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Formulation and Evaluation of Herbal Hair Gel

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Abstract: Herbal hair gels are chemical-free products that promote hair health. It aims to nourish the scalp, moisturize hair, reduce hair fall, promote growth, and address scalp issues like dandruff. Herbal gels offer styling benefits without damaging the hair and are suitable for various hair types. Additionally, they focus on using environmentally sustainable, biodegradable ingredients. The main objective of present work is to formulate and evaluate herbal hair gel containing flax seed and curry leaf extract. Extracts from flax seed and curry leaves were obtained through aqueous extraction. Formulation of herbal hair gel was done by varying drug concentration of ingredients as F1–F5. Methyl paraben was used as preservative, Triethanolamine use as pH adjuster in formulation. Five different gel formulations, with varying concentrations of these extracts, were prepared and evaluated. The formulations F1 to F5 were analyzed based on following parameters colour, odor, texture, clarity, pH, viscosity, spread ability, extrudability, gel strength, homogeneity, stability, washability, antimicrobial activity and antifungal activity. Consistency testing confirmed that the gel spreads evenly and provides a lightweight feel without leaving a sticky residue. The pH level helps prevent scalp irritation and maintains the natural hair balance, promoting healthier hair. Viscosity testing verified that the gel was neither too runny nor overly thick, making it suitable for both styling and conditioning purposes. The herbal hair gel formulation demonstrated good texture, stability, and sensory appeal, with a balanced pH and effective hair and scalp benefits. These results indicate that the product meets quality standards for a natural, non-irritating hair styling solution suitable for regular use.

Keywords: Flaxseed, Curry leaf, Hair Gel, Hair Growth.

Introduction

Hair care is an essential part of personal hygiene and overall health. Healthy hair not only enhances physical appearance but also reflects a person's nutritional status, lifestyle, and general well-being. Hair is considered one of the most important features contributing to beauty and self-confidence. Proper hair care practices help maintain the strength, shine, texture, and growth of hair while preventing common problems such as dandruff, hair fall, split ends, dryness, and scalp infections. Hair care involves cleansing, conditioning, nourishing, protecting, and maintaining both the scalp and hair fibers. In modern life, environmental pollution, stress, poor diet, irregular sleep, and excessive use of chemical products have greatly affected hair health. Therefore, maintaining a proper hair care routine has become increasingly important.

Hair care is essential for maintaining healthy, strong, and beautiful hair. It helps prevent damage and breakage, supports scalp health, promotes hair growth, and improves hair texture and appearance. Good hair care routines also reduce hair loss, protect against environmental damage, and make hair easier to style. Beyond physical benefits, caring for hair boosts confidence and self-esteem, as healthy hair

enhances overall appearance and personal expression Hair damage is caused by factors like excessive heat styling, chemical treatments, environmental exposure, harsh products, and lack of moisture. Poor diet, rough handling, and health issues also weaken hair, making it more prone to breakage, dryness, and dullness. Reducing these damaging factors helps maintain healthier, stronger hair. *Malassezia furfur*, *Candida albicans*, ringworms etc. can cause various scalp problems like Dandruff, Red or Purple rashes, cracks, patches, white flaky scales etc.¹ the beauty and personal care sector have seen a notable movement in favor of natural and herbal products in recent years. This trend is particularly pronounced in hair care, where consumers are increasingly seeking alternatives to synthetic formulations. Herbal hair care products derived from plant-based ingredients, have gained popularity due to their perceived safety, reduced side effects, and potential for providing multiple benefits to hair and scalp health.² Herbal hair gels offer a natural alternative to chemical based styling products. They use plant-based ingredients that nourish and strengthen hair while minimizing irritation and damage. These gels are free from harmful chemicals, provide hydration, reduce frizz, and are more eco-friendly³. Herbal gels are great for those looking to style their hair while also promoting hair health and being kind to the environment. Most topical gels utilize organic polymers, giving them an attractive, clear appearance. These semisolid preparations are typically applied to the skin to deliver medications, act as emollients, or provide protective barriers⁴. The global market for natural and organic personal care products, including haircare, has been growing steadily, with projections indicating continued expansion. This growth is driven by increasing consumer awareness of the potential harmful effects of certain synthetic ingredients, as well as a broader trend towards sustainable and environmentally friendly products.

