

FORMULATION AND EVALUATION OF HERBAL HAIR SERUM BY USING FLAXSEED, MORINGA, AND ROSEMARY EXTRACTS

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➤ Abstract

• **Background:** - Hair disorders including alopecia, dandruff, split ends, and premature greying represent significant cosmetic and dermatological concerns. Synthetic hair care products often contain harsh chemicals that may cause adverse effects, necessitating the development of safe, effective herbal alternatives. Objective: - The present study was aimed to formulate and evaluate a herbal hair serum incorporating flaxseed (*Linum usitatissimum*), moringa (*Moringa oleifera*), and rosemary (*Rosmarinus officinalis*) extracts for promoting healthy hair growth, reducing hair fall, improving scalp nourishment, and enhancing hair shine and strength.

• **Keywords:** - Herbal hair serum, *Linum usitatissimum*, *Moringa oleifera*, *Rosmarinus officinalis*, Phytochemical screening, Hair care formulation, Stability studies.

➤ INTRODUCTION

Flaxseed, also known as linseed, has emerged as a highly valued ingredient in the development of functional foods due to its exceptional nutritional composition and wide range of health benefits. It is particularly rich in alpha-linolenic acid [ALA], a plant-based omega-3 fatty acid that plays a crucial role in maintaining overall physiological health. In addition to ALA, flaxseed contains significant amounts of lignans—phytoestrogen compounds with antioxidant properties—as well as both soluble and insoluble dietary fiber. Together, these bioactive components contribute to improved metabolic function, cardiovascular health, and enhanced immune response^[1].

Lignans present in flaxseed also play an important role in hair health due to their antioxidant and mild estrogenic properties. These compounds help neutralize free radicals, which can otherwise damage hair follicles and accelerate hair aging. By supporting hormonal balance, lignans may also help address hair loss associated with hormonal fluctuations^[2].

➤ Material and method

➤ MATERIALS AND METHODS

Materials:

The following materials were used for the formulation and evaluation of the herbal hair serum:

Plant Materials: Flaxseeds (*Linum usitatissimum*), moringa leaves (*Moringa oleifera*), and rosemary leaves (*Rosmarinus officinalis*) were procured from authenticated sources^[10].

Chemicals and Reagents:

Distilled water, glycerin, rose oil, sodium benzoate, vitamin E capsules, citric acid, ruthenium red solution, Molisch reagent, concentrated sulfuric acid, sodium hydroxide, copper sulfate, ferric chloride, Sudan III stain, Mayer's reagent, magnesium turnings, hydrochloric acid, and other analytical grade reagents^[12].

Apparatus:

Three 100 mL beakers, spatula, stirrer, measuring cylinder, magnetic stirrer, heating mantle, weighing balance, pH meter, viscometer, and muslin cloth^[13].

➤ Methods And Preparation of Extracts^{[12] [13]}**1. Extraction of Flaxseed Extract:**

Exactly 2 g of flaxseed was accurately weighed and transferred to a beaker. Thirty-five millilitres of distilled water was added, and the mixture was boiled for 10 minutes with continuous stirring. The hot extract was filtered through muslin cloth, and the filtrate was collected. The yield obtained was approximately 4 ml^{[12] [13]}.

**Extraction of Flaxseed Extract****2. Extraction of Moringa Extract:**

Exactly 2 g of dried moringa leaves was accurately weighed and transferred to a beaker. Twenty millilitres of distilled water was added, and the mixture was boiled for 10 minutes. The extract was filtered through muslin cloth, yielding approximately 3ml of filtrate^[12].



Extraction of Moringa Extract

3. Extraction of Rosemary Extract:

Exactly 2 g of dried rosemary leaves was accurately weighed and transferred to a beaker. Twenty millilitres of distilled water was added, and the mixture was boiled for 10 minutes. The extract was filtered through muslin cloth, yielding approximately 3 ml of filtrate^[13].



Extraction of Rosemary Extract

4. Preparation of Base:

A glycerin-water base was prepared in a 1:4 ratio. The total quantity of base used was 5–6 mL for the 15 mL formulation.

➤ Formulation of Herbal Hair Serum^{[14][15]}

Three formulations (F1, F2, and F3) were prepared with varying concentrations of the active extracts.

