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Formulation And Evaluation of Polyherbal Interpenetrating Polymer Network Hair Nourishing Gel Mask

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Abstract

This study focuses on the formulation and evaluation of a polyherbal interpenetrating hair nourishing gel mask, leveraging the synergistic benefits of natural ingredients such as coconut oil, castor oil, vitamin E oil, aloe vera, and lavender oil. The gel mask is designed to provide a comprehensive solution for various hair-related problems, including dandruff, dryness, and brittleness. The formulation aims to nourish and moisturize the hair, promoting smooth, silky, and healthy locks. The polyherbal approach combines the therapeutic properties of each ingredient, enhancing the overall efficacy of the product. This gel mask offers a promising natural alternative for hair care, potentially reducing the reliance on chemical-based products and traditional oiling. The project's findings suggest that the developed gel mask exhibits promising hair-nourishing with advanced penetration and absorption of the ingredients to the roots with damage-controlling properties, making it a valuable addition to natural hair care regimens.

Key Words: Hair Mask, Oils, Hair Nourishing, gel, Traditional hair oiling,hair.

Key Highlights

- Polyherbal gel mask formulation using natural ingredients
- Nourishes and moisturizes hair, promoting smooth and silky texture
- Controls damage, dandruff, and other hair-related problems
- Offers a natural alternative to traditional oiling methods and chemical-based hair care products

Introduction

Hair Structure and Growth

Hair is a complex protein filament that grows from follicles in the skin, composed of keratin, a protein rich in carbon, nitrogen, sulfur, and oxygen. The hair growth cycle consists of distinct phases: anagen (growth), catagen (transition), telogen (resting), and exogen (shedding).

Importance of Hair Care

Poor hair hygiene can lead to fungal infections, characterized by redness, flaking, and itching. Natural hair care products offer a safer alternative to chemical-based products, which can damage hair and scalp. Ayurveda, an ancient Indian medical tradition, recommends using herbal hair masks to nourish the scalp and promote healthy hair growth.

Benefits of Herbal Hair Masks

Herbal hair masks can provide intense nourishment and hydration to hair, addressing issues like dandruff, dryness, and brittleness. Our polyherbal interpenetrating polymer network (IPN) hair gel mask combines the benefits of coconut oil, castor oil, vitamin E oil, aloe vera, and lavender oil to:

1. Nourish and moisturize hair: Promoting smooth, silky, and healthy locks.
2. Control dandruff: Reducing flaking, itching, and scalp irritation.
3. Foster healthy hair growth: By providing essential nutrients and promoting a healthy scalp environment.

Interpenetrating Polymer Network (IPN) Technology

The IPN technology used in our hair gel mask allows for a unique blend of natural ingredients to be delivered deep into the hair shaft, providing long-lasting nourishment and hydration. This technology enables:

1. Sustained release: The blend of active ingredients ensures prolonged benefits for hair and scalp.
2. Enhanced penetration: Allowing for deeper absorption of nutrients, promoting healthier hair growth.

Our polyherbal IPN hair gel mask offers a natural and effective solution for various hair-related problems, making it a valuable addition to natural hair care regimens. With its unique blend of natural ingredients and advanced IPN technology, this gel mask has the potential to become a popular choice for those seeking a chemical-free hair care solution.

Hair Structure

Hair is a complex protein filament that grows from follicles in the skin. It consists of several parts:

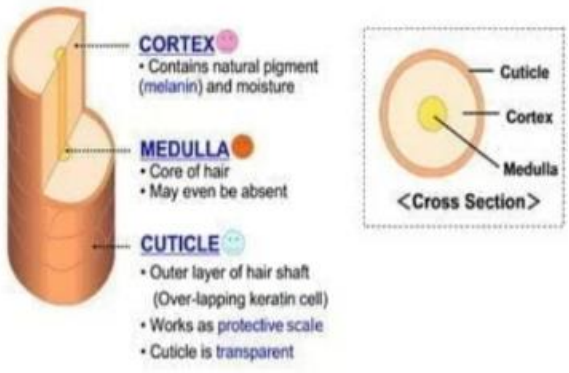
Parts of Hair

1. Root: The part of the hair below the skin's surface, anchored in the hair follicle.
2. Shaft: The visible part of the hair above the skin's surface.
3. Bulb: The base of the hair root, where hair growth occurs.

Hair Shaft Structure

The hair shaft consists of three layers:

1. Medulla: The innermost layer, not always present in every hair.
2. Cortex: The middle layer, making up most of the hair shaft and containing melanin, which gives hair its color.



