability and smoothness. They serve as effective styling aids that make the hair appear sleek, shiny, and voluminous. Unlike hair oils, which are intended to penetrate deeply into the scalp and roots to deliver nourishment, serums mainly act on the hair's surface to provide smoothness, luster, and protection. Thus, while hair oils focus on internal nourishment, hair serums play a key role in external care and styling.

SUITABLE TYPES OF HAIRS FOR USING HAIR SERUM[12,13.14]

1.Straight
2.Wavy
3.Curly
4.Coily

IDEAL CHARACTERISTICS OF SERUMS[15]

- The serum should be gentle on both hair and scalp without causing dryness or damage.
- It should offer long-lasting effectiveness.
- It must enhance hair smoothness, add shine, and make detangling easier.
- The formulation should be non-irritating and safe for regular use.
- It should be convenient and easy to apply.
- The action of the serum should remain localized to the applied area.
- It should be easy to wash off or remove when desired.

ADVANTAGES OF HAIR SERUM[16,17,18]

- Makes the hair feel softer, smoother, and silkier in texture.
- Protects the hair from heat styling and environmental damage.
- Reduces frizz and dryness, keeping the hair easy to manage.
- Enhances shine and helps prevent knots and tangles.
- Improves the overall look of both straight and curly hairstyles.

DISADVANTAGES OF HAIR SERUM

- Frequent or excessive use of hair serum may cause the hair to become dry and lose its natural health.
- Direct application of serum on the scalp can cause irritation or inflammation.
- Prolonged exposure to silicones in hair serums may negatively affect hair health over time.
- Applying serum to the scalp should be avoided, as it can make the scalp greasy or trigger inflammation

TYPES OF HERBAL HAIR SERUMS [19]

Herbal hair serums are available in various forms, each formulated to nourish the scalp, enhance hair health, and address specific concerns. The most common types of herbal serums include:

1) Moisturizing Serum

These serums are developed to restore hydration to dry, rough, or brittle hair. Enriched with natural ingredients such as coconut oil, shea butter, argan oil, and aloe vera, they help lock in moisture, soften the hair shaft, and make hair smoother, shinier, and easier to manage.

2) Growth-Promoting Serum

Formulations in this category focus on stimulating hair growth and improving density. Ingredients like biotin, ginseng, and fenugreek extracts are often included for their ability to strengthen hair follicles, enhance blood circulation to the scalp, and promote healthy regrowth.

3) Strengthening Serum

Strengthening serums are designed to repair and reinforce fragile or damaged hair strands. They are commonly enriched with vitamins, minerals, and antioxidant-rich herbs such as horsetail, nettle, and rosemary extracts that help improve hair resilience, reduce breakage, and support overall hair vitality.

4) Anti-Dandruff Serum

These serums target scalp conditions like dandruff, itching, and flakiness. Natural antibacterial and anti-inflammatory agents such as neem oil, peppermint oil, and tea tree oil help minimize scalp irritation, control microbial growth, and maintain a clean, healthy scalp environment.

5) Colour-Protecting Serum

Colour-protecting serums are specifically formulated for colour-treated hair. They help maintain colour vibrancy and shield hair from damage caused by sunlight and environmental stressors. Herbal ingredients such as sunflower seed oil, grapeseed oil, and green tea extract are often used for their protective and antioxidant properties.

6) Soothing Serum

Soothing serums are intended to calm sensitive or irritated scalps. They may include natural extracts like calendula, lavender, and chamomile, which provide a cooling effect and help reduce inflammation, redness, and discomfort on the scalp.

7) Shine Serum

These serums are designed to enhance the natural lustre of dull or lifeless hair. Lightweight oils such as jojoba and coconut oil, along with reflective botanical ingredients, give the hair a glossy appearance without adding greasiness or heaviness.

8) Heat Protectant Serum

Heat protectant serums act as a shield against damage caused by styling tools such as hair dryers, straighteners, and curling irons. They form a protective coating around each hair strand,

reducing the impact of heat and helping maintain the hair's strength and smoothness after styling.