Table 1. Formulation Composition of Herbal Hair Serum

Sr no.	Ingredients	F1	F2	F3	Category
1	Flaxseeds	1.5ml	2ml	1ml	Hair conditioning agent
2	Moringa	1.5ml	2ml	1ml	Nourishing agent/ protein source
3	Rosemary	1.5ml	2ml	1ml	Hair growth promoter
4	Glycerin	2.25ml	2ml	2.75	Humectant
5	Rose oil	0.25ml	0.25ml	0.25ml	Fragrance
6	Sodium benzoate	0.05%	0.05%	0.05%	Preservative
7	Vitamin E Capsule	0.475 ml	0.5 ml	0.575 ml	Preservative
8	Citric acid	q. s	q. s	q. s	pH adjusts
9	Water	q. s	q. s	q. s	Base

➤ Requirement^[15]: -

1. Ingredients: -

Flaxseed, Moringa, Rosemary, Glycerin, Rose Oil, Sodium Benzoate, Vitamin E Capsule, Citric Acid.

2. Apparatus: -

Three 100 ml Beaker, Spatula, Stirrer, Measuring Cylinder.

3. Instruments: -

Magnetic Stirrer, Heating Mantel, Weighing Scale.

➤ Formulation Procedure:

The herbal hair serum was prepared by first extracting flaxseed, moringa, and rosemary separately using aqueous extraction methods as described previously. The prepared extracts were filtered through muslin cloth to remove any insoluble particles and obtain clear filtrates. Measured quantities of each extract were then transferred into a clean beaker and mixed thoroughly using a magnetic stirrer to ensure uniform blending of the active herbal constituents.

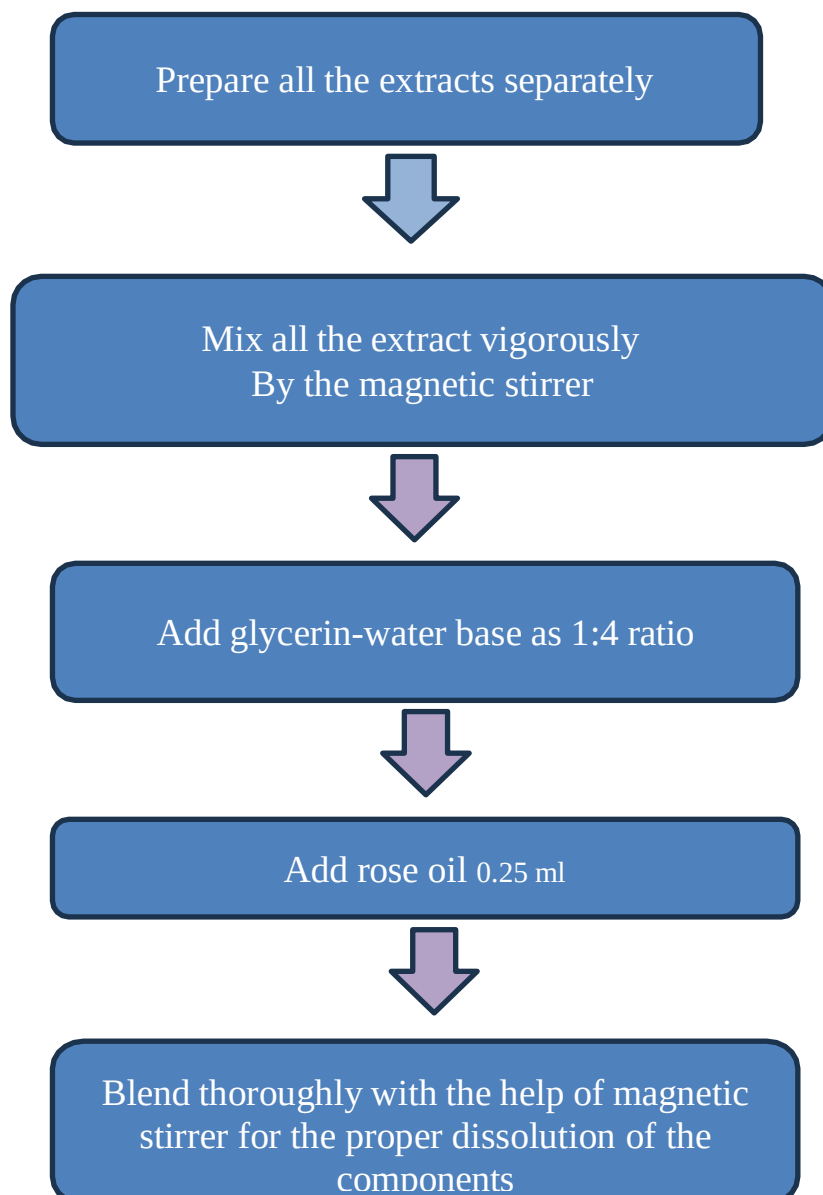
A glycerin-water base was prepared separately in a ratio of 1:4 and added slowly to the mixed extracts with continuous stirring. Glycerin acted as a humectant and provided moisturizing properties to the formulation. Rose oil (0.25 mL) was incorporated into the mixture as a fragrance enhancer and to improve the overall acceptability of the serum.