3. Cuticle: The outermost layer, a thin, transparent layer that protects the hair shaft.

Hair Follicle

The hair follicle is a small pocket in the skin where the hair root is anchored. It plays a crucial role in hair growth and development.

Hair Growth Cycle

Hair growth occurs in cycles, consisting of:

1. Anagen phase: The active growth phase, lasting several years.
2. Catagen phase: A short transitional phase, lasting about 2-3 weeks.
3. Telogen phase: The resting phase, lasting about 3-4 months.
4. Exogen phase: The shedding phase, where the hair is released from the follicle.

The chemical composition of hair growing on a person's head is varied. It includes various substances of organic origin. As a percentage, they are:
Keratin (a protein consisting of the amino acids cystine and methiotin) – 78%;
water – 15%;
lipids – 6%;
pigment – 1%

Internal structure
The visible part of the hair belongs to the dead structures (the core), and the processes of cell division and hair growth occur in the skin where the hair follicle is located.
Strictly speaking, the following components of the system can also be attributed to the definition of what is human hair:
hair follicle and its papilla;
root;
blood vessels responsible for root nutrition;
nerve endings;
muscle responsible for the movement of the hair (located in the dermis);
sebaceous gland (produces fat, lubricates the hair shaft and protects the scalp);
sweat gland (responsible for the secretion of cellular metabolism products).
Also of interest is the structure of the hair, if we consider it in cross section. It consists of several layers consisting of various substances that make up the hair structure.

Hair shaft structure
The structure of the hair shaft is layered. Although it is not considered living tissue, the hair structure in the outer (visible) part consists of three layers:
outer layer (about 10%) – cuticle;
middle (85%) – cortex;
the core (about 5%) is the medulla.

The hair cuticle consists of adjacent keratin scales that perform a protective function. They are imposed on each other on the principle of tile, from the root to the tip. This shell also has a layered cellular structure, the number of layers varies from 5 to 10. The appearance of the hair depends on the state of the outer shell – their luster and smoothness.

The second layer, the cortex, constitutes the main hair shaft, which dictates its thickness. This layer has a protein nature and consists entirely of keratin. The number of collagen fibers that make up the keratin layer, tens of thousands. Intertwined with each other, they form a pattern of chains. The resulting collagen chains form the structure of this layer. Cortex also contains coloring pigment that causes hair color.
The core of the hair, or medulla, is present only in long hair growing on the head. In its composition – the medulla, saturated with air bubbles, responsible for thermal conductivity.

Hair cycle
There are the following phases of hair growth:
anagen — active growth phase;
catagen – intermediate phase;
telogen – rest phase.

Anagen
This is the most active stage of the life cycle. The cells in the hair follicle begin to rapidly divide under the influence of the hormones responsible for hair growth. The follicle takes the form, formation of the hair shaft begins, melanin is formed. At this stage of hair growth daily increment is 0.5 mm. This is the longest period, whose duration varies from 2 to 5 years. In women, the hair stays in the anagen stage for 5 years, in men it is much less – 2 years. In the stage of active growth is usually up to 90% of all the hair on the human head.
The shape of the hair bulb depends on the appearance of the hair on the head:
round – straight;
oval – curly;
kidney shaped – curly.

Catagen
The duration of this intermediate phase of hair growth is the shortest – from 2 to 4 weeks. At this stage, the hair bulb is already separated and begins to move towards the upper layer of the epidermis. Due to separation from the feeding blood vessels, the vital activity of the follicle ceases, and its death occurs. The production of melanin also stops. About 2-3% of the total hair volume is in this condition. It is these hair shafts that make up the daily rate of natural loss.

Telogen
The final stage of the life cycle is characterized by a period of rest. Hair is held on the head only by the skin and, at the slightest impact, is separated. At this stage, the birth of a new follicle begins, then it moves into the anagen phase. The duration of telogen on average is 3 months. About 10% of the total amount of hair on the head is in this state.
The rate of natural hair loss is:
Blondes have up to 100 hairs per day;
for brunettes – up to 100 hairs per day;
in red – up to 80 hairs.