MATERIAL AND METHODS

➢ FLAXSEED

Synonym: Linseed, flaxseed

Botanical name: Linumusitatissimum

Family: Linaceae

Biological source: It consists of the dried fully ripe seeds of *Linum usitatissimum Linn.*

Chemical constituent: Alpha-linoleic acid (ALA), Omega-3 fatty acid, lignans, etc

Uses: 1. Anti-inflammatory, anti-oxidants, hair growth

2. Omega 3 fatty acid provides vitamins, proteins and nutrients to hair and scalp [20,21]

Figure : 4 Flax Seed

➢ FENUGREEK

Synonym :- Methi, Methika, Alholva, Chandrika
Botanical name:- Trigonella foenum- graceum
Family:- Leguminosae
Biological source:- It is obtained from the dried seeds to Trigonella foenum- graecum.
Chemical constituent:- Vitamin B, alkaloids, flavonoids, saponins, etc
Uses :- Hair growth stimulant, antibacterial.[2,22]

Figure : 5 Fenugreek

- **VITAMIN E CAPSULE**

An oil enriched with vitamin E can help restore shine by rebuilding the hair's protective barrier. Generally, oils lock in moisture, reduce breakage, and shield the hair from damage. Vitamin E, being rich in natural antioxidants, may promote a healthy scalp and encourage hair growth. These vitamins and antioxidants help lower oxidative stress and neutralize free radicals that contribute to the weakening and damage of hair follicle cells.[23]

Figure : 6 Vitamin e capsule

- **ALOE VERA**

Synonyms: Grihakanya, Kanya, Ghritakumari, Vipulasrava, Sthuladala

Botanical Name: Aloe ferox Mill., A. perryi Baker, A. vera (L.) N.L. Burm. (= A. barbadensis Mill.)

Family: Liliaceae

Biological Source: Obtained from the dried latex of Aloe ferox Mill., A. perryi Baker, and A. vera (L.) N.L. Burm. (= A. barbadensis Mill.) [24]

Chemical Constituents: Aloe vera is a rich source of anthraquinone glycosides and contains compounds such as aloin, barbaloin, and aloe-emodin.

Uses: Aloe vera strengthens the hair and exhibits antioxidant and emollient properties. It helps improve hair texture, repairs damaged scalp tissue, and its slightly viscous, transparent gel offers excellent moisturizing effects [25].

Figure : 7 Aloe vera

- **HIBISCUS**

Synonym : Rose mallow, Chinese hibiscus
Botanical Name: *Hibiscus rosa-sinensis* L.
Family: Malvaceae
Biological Source: A tropical species of hibiscus belonging to the tribe Hibisceae [26].
Chemical Constituents: Contains anthocyanins (such as cyanidin), flavonoids (including quercetin), vitamins (C, B1, B2, B6), and essential minerals like potassium, calcium, and iron.
Uses: Helps increase hair volume and thickness, treats dandruff-related issues, prevents hair fall, and promotes overall hair health [27].

Figure : 8 Hibiscus flower

- **NIGELLA SATIVA**

Synonyms: Black cumin, Black caraway, Kalonji, Black seed
Botanical Name: *Nigella sativa* Linn.
Biological Source: The drug consists of the dried seeds of *Nigella sativa*, a member of the Ranunculaceae family
Chemical Constituents: Contains bioactive compounds such as thymoquinone, thymohydroquinone, dithymoquinone, thymol, carvacrol, nigellimine, nigellisin, and alpha-hederin [28].
Uses: Supports natural hair growth and can decrease hair fall by up to 76% when incorporated into hair serum formulations. It possesses antioxidant and antimicrobial properties that safeguard the scalp and hair from damage and infections. Additionally, it is widely utilized in cosmetic products like anti-dandruff shampoos and cleansing creams for its anti-inflammatory and detoxifying effects [29].

Figure : 9 Nigella sativa

➢ **LAVENDER OIL**

Synonyms: True Lavender, English Lavender, Garden Lavender
Botanical Name: *Lavandula angustifolia* Mill.
Biological Source: Lavender oil is derived from the fresh flowering tops of *Lavandula angustifolia*.
Chemical Constituents: Major components include linalool, linalyl acetate, 1,8-cineole, camphor, lavandulol, geraniol, borneol, and tannins.
Uses: Encourages hair growth and helps minimize hair loss and thinning. Possesses anti-inflammatory, antimicrobial, and antiseptic properties that promote scalp health. Enhances blood circulation in the scalp and balances natural oil secretion. Functions as a natural insect repellent against lice, fleas, ticks, and mosquitoes. Commonly incorporated into cosmetic products, aromatherapy blends, and skincare formulations due to its calming scent and restorative benefits [30].

Figure : 10 Lavender oil

METHODOLOGY

1. PREPARATION OF HIBISCUS EXTRACT

In a beaker, add 5g dried hibiscus petals in 50ml of water. Boiled for 20-30minutes, cooled. Filtered and 10 ml extract collected

Figure : 11 Hibiscus extract

2. PREPARATION OF FENUGREEK EXTRACT

Take 5 g of flaxseeds in a beaker containing 50 ml of water. Heat the mixture for about 20–30 minutes, allow it to cool, and then filter to obtain 10 ml of extract.