The formulation was continuously stirred to obtain a smooth, homogeneous, and non-greasy preparation.

The pH of the serum was carefully adjusted to the range of 4–5 using citric acid in order to maintain scalp compatibility and prevent irritation. Sodium benzoate (0.05%) was added as a preservative to protect the formulation from microbial contamination, while

vitamin E was incorporated as an antioxidant to improve stability and prevent oxidative degradation of the herbal constituents. The final formulation was mixed thoroughly until a uniform consistency was achieved and then stored in clean, airtight containers for further evaluation studies.

• Formulation Procedure of the Hair Serum



➤ Evaluation Parameters ^{[17][18]}: -

➤ Organoleptic Properties

The formulated serum was evaluated for physical appearance, colour, odour, texture, and homogeneity by visual observation. The presence of coarse particles and consistency were assessed to determine texture and homogeneity. Skin feel, including oiliness and greasiness, was also evaluated.

➤ Measurement of pH

The pH of the hair serum was measured using a calibrated pH meter at room temperature. The acceptable pH range for hair care products was considered to be 4.0–5.5 to maintain the acid mantle of the scalp and prevent irritation.

➤ Viscosity Determination

Viscosity was determined using an Ostwald viscometer at 25°C. The following data were used for calculation:

- Viscosity of water at 25°C (η_2): 0.89 cP
- Density of water (ρ_2): 1.0 g/cm³
- Density of hair serum (ρ_1): 1.05 g/cm³
- Time for water (t_2): 50 sec
- Time for hair serum (t_1): 420 sec

The viscosity was calculated using the formula:

$$\eta_1 = (\eta_2 \times \rho_1 \times t_1) / (\rho_2 \times t_2)$$

$$\eta_1 = (0.89 \times 1.05 \times 420) / (1.0 \times 50)$$

$$\eta_1 = (0.89 \times 441) / 50 \quad \eta_1 = 0.89 \times 8.82$$

$$\eta_1 = 7.85 \text{ cP} \times 10$$

$$\eta_1 = 78.5 \text{ cP}$$

➤ Skin Irritation Test

A small quantity of the serum was applied uniformly on a clean, dry area of the skin, preferably the inner forearm or behind the ear, and left undisturbed for 10 minutes. The area was observed for signs of irritation including redness, itching, burning sensation, swelling, rashes, or discomfort. After completion, the area was washed with water and examined for any delayed reaction.

➤ Spreadability Test

Spreadability was determined using the slide method. The formulation was sandwiched between two glass slides, and a standard load was applied. The spreading diameter was measured, and visual observations were made regarding the uniformity of layer formation. The following grading criteria were employed:

- **G (Good):** Homogeneous spread
- **I (Intermediate):** Moderate homogeneity
- **B (Bad):** Uneven spread

➤ Skin Sensitivity Test

The product was applied as a patch to the skin for 30 minutes, and the site was observed for reactions using the following criteria:

- **N:** No reaction
- **R:** Skin redness
- **I:** Irritation or itching

➤ Washability Test

A small amount of hair serum was applied on the hand and subsequently washed with tap water. The ease of removal was observed and recorded.

➤ Stability Studies

The formulated hair serum was evaluated for stability for 30 days under various temperature conditions:

- Room temperature: $25 \pm 2^\circ\text{C}$
- Accelerated temperature: $40 \pm 2^\circ\text{C}$ (oven)
- Refrigerated temperature: $5 \pm 2^\circ\text{C}$

Characteristics such as organoleptic properties (colour, odour, appearance), pH, and spreadability were evaluated on days 7, 15, and 30.