Hair Conditions

- Alopecia Areata: Round patches of total hair loss, usually from the scalp. The cause of alopecia is unknown; the hair usually grows back.
- Male Pattern Baldness: The most common type of hair loss in men. Male pattern baldness usually includes either a receding hairline, hair loss at the crown, or both.
- Female Pattern Baldness: In women, hair loss usually includes uniform thinning across the scalp, with a preserved hairline. The crown may be affected, but hair loss rarely proceeds to baldness as in men. See a picture of female pattern baldness.
- Dandruff (seborrheic dermatitis): Ongoing mild inflammation of the scalp, resulting in scaly skin that may be itchy and flake off. Seborrheic dermatitis may also affect the ears and face.
- Tinea Capitis (ringworm): A fungal infection of the scalp, creating round patches of hair loss. Although the patches can appear in a ring shape, no worm is involved in tinea capitis.
- Head lice: Tiny insects that live on the scalp and feed on blood. Preschool and elementary school-aged children and adults who live with children are most susceptible to catching head lice, which are only spread through close contact.
- Hirsutism: A condition in which women develop male-pattern hair (such as facial hair). An excess of testosterone due to a medical condition is usually responsible.
- Folliculitis: Inflammation of hair follicles, usually due to an infection. *Staphylococcus aureus* is a bacteria that frequently causes folliculitis. Acne is a form of folliculitis that is caused by inflammation. The bacteria Propionibacterium acne can sometimes worsen this inflammation.

Types of Human Hair

Human hair can be classified into several types based on its texture, shape, and other characteristics. Here are the main types:

1. Hair Texture

- Straight hair: Hair that lies flat against the head, with no visible curl or wave.
- Wavy hair: Hair that has a gentle, flowing curve, often with a loose "S" shape.
- Curly hair: Hair that has a defined curl pattern, ranging from loose to tight curls.
- Kinky hair: Hair that has a tightly coiled curl pattern, often with a zig-zag shape.

2. Hair Shape

- Round hair: Hair with a round cross-section, often associated with straight or wavy hair.
- Oval hair: Hair with an oval cross-section, often associated with curly or wavy hair.
- Flat hair: Hair with a flat cross-section, often associated with straight or fine hair.

3. Hair Length

- Short hair: Hair that reaches the chin or shorter.
- Medium hair: Hair that reaches the shoulders or chest.
- Long hair: Hair that reaches the back, waist, or longer.

4. Hair Porosity

- Low porosity hair: Hair that has a compact cuticle layer, making it difficult for moisture to penetrate.
- Medium porosity hair: Hair that has a moderate cuticle layer, allowing for some moisture penetration.
- High porosity hair: Hair that has a lifted cuticle layer, allowing for easy moisture penetration.

5. Hair Density

- Fine hair: Hair that is thin and light, often prone to breakage.
- Medium hair: Hair that is average in thickness and density.
- Coarse hair: Hair that is thick and dense, often more prone to dryness.- Fine hair: Hair that is thin and light, often prone to breakage.
- Medium hair: Hair that is average in thickness and density.
- Coarse hair: Hair that is thick and dense, often more prone to dryness.

Interpenetrating Polymer Network (IPN) Hair Gel Mask vs. Traditional Hair Oiling

Both IPN hair gel masks and traditional hair oiling can be beneficial for hair care, but they work in different ways and offer distinct advantages.

Advantages of IPN Hair Gel Mask

1. Long-lasting nourishment: IPN technology allows for sustained release of active ingredients, providing prolonged benefits for hair and scalp.
2. Deep penetration: The gel mask can penetrate deeper into the hair shaft, delivering nutrients and moisturizers more effectively.
3. Targeted benefits: IPN hair gel masks can be formulated to address specific hair concerns, such as dandruff, dryness, or damage.
4. Easy to use: Gel masks can be applied and left on for a specified time, making them a convenient option.

Limitations of Traditional Hair Oiling

1. Short-term benefits: Hair oiling provides temporary nourishment and moisturization, which may not last long.
2. Surface-level benefits: Oils may not penetrate deeply into the hair shaft, limiting their effectiveness.
3. Messy and time-consuming: Hair oiling can be messy and time-consuming, requiring repeated applications.

Why IPN Hair Gel Mask Is Better

1. More effective delivery: IPN technology can deliver active ingredients more effectively, providing longer-lasting benefits.
2. Customizable benefits: IPN hair gel masks can be formulated to address specific hair concerns, making them a more targeted solution.
3. Convenience: Gel masks can be easier to use and less messy than traditional hair oiling.

While traditional hair oiling has its benefits, IPN hair gel masks offer a more advanced and targeted approach to hair care. The sustained release of active ingredients and deep penetration of the gel mask can provide longer-lasting benefits and more effective nourishment for the hair and the scalp.

