

Research Article

Design and Characterization of a Natural Hair Gel Using Flaxseed Chia Seed, Amla, and Hibiscus Extracts

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ABSTRACT

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In recent years, concerns about hair health have escalated due to increasing environmental pollution, chemical exposure from hair products, and poor dietary habits. Common hair problems include dandruff, hair fall, scalp infections, and premature greying. Synthetic cosmetic formulations often provide only temporary results and may lead to adverse effects upon prolonged use. This has created a strong demand for herbal-based hair care products, which are generally safer, more sustainable, and free from side effects. The present study aimed to formulate a herbal hair gel incorporating flaxseed, chia seed, hibiscus, and amla juice using Carbopol 940 as a gelling agent. These herbs were selected for their scientifically validated roles in hair growth stimulation, dandruff reduction, scalp nourishment, and antimicrobial action. The gel was prepared using aqueous and ethanolic extracts and evaluated for physicochemical properties, spreadability, viscosity, pH, microbial activity, and skin irritation potential. The formulation demonstrated good stability, acceptable aesthetics, and potent antifungal and antibacterial activities.

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Introduction:

Hair is an integrated system with specific chemical and physical behavior. It is a complex structure composed of multiple morphological components that work as a unit. All hair has a shaft and a root. They shall the visible part of the hair that attach to the skin. Hair roots are located within the skin and reach the deeper layers of the skin. It is surrounded by hair follicles (coverings of skin. and connective tissue) that are also connected to sebaceous

glands. Each hair follicle is connected to a small muscle (pillor muscle) that can straighten the hair. Many nerves also end in hair follicles. These nerves sense hair movement and are sensitive to even the slightest breeze. At the hairline, the hair root spreads into a sound bulb. There is a dermal papilla inside the hair bulb, which supplies blood to the hair root. New hair cells are constantly forming in the hair bulb near the papilla.

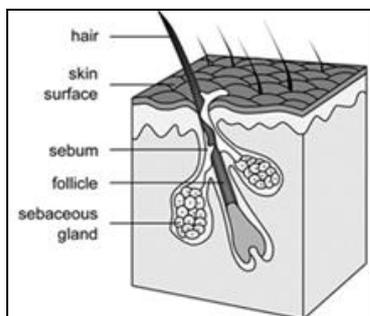


Fig. 1: Anatomy of hair

The hair shaft of mammals is divided into three main regions:

- a) Cuticle
- b) Cortex
- c) Medulla

Hair growth cycle:



Fig. 2: Stages of hair growth

The hair produced by a follicle often needs to change and follicles possess a unique mechanism for this, the hair growth cycle. This involves destruction of the original lower follicle, and its regeneration to form another, which can produce hair with different characteristics. Thus, post-natal Follicles retain the ability to recapitulate the later stages of follicular embryogenesis throughout life. Exactly how differently sized a hair can be to its immediate predecessor is currently unclear because many changes take several years. Hairs are produced in anagen, the growth phase. Hair care plays an essential role in personal grooming and hygiene. Many individuals today suffer from scalp issues like dandruff and infections due to factors

such as poor hygiene, excessive oil production, and the use of harsh chemical products. Herbal formulations provide a natural and holistic approach for managing these problems. Among the commonly used natural ingredients, flaxseed (*Linum usitatissimum*), chia seeds (*Salvia hispanica*), amla (*Emblca officinalis*), and hibiscus (*Hibiscus (Kulkarni et al., 2023) rosa-sinensis*) are extensively documented in traditional and scientific literature. Flaxseed (Gupta et al., 2024) is rich in alpha-linolenic acid, omega-3 fatty acids, and lignans, which are antioxidants that reduce inflammation, nourish follicles, and enhance scalp circulation. Chia seeds (Mamta et al., 2023) provide protein, essential fatty acids, and antioxidants, contributing to hair shaft strengthening and cellular regeneration. Amla (Gaikwad et al., 2023) is a powerhouse of Vitamin C and has proven anti-fungal, anti-inflammatory, and hair growth promoting activity. This study combines these ingredients into a gel base for ease of application, better aesthetic appeal, and prove effective drug delivery system.