➤ Phytochemical Screening Of Phytochemical Plants

● Identification Tests for Flaxseed Extract ^[20] -

1. Ruthenium Red Test (Mucilage): A few drops of ruthenium red solution were added to the extract. The development of pink/red colour indicated the presence of mucilage, confirming the gel-forming property.

2. Molisch's Test (Carbohydrates): Molisch reagent was added followed by concentrated sulfuric acid along the sides of the test tube. A violet ring at the junction indicated the presence of carbohydrates (polysaccharides/mucilage).

3. Biuret Test (Proteins): Sodium hydroxide solution was added followed by copper sulfate solution. The development of violet colour indicated the presence of proteins.

4. Ferric Chloride Test (Phenols): A few drops of ferric chloride solution were added. The appearance of green/blue-black colour indicated the presence of phenolic compounds.

5. Sudan III Test (Lipids): Sudan III stain was added to the extract. The development of red/orange colour indicated the presence of lipids (omega fatty acids).

6. Viscosity/Gel Test: The extract was observed for thick gel formation and sticky/slimy texture, indicating high mucilage content.

➤ Identification Tests for Moringa Extract ^{[22][23]} -

1. Foam Test (Saponins): The extract was shaken vigorously with water. Stable foam formation indicated the presence of saponins.

2. Mayer's Test (Alkaloids): Mayer's reagent was added to the extract. The formation of cream/white precipitate indicated the presence of alkaloids.

3. Biuret Test (Proteins): Sodium hydroxide and copper sulfate solutions were added. Violet colour development indicated the presence of proteins.

4. Shinoda Test (Flavonoids): Magnesium turnings and concentrated hydrochloric acid were added to the extract. The appearance of pink/red colour indicated the presence of flavonoids.

➤ Identification Tests for Rosemary Extract ^{[22][23]}

1. Ferric Chloride Test (Phenols): A few drops of ferric chloride solution were added. Dark green/blue-black colour indicated the presence of phenols.

2. Shinoda Test (Flavonoids): Magnesium turnings and hydrochloric acid were added. Pink/red colour indicated the presence of flavonoid.

➤ Result

➤ Evaluation Test ^{[17][18]}: -

○ Organoleptic Properties: -

The formulation was examined for its physical appearance, colour, and odour characteristics.

These Characteristics were evaluated by physical Observation. Texture and homogeneity were tested. The presence of coarse particles and Consistency were used to evaluate the texture and homogeneity of the formulations Skin feel (including oily, greasiness) was also evaluated.

○ Measurement of pH: - (4–5)



Fig no.11

○ Skin Irritation Test: -

Skin irritation test is carried out by applying hair serum on the skin for 10 min. The skin irritation test was performed to evaluate the safety and suitability of the formulated herbal hair serum for topical application. A small quantity of the serum

was applied uniformly on a clean and dry area of the skin, preferably on the inner forearm or behind the ear, and left undisturbed for 10 minutes. During the test period, the applied area was carefully observed for any signs of irritation such as redness, itching, burning sensation, swelling, rashes, or discomfort. After completion of the test, the area was washed with water and further examined for any delayed reaction. The formulation showed no visible irritation, erythema, or allergic response, indicating that the prepared herbal hair serum is safe, gentle, and suitable for regular application on the scalp and hair.

○ Viscosity: - Formula Used

▪ Given Data

○ Viscosity of water at 25°C (η_2) = 0.89 cP

○ Density of water (ρ_2) = 1.0 g/cm³

- Density of hair serum (ρ_1) = 1.05 g/cm³
- Time for water (t_2) = 50 sec
- Time for hair serum (t_1) = 420 sec

▪ **Calculation**

nsample :- $0.89 \times 1.05 \times 420 / 1.0 \times 50$

nsample :- $0.89 \times 441 / 50$

nsample :- 0.89×8.82

nsample :- $7.85 \text{ cP} \times 10$

nsample :- 78.5 cP

○ **Test for Spreadability:** -

Spreadability is determined using a slide. The formulation is sandwiched between two blades and a load applied; the formulation has been spread on the slides. Visual inspection was carried out to evaluate the consistency and uniformity of the formed layer. The following standards were considered during the assessment:

G-Good: homogenous

I-Moderate homogeneity

B-Bad: uneven

○ **Skin Sensitivity:** -

This is done by applying the product as a patch to the skin for 30 minutes and observing for a reaction of

N-No reaction R-Skin redness

I-Imitation or itching

○ **Washability:** -

This test is carried out by applying a small amount of Hair serum on the hand and then washing it with tap water.