Objectives:

1. Develop an INTERPENETRATING POLYMER NETWORK GEL [IPN] hair mask incorporating multiple herbal extracts.
2. Ensure the formulation is stable, non-toxic, and suitable for different hair types.
3. Achieve an optimal consistency for easy application and absorption.
4. Herbal Ingredient Selection
5. Hydrogel Base Development
6. Evaluation of Physicochemical Properties
7. Safety and Efficacy Testing
8. Comparison with Marketed Formulations
9. Potential Applications & Commercial Viability

Name of Ingredients and category:

This table categorizes the key ingredients used in a Polyherbal Interpenetrating Polymer Networks Hair Nourishing Mask, ensuring a well-balanced formulation.

Sr. No	Ingredients	Category
1.	Aloe vera	Moisturizes the scalp, promotes hair growth, and strengthens hair follicles.
2.	Vitamin-E	Vitamin E promotes hair growth by improving scalp circulation and providing essential antioxidants.
3.	Castor oil	Castor oil can also stimulate dormant hair follicles, potentially leading to thicker hair growth
4.	Coconut oil	Coconut oil deeply nourishes hair, reduces protein loss, and promotes a healthy scalp.
5.	Gellan gum	It acts as a gelling agent in IPG formulations, providing structure, stability, and controlled drug release
6.	Sodium benzoate	Sodium benzoate acts as a preservative in hair gel masks, preventing bacterial and fungal growth to extend shelf life and maintain product safety.
7.	Lavender oil	Lavender oil in hair mask gels soothes the scalp, promotes hair growth, and provides a calming fragrance.

Natural Ingredients:

Castor Oil:

Castor oil is a popular natural remedy for promoting hair growth, improving hair texture, and addressing various scalp issues.

Scientific Name

The scientific name of the castor oil plant is Ricinus communis.

Main Component

The main component of castor oil is ricinoleic acid, a monounsaturated fatty acid that makes up approximately 90% of the oil's fatty acid content.

Benefits for Hair

1. Hair growth promotion: Ricinoleic acid in castor oil may help stimulate hair growth by increasing blood flow to the scalp and reducing inflammation.
2. Moisturizing properties: Castor oil's fatty acids can help nourish and moisturize hair, leaving it soft and manageable.
3. Scalp health: Castor oil's antimicrobial and anti-inflammatory properties may help soothe and calm scalp irritations, reducing dandruff and itchiness.

Coconut Oil:

Coconut oil is a popular natural remedy for promoting hair health, nourishing hair, and addressing various scalp issues.

Scientific Name

The scientific name of the coconut tree is Cocos nucifera.

Main Component

The main components of coconut oil are medium-chain triglycerides (MCTs), particularly:

1. Lauric acid: A medium-chain fatty acid with antimicrobial properties.
2. Capric acid: A medium-chain fatty acid with antimicrobial and anti-inflammatory properties.

Benefits for Hair

1. Moisturizing properties: Coconut oil's MCTs can help nourish and moisturize hair, reducing protein loss and improving hair texture.
2. Antimicrobial properties: Lauric acid in coconut oil may help control scalp infections and reduce dandruff.
3. Hair protection: Coconut oil's fatty acids can help protect hair from damage, reducing frizz and improving shine.

Vitamin E Oil

Vitamin E oil is a popular natural remedy for promoting hair health, protecting hair from damage, and improving overall hair appearance.

Scientific Name

The scientific name for Vitamin E is Tocopherol.

Main Component

The main components of Vitamin E oil are:

1. Alpha-tocopherol: The most active form of Vitamin E, with potent antioxidant properties.
2. Gamma-tocopherol: Another form of Vitamin E with antioxidant and anti-inflammatory properties.

Benefits for Hair

1. Antioxidant properties: Vitamin E oil's antioxidants can help protect hair from damage caused by free radicals, promoting healthy hair growth.
2. Improved hair texture: Vitamin E oil may help improve hair texture, reducing frizz and improving shine.
3. Scalp health: Vitamin E oil's antioxidant properties may help soothe and calm scalp irritations, reducing inflammation.

Lavender Oil

Lavender oil is a popular essential oil used to promote hair health, reduce stress, and improve overall well-being.

Scientific Name

The scientific name of the lavender plant is Lavandula angustifolia.

Main Component

The main components of lavender oil are:

1. Linalool: A monoterpene alcohol with calming and relaxing properties.
2. Linalyl acetate: An ester with anti-inflammatory and antimicrobial properties.