Hair has been valued since ancient times, and different cultures developed various methods to keep hair healthy and attractive. Traditional hair care methods mainly involve the use of natural herbs, oils, and plant-based ingredients such as coconut oil, aloe vera, hibiscus, amla, shikakai, fenugreek, and flaxseed and curry leaves. These natural remedies were commonly used to improve hair growth, reduce hair fall, and maintain scalp health. In recent years, scientific advancements have led to the development of many hair care products including shampoos, conditioners, hair serums, hair masks, and medicated treatments. Although modern products are widely available, herbal ingredients continue to remain popular because they are considered safe, effective, economical, and suitable for long-term use.

Hair is mainly composed of a protein called keratin and grows from hair follicles present in the scalp. Each strand of hair consists of three layers known as the cuticle, cortex, and medulla. The cuticle is the outer protective layer that gives hair shine and smoothness. The cortex forms the major portion of the hair and is responsible for its strength, elasticity, and color. The medulla is the innermost layer that provides structural support. Hair follicles are nourished by blood vessels and supported by sebaceous glands that produce natural oils called sebum. Sebum helps keep the scalp moisturized and protects hair from dryness and damage. Healthy hair growth occurs through different stages known as the anagen, catagen, and telogen phases.

Hair care is important not only for cosmetic purposes but also for maintaining scalp health and preventing disorders. A healthy scalp provides a suitable environment for strong hair growth. Poor scalp hygiene can lead to dandruff, itching, infections, irritation, and excessive hair loss. Regular cleansing of the scalp helps remove dirt, oil, sweat, and dead skin cells. Conditioning improves hair softness and reduces dryness, while regular oil massage improves blood circulation and nourishes the hair roots. Gentle combing, natural drying, and protection from excessive heat and pollution also contribute to maintaining healthy hair.

Different people have different hair types such as normal, dry, oily, curly, straight, and combination hair. Each hair type requires specific care and suitable products. Dry hair lacks moisture and appears rough and dull, while oily hair results from excessive sebum production and appears greasy. Curly hair tends to become dry and frizzy because natural oils do not spread evenly along the hair shaft. Straight hair usually appears smoother and shinier because oils are distributed more evenly. Understanding hair type is essential for selecting appropriate shampoos, conditioners, oils, and treatments.

Several internal and external factors affect hair health. Nutrition plays a major role in hair growth and strength because hair requires proteins, vitamins, minerals, and essential fatty acids. Deficiency of nutrients such as iron, zinc, biotin, and vitamins may lead to hair thinning and hair fall. Stress is another important factor that can disturb the hair growth cycle and increase hair shedding. Hormonal changes, medical conditions, pollution, chemical treatments, and excessive heat styling can also damage hair. Frequent use of hair dyes, bleaching agents, straighteners, and curling tools weakens the hair structure and causes dryness and breakage.

A proper daily hair care routine is necessary to maintain healthy hair. Hair should be washed regularly using a mild shampoo suitable for the individual's hair type. Over washing should be avoided because it can remove natural oils from the scalp. Conditioners help restore moisture and make hair smooth and manageable. Oiling the scalp using natural oils such as coconut oil, almond oil, castor oil, or olive oil nourishes the hair roots and improves scalp health. Hair should be combed gently using a wide-toothed comb to avoid unnecessary breakage. Excessive use of hair dryers and straighteners should be minimized, and hair should be protected from direct sunlight, dust, and pollution.

Nutrition is one of the most important aspects of hair care. Hair is mainly made of keratin protein, and therefore adequate protein intake is necessary for healthy hair growth. Vitamins such as Vitamin A, Vitamin C, Vitamin D, Vitamin E, and Biotin support scalp health and strengthen hair follicles. Minerals like iron, zinc, magnesium, and selenium are also essential for maintaining healthy hair. Drinking sufficient water helps maintain moisture balance in the scalp and prevents dryness. A balanced diet rich in fruits, vegetables, nuts, seeds, milk, eggs, and green leafy vegetables supports healthy hair growth.