○ **Stability studies:** -

The formulation of the Hair serum has been evaluated for stability for 30 days under various temperature conditions mainly room temperature ($25 \pm 2^\circ \text{C}$), higher temperatures in the oven ($40 \pm 2^\circ \text{C}$) and refrigerator ($5 \pm 2^\circ \text{C}$). Characteristics such as organoleptic properties and Spreadability were evaluated days 7, 15, and 30.

➤ **Discussion**

The present study successfully formulated and evaluated a polyherbal hair serum incorporating three well-established botanicals—flaxseed, moringa, and rosemary—known for their beneficial effects on hair health. The formulation strategy was based on the complementary mechanisms of action of these

ingredients.

Flaxseed extract contributed mucilage and omega-3 fatty acids, which form a protective coating around the hair shaft, improve moisture retention, and enhance blood circulation to the follicles. The presence of mucilage was confirmed by the ruthenium red test and physical viscosity examination. The omega fatty acid content was substantiated by the Sudan III test. These findings align with the reported literature on flaxseed's conditioning and anti-inflammatory properties.

Moringa extract provided essential nutrients including vitamins, proteins, and minerals. The phytochemical screening confirmed the presence of saponins, alkaloids, proteins, and flavonoids. Moringa's high protein content (confirmed by biuret test) supports keratin production and hair strengthening, while its antioxidant vitamins C and E protect against oxidative stress-induced follicular damage. The antimicrobial properties of moringa saponins and alkaloids may contribute to scalp health by reducing dandruff and infections.

Rosemary extract, rich in rosmarinic acid and essential oils, was included for its circulatory stimulant and potential DHT-inhibitory properties. The presence of phenols and flavonoids was confirmed, supporting its antioxidant and anti-inflammatory roles. Previous studies have demonstrated rosemary's efficacy comparable to minoxidil in promoting hair growth with fewer side effects.

The combination of these extracts in a glycerin-water base provided a lightweight, non-greasy formulation. Glycerin served as an effective humectant, drawing moisture to the hair shaft, while the 1:4 glycerin-water ratio ensured optimal consistency without excessive viscosity. The pH of 4.5–5.0 was maintained to preserve the scalp's acid mantle and enhance cuticle sealing.

The viscosity of 78.5 cP was considered appropriate for a hair serum, allowing easy application without dripping or excessive thickness. The good spreadability grade confirmed uniform distribution across hair strands. The absence of skin irritation and sensitivity reactions, along with easy washability, indicated good cosmetic acceptability and safety.

Stability studies demonstrated that the formulation remained physically and chemically stable for 30 days under room temperature, refrigerated, and accelerated conditions. This stability may be attributed to the preservative action of sodium benzoate and the antioxidant protection provided by vitamin E, which prevented oxidative degradation of the active phytoconstituents.

The formulation approach aligns with contemporary trends in herbal cosmetics, where multi-extract formulations are preferred for synergistic effects. Patel et al. (2024) reported enhanced hair growth outcomes with combined flaxseed, rosemary, and moringa extracts compared to individual extracts, supporting the rationale for the present polyherbal approach.

➤ Conclusion

The aim of this study was to develop a herbal hair serum using flaxseed, moringa, and rosemary extracts for their beneficial properties in hair care. Flaxseed was incorporated for its conditioning and moisturizing effects, moringa served as a rich source of nutrients and proteins to nourish the hair, and rosemary was included for its antioxidant properties and potential to promote hair growth.

The prepared formulation was assessed using different physicochemical evaluation parameters such as appearance and other organoleptic properties, viscosity, pH, and spreadability. The results indicated that the serum possessed desirable properties such as appropriate consistency, ease of application, and acceptable sensory characteristics.

Based on the findings, it can be concluded that the herbal hair serum was successfully formulated using natural ingredients. The formulation demonstrated good stability under both room temperature and refrigerated conditions. Additionally, it was found to be safe for use, showing no signs of phase separation or degradation during the study period.

Overall, the developed herbal hair serum can be considered an effective and stable natural formulation for improving hair health and managing hair-related concerns.

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