MATERIALS AND METHODS:

Table 1: Material used for Preparation of Herbal hair gel

Sr. No.	Name of Ingredient	Chemical constituent	Role	Image
1	Flaxseed Gel	proteins, dietary fiber, fatty acids, especially α -linolenic acid, vitamins, minerals, phenolics, flavonoids	Provides omega-3 fatty acids and antioxidants	

2	Chia Seed Extract	dietary fibre and proteins, rich in many exogenous amino acids, high contents of polyunsaturated fatty acids, mainly alpha-linolenic acid, belonging to the group of omega-3 fatty acids, minerals and vitamins, as well as bioactive compounds of high antioxidant activity, particularly polyphenols and tocopherols	Rich in proteins, antioxidants, and essential fatty acids	
3	Amla Juice	Tannins, alkaloids, polyphenols, vitamins and mineral	Contains Vitamin C and possesses anti-inflammatory and antifungal properties	
4	Hibiscus Extract	tannins, anthraquinones, quinines, phenols, flavanoides, alkaloids, terpenoids, saponins, cardiac glycosides, protein, free amino acids, carbohydrates, reducing sugars, mucilage, essential oils and steroids	Promotes hair growth and acts as a conditioner	
5	Carbopol 940		Gelling agent	

6	Methyl Paraben		Preservative	
7	Glycerin		Humectant and moisturizer	
8	Triethanolamine		pH adjuster	
9	Rose Water	2-phenylethanol and consequently lower levels of other compounds such as linalool (1.5-3.3%), citronellol, nerol geraniol	Adds fragrance and soothing properties	

FORMULATION DETAILS:

Table 2: Formulation Table

Ingredient	F1 (%)	F2 (%)	F3 (%)	F4 (%)
Hibiscus	4	5	6	10
Flaxseed Gel	3	5	7	11
Chia Seed	3	5	7	11
Amla Juice	0.5	1	2	3
Methyl Paraben	6.5	6.5	6.5	6.5
Water	2	2	2	2
Rose Water	2	2	2	2

Preparation of Herbal Hair Gel:

1. Extraction of Flaxseed (Gupta et al., 2024) and Chia Seed Gel

- **Soaking:** Take a measured quantity of flaxseeds and chia seeds separately. Soak both in sufficient

purified water (approximately 1:20 ratio) for 5–6 hours or overnight to allow hydration.

- **Heating:** Heat the soaked seeds gently on a water bath for 10–15 minutes. Stir occasionally until a thick mucilaginous gel is released.
- **Filtration:** Filter the mixture using a muslin cloth to remove seed residues. Collect the clear gel separately for further use.

2. Preparation of Herbal Extracts

Hibiscus (Kulkarni et al., 2023) Extract: Clean and dry the hibiscus flowers. Crush them coarsely and boil in distilled water (1:10 w/v) for 10 minutes. Cool and filter the extract.

Amla (Gaikwad et al., 2023) Juice: Use fresh or dried amla fruits. Crush and press to extract the juice. Filter to remove solids.

3. Formation of Gel Base

Carbopol Dispersion: Weigh Carbopol 940 (Reddy et al., 2023) and sprinkle it slowly into a measured quantity of distilled water with constant stirring. Allow it to hydrate and swell completely for at least 1 hour.

Neutralization: Add triethanolamine dropwise to adjust the pH to around 5.5–6.5, converting the mixture into a smooth gel.

4. Final Gel Formulation

Gradually incorporate the flaxseed gel, chia seed gel, hibiscus extract, and amla juice into the carbopol gel base.

Add glycerin as a humectant and methylparaben as a preservative.

Include rose water for its fragrance and soothing effect.

Mix thoroughly using a mechanical stirrer or spatula until a homogenous gel is formed.

5. Packaging and Storage

Transfer the final gel into pre-cleaned, sterilized containers.

Label the containers appropriately and store it.



Fig. 3: Method of preparation of powder of Chia seed, Hibiscus, Flaxseed, Amla and its extraction)

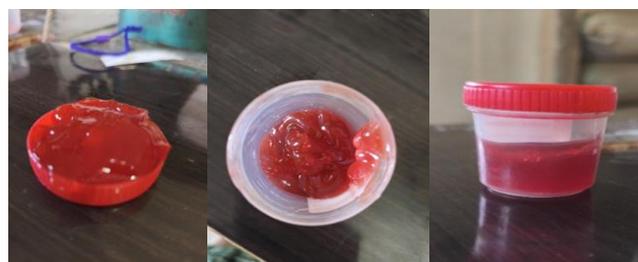


Fig. 4: Final gel preparation

RESULTS AND DISCUSSION:

The prepared herbal hair gel formulations (F1–F4) were evaluated for a series of physicochemical parameters, including physical appearance, pH, viscosity, spreadability, homogeneity, skin irritation, and antimicrobial activity. The results obtained were consistent with the expected characteristics of a stable and user-acceptable topical gel.