Many individuals experience common hair problems such as dandruff, hair fall, split ends, dry hair, oily scalp, and premature greying. Dandruff is characterized by white flakes and itching of the scalp, often caused by fungal growth or dryness. Hair fall may result from stress, poor nutrition, hormonal imbalance, infections, or medical conditions. Split ends occur when the outer protective cuticle becomes damaged. Premature greying may occur due to genetics, nutritional deficiencies, stress, and lifestyle factors. Early care and proper treatment can help reduce these problems and improve overall health.

Herbal hair care has gained great popularity because of its natural and safe approach. Herbal ingredients nourish the hair deeply and have fewer side effects compared to synthetic chemicals. Common herbal ingredients used in hair care include amla, aloe vera, hibiscus, neem, fenugreek, bhringraj, curry leaves, and flaxseed. These herbs provide vitamins, antioxidants, and essential nutrients that improve scalp health and support hair growth. Herbal oils, shampoos, hair masks, and conditioners are commonly used in both traditional and modern cosmetic preparations.

Flaxseed is one of the most beneficial natural ingredients used in hair care. It is rich in omega-3 fatty acids, proteins, Vitamin E, antioxidants, and lignans that nourish the hair and scalp. Flaxseed promotes healthy hair growth by improving blood circulation and strengthening hair follicles. It helps reduce hair fall, dryness, and breakage while improving hair texture and shine. Flaxseed gel, prepared by boiling flaxseeds in water, is widely used as a natural hair styling gel and conditioner. Its moisturizing and anti-inflammatory properties help soothe scalp irritation and maintain hydration.

Curry leaves are another valuable herbal ingredient widely used in traditional hair care remedies. Curry leaves contain proteins, iron, calcium, antioxidants, and vitamins that strengthen hair roots and improve scalp health. Regular use of curry leaves helps reduce hair fall and delays premature greying by preserving natural hair pigment. Curry leaves also possess antimicrobial properties that help reduce dandruff and scalp infections. They are commonly used in the preparation of hair oils, hair masks, herbal pastes, and shampoos.

Various hair care products are available today to support different hair needs. Shampoos help cleanse the scalp and remove dirt, sweat, and excess oil. Conditioners improve softness and reduce tangling. Hair oils nourish the scalp and improve blood circulation, while serums help reduce frizz and provide shine. Hair masks deeply nourish damaged hair and restore moisture. Medicated products are also available for treating dandruff, fungal infections, and hair loss. Selection of hair care products should depend on the individual's hair type and scalp condition.

Modern cosmetology and dermatology have introduced advanced methods for hair care and treatment. Hair spa treatments improve scalp health and repair damaged hair. Keratin treatments help smoothen and strengthen hair, while hair transplantation is used to treat baldness. Low-level laser therapy and platelet-rich plasma therapy are modern techniques used to stimulate hair growth. Although these treatments can provide benefits, they should be performed carefully under professional supervision.

Maintaining healthy hair requires proper preventive measures and healthy habits. A balanced diet, adequate water intake, regular scalp hygiene, stress management, and proper sleep are important for hair health. Excessive use of chemicals and heat styling tools should be avoided. Regular trimming helps reduce split ends, and natural oils and herbal products can improve hair strength and texture. Protecting hair from pollution and sunlight also prevents damage.

Aim

The aim of the study is to formulate and evaluate an herbal hair gel using natural ingredients for promoting hair health, nourishment and styling.

Objectives

The main objective of study is to prepare Herbal hair gel using herbal extracts.

To study the properties of the prepared gel.

To evaluate parameters such as pH, viscosity, spreadability, and stability

To provide a safe and natural alternative to chemical based hair gels.