Figure: 12 Fenugreek extract

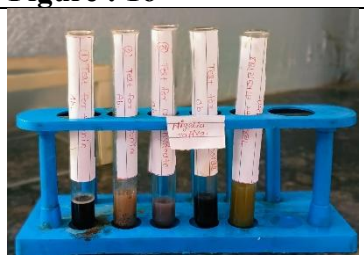
3. PREPARATION OF NIGELLA SATIVA EXTRACT

Take 5 g of nigella sativa in a beaker containing 50 ml of water. Heat the mixture for about 20–30 minutes, allow it to cool, and then filter to obtain 10 ml of extract.

Figure: 13 Nigella Sativa extract

PHYTOCHEMICAL SCREENING OF SELECTED PLANT EXTRACTS

Sr. No.	Plant Name	Phytochemical Test	Procedure	Observation	Inference	Observed images
1	Hibiscus	Tannin Test	1 ml of extract was treated with 2 ml of 5% ferric chloride solution and	Development of a bluish-green coloration	Indicates the presence of tannins	 **Figure: 14**

			mixed gently.			
2	Fenugreek	Saponin Test	2 ml of extract was diluted with an equal volume of distilled water and vigorously shaken for 15 minutes.	Stable frothing layer appeared on the surface	Confirms the presence of saponins	 **Figure: 15**
3	Flaxseed	Flavonoid Test	2 ml of extract was mixed with 1 ml of 2N sodium hydroxide solution.	Formation of a yellow coloration	Reveals the presence of flavonoids	 **Figure : 16**
4	Nigella sativa	Alkaloid Test	2 ml of extract was acidified with concentrated HCl and a few drops of Mayer's	Appearance of a white precipitate	Indicates alkaloid compounds	 **Figure 17**

PREPARATION OF HERBAL HAIR SERUM

1. **Selection of Solvent**: Distilled water was used as the extraction solvent for all plant materials.
2. **Flaxseed Extract Preparation:**

   5 g flaxseeds were boiled in 50 mL distilled water (70–80°C) for 20–30 minutes with stirring until a mucilage-like gel formed, then filtered and 10 mL extract collected.
3. **Fenugreek Extract Preparation:**

   5 g fenugreek seeds were extracted with 50 mL distilled water for 30 minutes, filtered, and 10 mL extract collected.
4. **Hibiscus Extract Preparation:**

   5 g dried hibiscus petals were boiled in 50 mL hot distilled water for 20–30 minutes, cooled, filtered, and 10 mL extract collected.
5. **Nigella sativa Extract Preparation:**

5 g *Nigella sativa* seeds were lightly crushed, boiled with 50 mL hot distilled water (70–80°C) for 30 minutes, filtered, and 10 mL extract collected.

6. **Base Preparation:**

A clean 100 mL beaker was used. A larger quantity of aloe vera gel (around 50–60 mL) and a smaller amount of distilled water (about 20–30 mL) were taken to prepare a thick, stable serum base.

7. **Mixing of Base:**

The gel and water were stirred using a glass rod or magnetic stirrer until a smooth, uniform consistency was achieved.

8. **Addition of Plant Extracts:**

2 mL each of flaxseed, fenugreek, hibiscus, and *Nigella sativa* extracts were added successively, stirring well after each addition.

9. **Addition of Functional Ingredients:**

0.5 mL vitamin E oil, 0.8 mL lavender oil, and 0.2 g sodium benzoate were incorporated and stirred until completely dissolved.

10. **Storage:**

The final uniform herbal hair serum was transferred to an airtight amber bottle and stored under refrigeration until further use.

FORMULATION TABLE

Sr.no	Ingredient	F1	F2	F3	F4	F5
	Flaxseed Extract	2 ml	3 ml	4 ml	5 ml	6 ml
	Fenugreek Extract	2 ml	3 ml	4 ml	5 ml	6 ml
	Hibiscus Extract	2 ml	3 ml	4 ml	5 ml	6 ml
	Nigella sativa Oil	2 ml	3 ml	4 ml	5 ml	6 ml
	Aloe Vera Gel	40 ml	45 ml	50 ml	55 ml	60 ml
	Vitamin E	0.5 ml	0.5 ml	0.5 ml	0.5 ml	0.5 ml
	Lavender Oil	0.3 ml	0.3 ml	0.3 ml	0.3 ml	0.3 ml
	Sodium Benzoate	0.2 g	0.2 g	0.2 g	0.2 g	0.2 g
	Distilled Water (Q.S.)	to 100 ml (approx. 51.0 ml)	to 100 ml (approx. 44.9 ml)	to 100 ml (approx. 38.8 ml)	to 100 ml (approx. 32.7 ml)	to 100 ml (approx. 26.6 ml)