Benefits for Hair

1. Stress reduction: Lavender oil's calming properties may help reduce stress, which can contribute to hair loss.
2. Improved scalp health: Lavender oil's antimicrobial properties may help soothe and calm scalp irritations, reducing dandruff and itchiness.
3. Promoting hair growth: Some studies suggest that lavender oil may help promote hair growth by improving circulation and reducing stress.

Name of Instruments:

1. Weighing balance
2. Magnetic stirrer
3. Homogenizer
4. Sonicator
5. Glass wears
6. Measuring cylinder
7. Ph meter
8. Viscometer
9. Centrifuge

Method/Procedure :

1. *Preparation of Herbal Extracts.*

Weigh the required amount of Aloe Vera juice. Blend the gel until it's frothy and liquefied. Take a beaker and add 15 mL of freshly prepared aloe vera gel and 2g of Xanthan gum, which acts as a gelling agent, into this beaker and mix thoroughly to form a uniform gel mixture. Then add the carrier oils,

such as coconut oil and castor oil. Add 10 ml each of coconut oil and castor oil to it. And then add lavender oil to the mixture, which acts as a perfuming agent.
Mix all these ingredients properly to make a uniform gel, if necessary, using a mechanical stirrer
to avoid any lumps in it. Then pour the mask into the container and store it in the refrigerator
for further use. Apply this hair mask for about once a week for
better results.

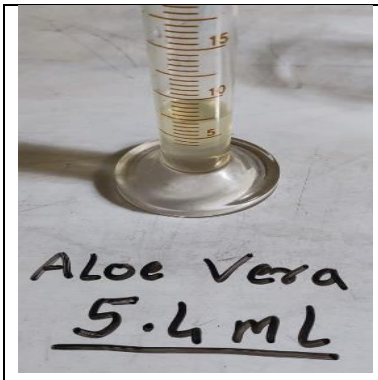
2. ***Preparation of*** **interpenetrating polymer networks** ***Base.***
Weigh gelling agent (e.g., Gellan Gum, Xanthan gum, Cellulose gum). Disperse the gelling agent slowly in distilled water with constant stirring using a magnetic stirrer to avoid clumping. Allow the dispersion to swell for 3-4 hours at room temperature. Adjust the pH (4.5–6.5) using citric acid or sodium hydroxide solution. Add humectant

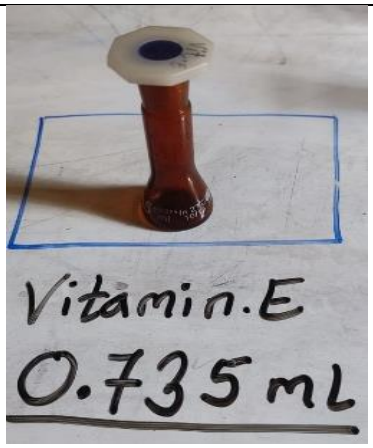
1. ***Stability & Homogeneity Testing.***
s (e.g., Glycerin, Aloe vera gel) for moisturization. Stir continuously using a mechanical stirrer or homogenizer to obtain a smooth gel base.

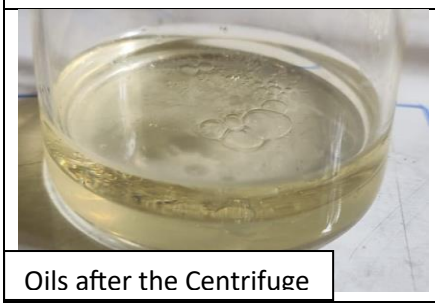
2. ***Incorporation of Herbal Extracts into IPN Base.***
Gradually add the prepared herbal extracts into the hydrogel base with constant stirring. Add essential oils (e.g., Lavender oil) and natural oils (e.g., Castor oil, Coconut oil) for fragrance and additional nourishment. Mix thoroughly using a homogenizer to ensure uniform distribution of active ingredients. Check viscosity and spreadability to maintain a smooth, non-sticky gel texture.
Observe the IPN for phase separation, color change, and precipitation over time. Conduct stability testing by storing samples at different temperatures (4°C, 25°C, 40°C) for 30 days. Measure pH, viscosity, and spreadability at regular intervals.