Plan of Work

Literature survey

Collection of materials

Preparation of Herbal extracts

Formulation of Herbal hair gel

Evaluation of Herbal hair gel

Data collection and analysis

Materials

List of Materials

Table 1: List of Materials

S.No	NAME OF THE PRODUCT	NAME OF THE SUPPLIER
1	Flax seeds	Local shops
2	Curry leaves	Local shops
3	PEG	
4	Methyl Paraben	
5	Glycerin	
6	Triethanolamine	
7	Carbopol	

List of Equipment's

Table 2: List of Equipment's

S.No	EQUIPMENT	MANUFACTURE
1	Conical Flasks	Garg process glass India private limited Mumbai
2	Test Tubes	Garg process glass India private limited Mumbai
3	Agar plates	Origin innovations
4	Homogenizer	
5	Electric water bath	

Methodology

Collection of plant material

The plant *Murraya koenigii* was collected from the surrounding agricultural area of Mahabubnagar, the fresh leaves were separated from the plant, and Flax seeds were procured from local shops and used for extraction.

Table 3: Materials used in herbal hair gel

S.No	INGREDIENTS	ROLE
1	Curry leaves	Strengthening of hair
2	Flaxseed	Hydration and moisture
3	PEG	Gelling agent, emulsifier
4	Methyl paraben	Preservative

5	Glycerin	Moisture
6	Triethanolamine	Thickening agent
7	Carbopol	Gelling agent
8	Distilled water	Vehicle

Preparation of Flaxseed Extract

The flaxseed extract was prepared by weighing suitable quantity of flaxseed and added to a beaker and pour in distilled water⁶. Boil it, a thick mucilage was obtained by constant stirring. Cover the beaker with foil paper. Place the beaker at room temperature or lower temperature. After that, strain the mixture through a cheese cloth or fine mesh strainer into a clean beaker. Store the extract in a clean, air-tight container in a cool place.

Preparation of curry leaves extract

The curry leaves extract was prepared by weighing suitable quantity of curry leaf and added to a beaker and pour in distilled water⁷. Boil it & cover the beaker with foil paper. Place the beaker at room temperature or lower temperature. After that, strain the mixture through a filter paper into a clean beaker. Store the extract in a clean, air-tight container in a cool place.

Preparation of Hair gel

Five herbal hair gel formulations were prepared by using varying number of herbal extracts. Weighed quantity of methyl paraben, polyethylene glycol and glycerin were dissolved in water and incorporated to Carbopol⁸. Using magnetic stirrer, the mixture was stirred at high speed. Finally varying concentrations of aqueous extract of flax seed 16 and curry leaves were incorporated into the above mixture. The preparation was neutralized by dropwise addition of triethanolamine. A gel was obtained by mixing. The prepared herbal hair gel formulation was stored at room temperature.

Table 4: Five Herbal hair gel formulations

Formulation	F1	F2	F3	F4	F5
Curry leaf extract (%)	1	2	3	4	5
Flaxseed extract (%)	5	4	3	2	1
Methyl paraben (mg)	75	75	75	75	75
Triethanolamine (ml)	0.5	0.5	0.5	0.5	0.5
Carbopol (gm)	2	2	2	2	2
PEG (ml)	6.25	6.25	6.25	6.25	6.25
Glycerine (ml)	3	3	3	3	3
Water (ml)	80	80	80	80	80

Phytochemical Screening of Aqueous flaxseed extract

Protein test

(a) General test (Biuret test): To 3 ml of T.S., add 4% NaOH and a few drops of 1%CuSO₄ solution. The blue shifts to violet or pink⁹.

(b) Million's test: Mix 3 ml of T.S. White PowerPoint with 5 ml of Million's reagent. Warm. Ppt. either turns brickred or dissolves to reveal a red solution.

The Molisch test (general test) for carbohydrates

To 2-3 ml of aqueous extract, shake a few drops of alpha-nap solution in alcohol. Then, add the concentrated H₂SO₄ from the test tube's sidewalls. At the intersection of two liquids, a violet ring appears.

Tannin Compound Test

Add a few drops of the following reagents to two to three milliliters of alcoholic or aqueous extract:

(a) A vivid blue-black solution containing 5% FeCl₃.

(b) White ppt solution of lead acetate.

Alkaloids Test

Evaporate the aqueous extract¹⁰. Add 1 diluted to the residual. After giving it a thorough shake, strain. Proceed with the following tests using filtrate:

(a) Hager's test: adding Hager's reagent to 2-3 ml of filtrate produces yellow ppt.

Acidic Compound Test

(a) Make effervescence in the test solution by adding sodium bicarbonate.