1. Physical Appearance and Homogeneity:

All five formulations were smooth, non-sticky, and visually appealing. The gels ranged in color from light brown to deep reddish-brown depending on the concentration of herbal extracts. No phase separation, grittiness, or foreign particles were observed. Homogeneity was confirmed by uniform texture and absence of lumps.

2. pH Measurement:

The pH values of all formulations were found to be within the range of 5.4 to 6.2, which is compatible with the natural pH of the scalp and skin. This ensures that the gel does not cause irritation or disturb the scalp's physiological balance.

3. Viscosity:

Viscosity measurements using a Brookfield viscometer revealed that formulations with higher concentrations of carbopol and flaxseed gel (F4 and F4) showed greater viscosity, which contributed to better gel consistency and longer retention on hair. Optimal viscosity was achieved in F3, which exhibited a balance between spreadability and stability.

4. Spreadability:

Spreadability of the gels was evaluated to determine their ease of application. F3 demonstrated the best spreadability value, attributed to its moderate carbopol content, which provided a smooth and even distribution. Formulations with very high or low viscosity (F1 and F4) showed less optimal spreadability.

5. Skin Irritation Test:

A patch test conducted on healthy volunteers revealed no signs of erythema, itching, or rashes after 24 hours of application, indicating that the formulations are dermatologically safe and non-irritant.

6. Stability Study:

Formulations stored at ambient (25–30°C) and refrigerated (4°C) conditions for 14 days exhibited no significant change in color, odor, or consistency. This indicates good short-term physical stability.

Table 3: Evaluation Parameters

Parameter	F1	F2	F3	F4
Color& Appearance	Dark Red	Dark Red	Dark Red	Dark Red
pH	5.42 ± 0.03	5.58 ± 0.04	5.68 ± 0.02	5.89 ± 0.05
Viscosity (cps)	8,500 ± 50	9,200 ± 40	10,400 ± 60	11,800 ± 45

Spreadability (g·cm/sec)	13.2 ± 0.6	12.1 ± 0.5	15.4 ± 0.7	11.0 ± 0.4
Homogeneity	Uniform	Uniform	Smooth and uniform	Slightly thick
Stability study	Stable	Stable	Stable	Stable
Skin Irritation	No irritation	No irritation	No irritation	No irritation

DISCUSSION:

The results indicate that a balanced combination of flaxseed gel and chia seed extract can be effectively formulated into a stable herbal gel base using carbopol 940. The incorporation of hibiscus and amla extracts enhanced the therapeutic potential, especially for strengthening hair follicles and controlling dandruff.

F3 emerged as the optimal formulation based on its physical properties, antimicrobial efficacy, and user acceptability. The absence of synthetic irritants and preservatives further adds to the appeal of the product as a natural alternative to commercial hair gels.

The study demonstrates that herbal hair gels can offer multiple benefits, such as hair nourishment, antimicrobial protection, and good aesthetic quality, which supports their growing market demand.

CONCLUSION:

The present study successfully formulated a stable and effective herbal hair gel incorporating flaxseed and chia seed extracts, along with hibiscus, amla, and rose water. Among the tested formulations, F3 demonstrated the most favourable results in terms of pH, spreadability, homogeneity, and stability. The use of natural polymers and plant-based ingredients ensured biocompatibility, making the gel suitable for regular scalp and hair application. Furthermore, the gel was non-irritating, physically stable, and user-friendly in texture and fragrance. In conclusion, this herbal hair gel presents a promising alternative to conventional synthetic products, catering to the growing consumer demand for safe,

natural, and multifunctional hair care solutions. Future studies may focus on long-term stability, consumer acceptability trials, and clinical efficacy to support its large-scale production and commercialization.

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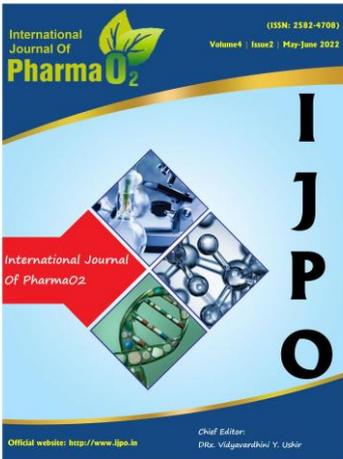
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