3. ***Evaluation & Performance Testing***
pH Testing: Use a pH meter to ensure scalp-friendly formulation.
Viscosity Testing: Measure gel consistency using a Brook-field viscometer.
Spread-ability Test: Use glass slide and weight method to check application ease.
Texture Analysis: Use a texture analyzer to assess smoothness and absorption.
Hair Hydration Test: Apply on hair strands and measure moisture retention using a moisture analyzer.
Scalp Irritation Test: Perform a patch test on volunteers or use an in-vitro skin model.

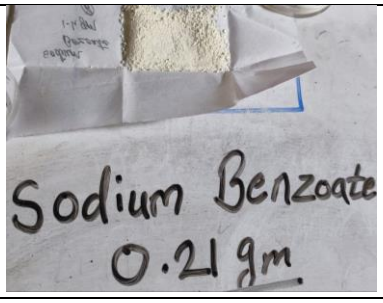
4. ***Comparative Study with Marketed Hair Masks***
Compare spreadability, absorption, stability, and effectiveness with existing commercial hair masks. Conduct a sensory evaluation (softness, shine, ease of application) through user feedback.

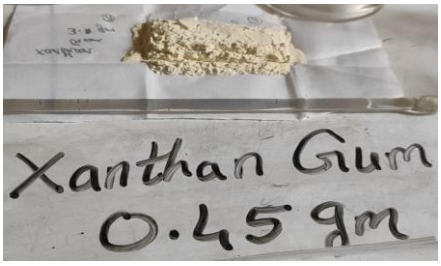


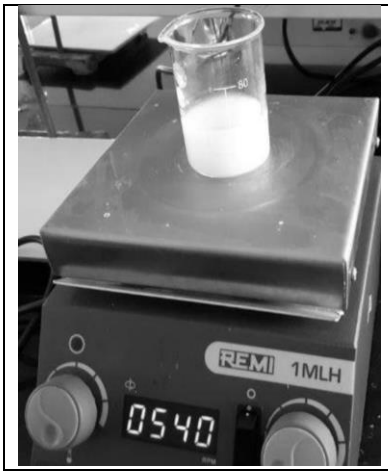


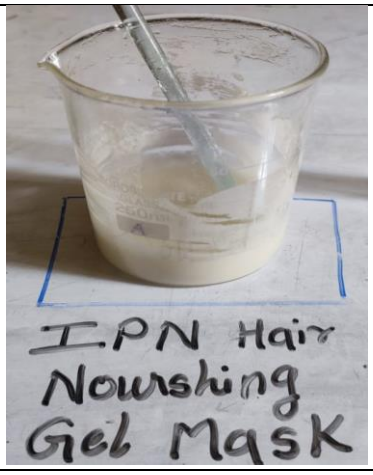


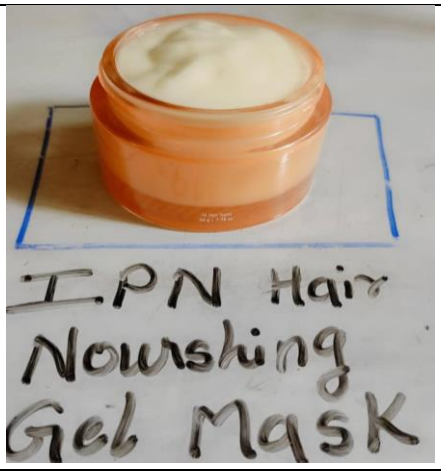
Oils after the Centrifuge











Evaluation Test:

1. *Physicochemical Evaluation*

1.1**.** pH Measurement: To ensure the formulation is scalp-friendly (pH 4.5–6.5).

Method: Measure 1g of IPN diluted in 10 mL distilled water. Use a digital pH meter to record the value.
Acceptable Range: 4.5 – 6.5 (compatible with scalp and hair).

2.Viscosity Measurement

Objective: To determine spread ability and consistency for smooth application.

Method: Use a Brookfield Viscometer at room temperature (25°C). Measure at different RPMs (10, 20, 30 rpm) using a spindle.

1.3. Spread-ability Test

Objective: To evaluate ease of application on hair and scalp.

Method (Glass Slide Test):

Place 1g of gel between two glass slides.
Apply a weight of 50g for 1 minute.
Measure the diameter of the spreaded gel.

Ideal Outcome: Should spread evenly without stickiness or residue.

1.4. Texture Analysis

Objective: To check the smoothness and uniformity of the gel.

Method:

Use a Texture Analyzer to measure gel firmness, stickiness, and elasticity.
Check visually and by touch for homogeneity and particle distribution.

Ideal Outcome: Should be smooth, non-greasy, and uniform.