Saponin Glycoside Test

(a) Foam Test: Use water to agitate the medication extract or dry powder thoroughly. Stable, long-lasting foam was noted

Phytochemical screening of Aqueous Curry leaf extract

The aqueous *Murraya koenigii* leaf extract was subjected to phytochemical analysis which was carried out by following the procedures. Tannins, Saponins, Flavonoids, Alkaloids, Proteins, Steroids, Quinones, Terpenoids, Cardio glycosides and Phenols were estimated by ensuring the Successive methods.

Tannins

1ml of aqueous *Murraya koenigii* leaf extract and 2-3 drops of 0.1% ferric chloride were combined and checked for the appearance of blue/black/brownish green colour.

Saponins

Powder *Murraya Koenigii* plant sample 0.5 g was boiled by 10 ml of distilled water. Then the filtrate 5 ml was mixed with 2.5 ml of distilled water and shaken it. And added 3 drop of saturated oil and shaken again. Emulsion formed indicating the presence of saponin.

Flavonoids

2 ml of *Murraya Koenigii* leaf extract solution was taken in test tube and 3ml of diluted ammonium was added to the solution and 1 ml concentrated sulphuric acid in solution¹¹ At time yellow colour appear detect the presence of flavonoid.

Alkaloids

1ml of aqueous *Murraya koenigii* leaf extract and 2-3 drops of Dragondorff reagent were combined and checked for the formation of orange red colour.

Proteins

1 ml of aqueous *Murraya koenigii* leaf extract and 2-3 drops of Bradford reagent were combined and checked for the development of blue colour.

Steroids

1 ml of aqueous *Murraya koenigii* leaf extract and 1ml of 10% Con. H₂SO₄ was combined and checked for the appearance of green colour¹².

Quinones

1 ml of aqueous *Murraya koenigii* leaf extract and 2-3 drops of aqueous ammonia were combined and checked for colour change in the aqueous layer from light brown to red, pink or violet colour.

Terpenoids

1 ml of aqueous *Murraya koenigii* leaf extract and 2-3 drops of Con. H₂SO₄ was combined and checked for the appearance of yellow colour.

Anthraquinones

2 ml of *Murraya Koenigii* extract was taken in test tube and added 4 ml concentrated sulphuric acid into test tube boiled and shaken well and add 3 ml chloroform in to the test tube and the chloroform layer was separated and pipette out into another test tube containing diluted ammonia. Pink or Red colour indicated presence of anthraquinones^{13, 14}.

Phenols

1 ml of aqueous *Murraya koenigii* leaf extract, 2ml of distilled water and 2-3 drops of Ferric chloride were combined and checked for the formation of green or blue colour.

Evaluation of herbal hair gel formulations

Physical appearance/ Visual inspection

The formulated herbal hair gel was evaluated for color, transparency, odor, visual appearance, and foreign particles.

Determination of pH

The digital pH meter was used to calculate the pH of different hair gel compositions. In 100ml of distilled water, ¹⁵one gram of gel was dissolved and allowed to stand for two hours. The pH of the hair gel formulations was measured after fully submerging the electrodes.

Spreadability

Spreadability was determined by the apparatus which consists of a wooden block, which was provided by a pulley at one end. By this method spreadability was measured on the basis on slip and drag characteristics of gels. An excess of gel (about 2 gm) under study was placed on this ground slide. The gel was then sandwiched between this slide and another glass slide having the dimension of fixed ground slide and provided with the hook. A one kg weighted was placed on the top of the two slides for 5 min. to expel air and to provide a uniform film of the gel between the slides¹⁶. Excess of the gel was scrapped off from the edges. The top plate was then subjected to pull of 80 gm. With the help of string attached to the hook and the time (in sec.) required by the top slide to cover a distance of 7.5 cm be noted. A shorter interval indicates better spreadability.

Spreadability was calculated using the following formula:

$$S = M \times L/T$$

Where,

S= Spreadability,

M= weight in the pan (tied to upper slide),

L= Length moved by the slide,

T= Time (in sec.)

Washability

All herbal formulations are checked for washability with water.