Figure:18 Batches of formulation

EVALUATION PARAMETERS OF FORMULATED HERBAL HAIR SERUM

1. Physical Appearance :-

The formulated herbal hair serums (F1-F5) were visually assessed for their color, clarity, consistency, and overall appearance. The sample were observed under natural daylight to confirm uniformity and to ensure the absence of phase or visible particles.

2. Homogeneity Test :-

A small amount of each serum was placed on a clean glass slide and covered with a coverslip. The samples were examined for uniform texture and to check for the presence of lumps, coarse particles, or aggregates. A smooth and consistent surface indicated good homogeneity.

3. pH Determination :-

The pH of the formulation was measured using a calibrated digital pH meter at room temperature. About 10ml of each sample was transferred into a beaker and the electrode was immersed until a stable reading was obtained. The pH values were recorded to confirm compatibility with scalp and hair (ideal range 4.5-6.5).

Figure: 19 brookfield viscometer

4. Viscosity :-

The viscosity of the prepared serums was determined using Brookfield viscometer fitted with a spindle number 6. Approximately 50 ml of each formulation was taken in a beaker, and the readings were noted at different rotational speeds(10,20,50 and 100 rpm). The average viscosity was used to evaluate consistency.

5. Spreadability :-

A small quantity of the formulation was placed between two slides, and a known weight was applied. The time required for the slides to move apart was recorded. Lesser separation time indicated better spreadability and ease of application.

6. Washability :-

A small amount of the serum was applied on the skin surface and rinsed with water to test removability. Formulation that could be easily washed off without leaving any sticky residue were considered satisfactory.

7. Globular size determination :-

Under the microscope. It should have a small globule size range for easy absorption.

8. Skin Irritation Test:

After applying the serum to the skin, it is checked for any redness or itching after two hours.

9.Sensitivity Test:

The procedure involves putting the serum to the skin, exposing it to sunlight for 10 minutes, and checking for rashes or itching.

RESULT AND DISCUSSION :-

1. Physical appearance :-

The physical appearance, odor and texture of the prepared herbal hair serum are visually tested

Parameter	Batch F1	Batch F2	Batch F3	Batch F4	Batch F5
Colour	Light Greenish yellow	Greenish Yellow	Greenish Brown	Dark Greenish Brown	Deep Olive Green
Odor	Mild Lavender	Mild Lavender	Lavender Scent	Pleasant Lavender	Strong Lavender
Texture	Smooth	Smooth	Smooth	Smooth	Smooth

Table 1:- The physical appearance, odor and texture of the prepared herbal hair serum.

2. pH, Homogeneity and Spreadability Test :-

The pH scale is used to specify the acidity basicity of a product in order to ensure that it is safe to use.

Parameter	Batch F1	Batch F2	Batch F3	Batch F4	Batch F5
pH	5.7±0.05	5.8±0.02	5.9±0.04	6.0±0.03	6.1±0.02

Homogeneity	Uniform, no lumps	Clear and uniform	Homogeneous	Homogeneous	Uniform and Stable
Spreadability	6.2 ± 0.1	6.5 ± 0.2	6.7 ± 0.1	6.8 ± 0.1	7.0 ± 0.1

Table 2 :- pH, Homogeneity and Spreadability Test

3. Viscosity

RPM	10 rpm	20 rpm	50rpm	100rpm
CPS	6700± 5	2950 ± 4	1760 ± 6	1110 ± 5

Table 3 :- Viscosity of the prepared herbal hair serum at different rotational speeds.

CONCLUSION :-

All the evaluated parameters of the prepared herbal hair serum were found to be within acceptable limits, confirming its desirable quality and stability. The formulation, enriched with multiple beneficial herbal ingredients, is expected to promote healthy hair growth, delay premature greying, and nourish the scalp by maintaining the normal function of sebaceous glands. The growing preference for herbal cosmetics in the personal care and hygiene sector highlights the increasing consumer trust in natural formulations. Consequently, herbal cosmeceuticals continue to gain prominence in the cosmetic industry, offering safer and more sustainable alternatives for effective hair and skin care.

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