2.1. Accelerated Stability Testing

Objective: To evaluate physical and chemical stability under different conditions.

Method:

Store samples at 4°C, 25°C, and 40°C (±2°C) for one month.
Observe color change, phase separation, odor, and consistency at regular intervals.

Ideal Outcome: No significant changes in appearance, viscosity, or pH.

2.2. Freeze-Thaw Stability

Objective: To test hydrogel stability under extreme temperature changes.

Method:

Store at -4°C for 24 hours, then shift to 40°C for 24 hours (repeat for 5 cycles).
Observe phase separation, precipitation, or texture degradation.

Ideal Outcome: Gel remains intact with no phase separation.

Safety & Skin Compatibility Tests

4. Patch Test (Skin Irritation Test)

Objective: To check if the formulation causes scalp irritation or allergies.

Method:

Apply a small amount of the gel on the inner forearm or behind the ear.
Observe for redness, itching, or allergic reactions for 24 hours.

Ideal Outcome: No skin irritation, redness, or itching.

Sr . No	**Ingredients**	**Quantity[100gm]**	**Quantity[15gm]**
1.	Aloe Vera Juice	36 ml	5.4
2.	Vitamin E	4.9 ml	0.735
3.	Coconut Oil	24.4 ml	3.66
4.	Castor Oil	24.4 ml	3.66
5.	Xanthan Gum	3 gm	0.45
6.	Sodium Benzoate	1.4 gm	0.21
7.	Lavender Oil	2.4 ml	0.36

Expected Outcome:

1. Longer Shelf Life
2. Deep Hydration
3. Enhanced Softness & Shine
4. Better Absorption
5. Hair Strengthening & Growth Benefits
6. Scalp Health & Anti-Dandruff Effects
7. Safety & User Acceptance

RESULTS AND DISCUSSION

The poly herbal IPN hair gel mask was prepared by using the preparation of aloe vera gel and different oils like coconut oil, castor oil, also blending them with the essential oils, lavender oil used as a perfuming agent, vitamin E, Xanthan gum is used as a gelling agent, and sodium benzoate as a preservative.
Formulated four different formulations named as G1, G2, G3 of 15 gm.

1. Physical appearance

Table 2: Physical appearance.

Sr. NO.	**G1**	**G2**	**G3**
Color	White	White	White
Odour	Aromatic	Aromatic	Aromatic

2. Homogeneity

After the mask formulations had been set in the container, all developed masks were tested
for homogeneity by visual inspection. They were tested for their appearance, and the presence of

any lumps, flocculates, or aggregates was not observed.

3. pH

Table 3: pH.

Sr.No.	G1	G2	G3
pH	4.8	5.2	4.2

4. Washability

Table 4: Washability.

Sr.No.	G1	G2	G3
Washability	Easily washable	Easily washable	Easily washable

5. Spreadability

The formulation shows lower sliding time having better spreadability.

Table 5: Spreadability

Sr.No.	G1	G2	G3
Spreadability (Mean + SD)	21.79	22.5	23.29

6. Skin irritation test

Table 6: Skin irritation test.

Sr.No.	G1	G2	G3
Skin Irritation	No Irritation	No Irritation	No Irritation

7. Viscosity

Table 7: Viscosity.

Sr.No.	G1	G2	G3
Viscosity	6450	6457	6452

8. Patch test: The site of patch was inspected after 24hrs. As there was not reaction the test was repeated 3 times. As no reaction was observed on 3rd application, the person may not hypersensitive to the formulations.

9. Accelerated stability studies

Table 8: Accelerated stability studies for G1.

Time intervals	Homogeneity	Viscosity	Physical changes	pH
0th day	+++	6451	No change in colour and odour	6.3
5th day	++	6452	No change in colour and odour	6.2
10th day	++	6454	No change in colour and odour	6.1
15th day	++	6454	No change in colour and odour	6.4
20th day	++	6455	No change in colour and odour	6.5
25th day	++	6456	No change in colour and odour	6.5
30th day	++	6456	No change in colour and odour	6.4

+=average ++=good +++=excellent

Table 9: Accelerated stability studies for G2.