Skin irritation test

Applied herbal hair gel formulation on the skin and observe for irritation, redness or rashes.

Viscosity

Viscosity was measured using a Brookfield viscometer. A sufficient amount of gel was added to each wide mouth jar independently¹⁷. The gel in the jar should be high enough to allow the spindle to be dipped. The spindle was set to run at 2.5 RPM. The formulas' viscosities were noted

Stability Studies

All the formulations were kept at varying conditions of temperature. The system was stable at 25 °C. There were no significant changes in the formulation when kept at room temperature (30±2°C) and also at refrigerated temperature (4±2°C). No much change of pH, Viscosity, Homogeneity, Spreadability, and Extrudability¹⁸.

Antibacterial activity

Prepare nutrient agar plates by pouring molten agar into Petri dishes and allowing it to solidify. Inoculate the agar by streaking the surface evenly with the bacterial culture using a sterile cotton swab.

- Create wells in the agar using a sterile cork borer or pipette tip.
- Apply the test sample (herbal gel), positive control (antibiotic), and negative control (sterile water) into separate wells¹⁹.
- Incubate the plates at 37°C for 18–24 hours.

- Observe and measure the zones of inhibition around the wells, indicating antibacterial activity.

Antifungal activity

- Select Fungal Strain: Choose relevant fungal strains like *Malassezia furfur*, responsible for scalp conditions like dandruff, or other fungi like *Candida albicans* and *Aspergillus niger*.
- Prepare Herbal Gel Sample: Ensure the gel is freshly prepared and may be diluted to different concentrations for comparative analysis
- Prepare Culture Media: Use Sabouraud Dextrose Agar (SDA) or Potato Dextrose Agar (PDA) to culture the fungal strains and sterilize and pour the media into Petri dishes.
- Inoculate Fungal Strain: Spread the fungal inoculum on the agar surface evenly using a sterile swab or spreader^{20, 21}.
- Apply Herbal Hair Gel
- Well Diffusion: Make wells in the agar and fill with herbal gel.

Incubation: Incubate the plates at 25°C to 30°C for 48 to 72 hours, depending on the fungal species.

Results and Discussion

Physical Evaluation

Table 5: Physical Evaluation

Formulation	Colour	Consistency
F1	Translucent, white colour, Smooth	Good
F2	Translucent, white colour, Smooth	Good
F3	Translucent, white colour, Smooth	Good
F4	Translucent, white colour, Smooth	Good
F5	Translucent, white colour, Smooth	Good



Fig 1: Formulation of Gel (F1 to F5)

pH**Table 6:** pH of Formulation

Formulation	pH
F1	6.52
F2	6.53
F3	7.02
F4	6.64
F5	6.54

Homogeneity**Table 7:** Homogeneity of Formulation

Formulation	Homogeneity
F1	Good
F2	Good
F3	Good
F4	Good
F5	Good

Spreadability**Table 8:** Spreadability

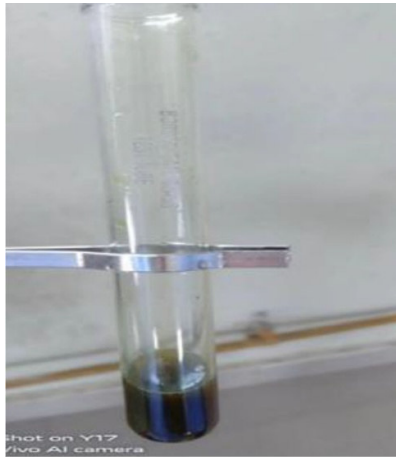
Formulation	Spreadability
F1	15.23± 0.002
F2	13.43± 0.002
F3	11.23± 0.001
F4	9.56± 0.001
F5	8.62± 0.002

Viscosity**Table 9:** Viscosity of herbal hair gel

Formulation	Viscosity (cps)
F1	9366 ± 0.002
F2	9368 ± 0.004
F3	9369 ± 0.002
F4	9376 ± 0.003
F5	9382 ± 0.003

Phytochemical screening of aqueous *Murraya koenigii* leaf extract**Table 10:** Phytochemical screening of aqueous *Murraya koenigii* leaf extract

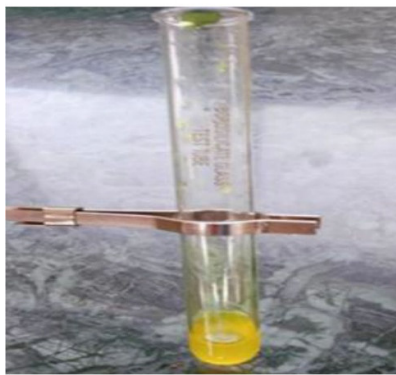
S. No	Constituents	Presence/Absence
1	Alkaloids	+
2	Proteins	+
3	Steroids	-
4	Saponins	+
5	Flavanoids	+
6	Tannins	+



Tannins



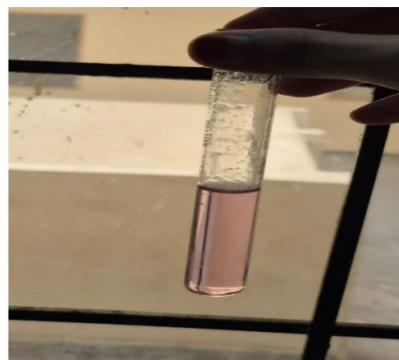
Saponins



Flavanoids



Phenols



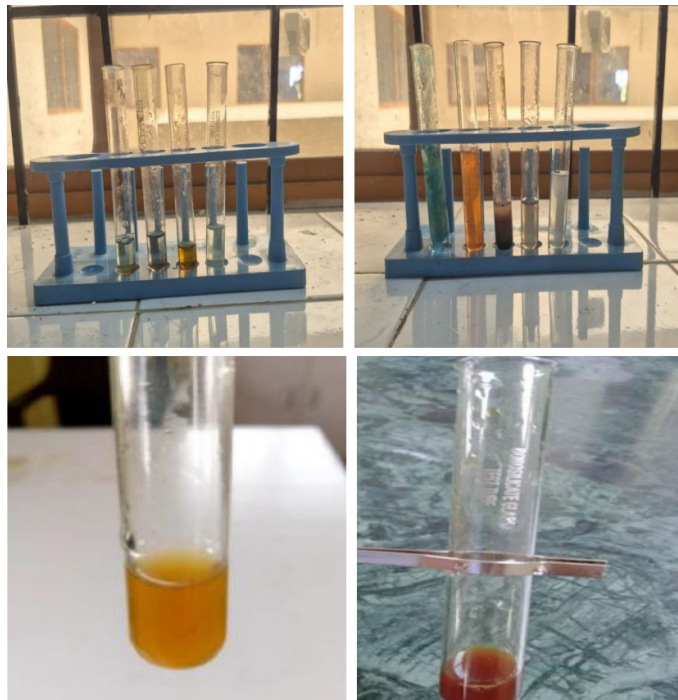
Protein Test

Phytochemical screening of aqueous flaxseed extract

Table 11: Phytochemical screening of aqueous flaxseed extract

Protein	
a) Biuret test	+
b) Millions test	+
Tannins compound	
a) FeCl ₃	+
b) Lead acetate	+
Saponin	
Foam test	+
Alkaloids	

Hager's test	+
Acidic compound	
Sodium bicarbonate	+
Carbohydrates	
Molish test	+



Conclusion

Herbal cosmetics are products designed to enhance appearance using natural ingredients. This research is focused on developing and accessing an herbal formulation hair gel made from curry leaves and flaxseed, aimed at promoting hair growth and reducing hair fall. Extracts from flax seed and curry leaves were obtained through aqueous extraction. Five different gel formulations, with varying concentrations of these extracts, were prepared and evaluated. The formulations F1 to F5 were analyzed based on parameters such as color, Odor, texture, clarity, pH, viscosity, spreadability, extrudability, gel strength, homogeneity, stability, washability, antimicrobial activity and antifungal activity. The findings indicate that the herbal hair gel formulated with curry leaves and flax seed is effective for promoting hair growth and reducing hair fall. The formulation highlights the potential of integrating herbal ingredients into cosmetic products, promoting sustainability and consumer preference for natural herbal formulations.

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