Time intervals	Homogeneity	Viscosity	Physical changes	pH
0th day	+++	6455	No change in colour and odour	5.4
5th day	+++	6454	No change in colour and odour	5.6
10th day	+++	6455	No change in colour and odour	5.1
15th day	+++	6455	No change in colour and odour	5.2
20th day	+++	6455	No change in colour and odour	5.3
25th day	+++	6454	No change in colour and odour	5.3
30th day	+++	6454	No change in colour and odour	5.3

+=average ++=good +++=excellent

Table 10: Accelerated stability studies for G3

Time intervals	Homogeneity	Viscosity	Physical changes	pH
0th day	+++	6454	No change in colour and odour	5.1
5th day	+++	6457	No change in colour and odour	5.0
10th day	+++	6454	No change in colour and odour	4.9
15th day	+++	6454	No change in colour and odour	4.8

20th day	+++	6455	No change in colour and odour	4.8
25th day	+++	6457	No change in colour and odour	4.7
30th day	+++	6460	No change in colour and odour	4.8

+=average ++=good +++=excellent

SUMMARY AND CONCLUSION

The recent studies conclude that the use of herbal plant products with proven efficacy, such as in the formulation of hair masks. This investigation was carried out on the basis of the traditional and present-day knowledge that was used to formulate the Polyherbal IPN Hair nourishing mask gel. The formulation aims to nourish and moisturise the hair, promoting smooth, silky, and healthy locks. The polyherbal approach combines the therapeutic properties of each ingredient, enhancing the overall efficacy of the product. This gel mask offers a promising natural alternative for hair care, potentially reducing the reliance on chemical-based products and traditional oiling. The project's findings suggest that the developed gel mask exhibits promising hair-nourishing with advanced penetration and absorption of the ingredients to the roots with damage-controlling properties, making it a valuable addition to natural hair care regimens.

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Literature Study:

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S. K. Ganisha Bhanu and Y. Sai Sri Sruthi, Department of Pharmaceutics, Mother Teresa Pharmacy College, Kothuru, Sathupally, FORMULATION AND EVALUATION OF HERBAL HAIR MASK
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2. Mishra et al. (2021).
Natural Polymers as aloe vera gel, xanthan gum, guar gum, pectin, chitosan. Synthetic Polymers: Carbopol, HPMC (hydroxypropyl methylcellulose), polyvinyl alcohol.

3. Kumar et al. (2020)
Hydrogels are three-dimensional, hydrophilic polymer networks capable of absorbing and retaining large amounts of water while maintaining their structure. They provide enhanced bioavailability, prolonged retention time, and better penetration of active ingredients into the scalp and hair follicles.

4. Gupta et al. (2019)
IPN form a moisture-locking barrier, preventing hair dryness. Sustained Release of Active Ingredients they allow gradual release of herbal extracts, prolonging therapeutic action. Unlike oil-based products, hydrogels are lightweight and do not leave residue on hair.

5. Patel et al., 2018).Comparative Analysis with Commercial Products. Studies have shown that polyherbal lformulations are more effective than synthetic hair masks due to their natural bioactive compounds, fewer side effects, and holistic benefits. Unlike synthetic hair masks containing silicones and sulfates, hydrogel-based herbal masks ensure deep nourishment without harmful residues.

6. ***Surjushe et al. (2008)***
7. Aloe vera contains proteolytic enzymes that repair dead scalp cells, improving hair growth and reducing dandruff. Its mucilage content enhances the hydrogel's texture and moisture retention.
Polyherbal Formulations
8. 1. Synergistic effects: Polyherbal formulations can exhibit synergistic effects, enhancing the therapeutic benefits of individual ingredients (Senthil Kumar, 2018).
9. 2. Hair growth promotion: Certain herbs and oils, such as coconut oil and castor oil, have been traditionally used to promote hair growth and improve hair health (Sharma, 2019).

Interpenetrating Polymer Network (IPN) Technology
10. 1. Controlled release: IPN technology can provide controlled release of active ingredients, ensuring prolonged benefits for hair and scalp (Lee, 2018).
11. 2. Improved stability: IPN gels can exhibit improved stability and shelf life, making them a promising option for hair care products (Gupta, 2013).

Ingredients
12. 1. Coconut oil: Coconut oil is rich in nutrients and has been shown to nourish and moisturize hair (Ogbolu, 2007).
13. 2. Vitamin E oil: Vitamin E oil is an antioxidant that can help protect hair from damage and promote healthy hair growth (Traber, 2013).
14. 3. Lavender oil: Lavender oil has been traditionally used to promote relaxation and reduce stress, which can contribute to hair loss (Lee, 2012).
15. 4. Castor oil: Castor oil is rich in ricinoleic acid, which has been shown to promote hair growth and reduce inflammation (Vijay Kumar, 2017).

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