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FORMULATION AND EVALUATION OF POLYHERBAL ANTI-DANDRUFF HAIR GEL

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ABSTRACT

This study describes the development and evaluation of a polyherbal anti-dandruff hair gel using medicinal plant extracts including guava leaves (Psidium guajava), curry leaves (Murraya koenigii), amla (Emblica officinalis), and aloe vera (Aloe barbadensis). Due to the limitations and side effects associated with prolonged use of conventional anti-dandruff products, herbal alternatives offer a safer approach. The gel was formulated by a simple and economical method and evaluated for physicochemical parameters such as appearance, pH, consistency, spreadability, viscosity, homogeneity, washability, and stability. Antimicrobial activity against dandruff-causing microorganisms was assessed using the agar well diffusion method. The formulated gel showed satisfactory physical characteristics, good stability, and effective antimicrobial activity. These findings indicate that the developed polyherbal hair gel has potential as a safe, effective, and eco-friendly formulation for the management of dandruff and improvement of scalp health.

Keywords: Herbal hair gel, Anti-dandruff, Guava leaves extract, Scalp health, Anti-microbial activity.

INTRODUCTION

Dandruff, a common and often frustrating scalp condition, is characterized by the shedding of dead skin cells, often accompanied by mild itching. Individuals with compromised immunity or poor scalp hygiene are more susceptible to these infections, leading to frequent scalp issues. While numerous conventional treatments are available in the market, herbal remedies are becoming increasingly preferred due to their proven effectiveness, safety, and ability to prevent recurrence. This growing preference for herbal solutions highlights the need for developing safe and natural alternatives to combat dandruff. Herbal extracts from plants like guava leaves (Psidium guajava), curry leaves (Murraya koenigii), amla (Emblica officinalis), and aloe vera (Aloe barbadensis) have shown promising results in treating various scalp infections, including candidiasis. Guava leaves are rich in vitamins B and C, which help nourish the scalp, promote hair growth, and exhibit antibacterial and antifungal properties. Similarly, curry leaves, containing monoterpenoids and sesquiterpenoids, have strong antimicrobial and anti-inflammatory effects. Amla, abundant in vitamin C, prevents premature graying and enhances hair strength, while aloe vera is known for its soothing properties, providing relief from scalp irritation and promoting overall scalp health.

This study focuses on the development and evaluation of a polyherbal anti-dandruff hair gel, combining these potent extracts. The gel was tested using the Agar well diffusion method to assess its effectiveness against Candida albicans and Staphylococcus aureus, two major contributors to dandruff and other scalp infections. The results indicate that the gel not only helps in treating candidiasis but also nourishes the scalp, promotes hair growth, and prevents premature graying, making it a potential natural and sustainable solution for managing dandruff and improving scalp health.

Scalp Infection

Scalp infections commonly include conditions such as dandruff, fungal infections (ringworm), inflammatory disorders like psoriasis and seborrheic dermatitis, parasitic infestations such as pediculosis (head lice), and allergic reactions. Tinea Capitis (Ringworm) is a highly contagious fungal infection resulting in scaly, inflamed, circular bald patches. Folliculitis is Inflammation or bacterial infection of the hair follicles, causing small, pimple-like bumps that may be tender or itchy. Scalp psoriasis is a chronic autoimmune skin condition that causes skin cells to multiply too rapidly, marked by thick, silvery scales and redness.Dandruff is a prevalent scalp condition characterized by the excessive shedding of dead skin cells, often accompanied by symptoms such as itching, redness, and flaking. It affects a significant portion of the global population and can have psychological effects, impacting self-esteem and social interactions. The primary causes of dandruff are multifactorial, including the overgrowth of microorganisms such as Malassezia species, Candida albicans, and Staphylococcus aureus, which thrive in oily scalp conditions, disrupting the skin microbiome and accelerating skin cell shedding. In severe cases, scaling and redness may extend to other areas like the forehead, eyebrows, and behind the ears, causing social embarrassment and discomfort.

Gel

Gels are semisolid systems that consist of dispersions of molecules in an aqueous liquid vehicle thickened

Dandruff **Folliculitis** **Scalp Psoriasis** **Scalp Ringworm**

Figure 1. Scalp infections

with a gelling agent. These systems possess intermediate properties between solids and liquids, making them easy to apply to the skin without being greasy. Gels are used in pharmaceutical and cosmetic formulations to deliver active ingredients to the skin.

Types of gels:

- Hydrogels
- Organogels
- Xerogels

Why use of Gels?

- Controlled release
- Topical applications
- Non-greasy
- Easy absorption
- Reduced systemic side effects

Herbal Hair Gel

Gels are semi-solid suspensions of small inorganic particles or large organic molecules impregnated with a liquid, consisting of a gelling agent and a liquid component. Ideal hair gel properties include antimicrobial properties, non-stickiness, cost-effectiveness, ease of washing, spreading, and safety. Herbal hair gel is a type of hair gel that is made from natural herbs, plants, and botanicals. These gels are designed to provide a natural and chemical-free alternative to traditional hair gels.

Benefits-

• Promotes healthy hair growth: Can help to stimulate hair growth and strengthen hair follicles.

• Reduce dandruff and itchiness: Can help to soothe and calm the scalp.

• Add shine and luster: Can help shine and luster to hair, leaving it looking healthy and vibrant.

• Antibacterial and Antifungal.

MATERIALS AND METHOD

Materials:

Guava leaves extract, Curry leaves extract, Aloe vera juice, Amla juice, Carbopol 940, Propylene glycol, Propyl and Methyl paraben, Triethanolamine, Water.

INGREDIENTS AND THEIR USES IN HERBAL HAIR GEL

1.GUAVA

Synonyms: Guava, Amrud, Peru,

Biological source: Guava consist of fresh and dried leavesof *Psidiumguajava Linn* (lemon guava, apple guava)

Family: Myrtaceae.

Figure 2. Guava leaves

Chemical constituents: The chemical constituents of guava are Flavonoids (Quercetin, Guaijaverin), Tannins (Ellagic acid), Saponins, Essential oils (Eucalyptol), terpenoids, Alkaloids,Phenolic compounds, Vitamin B & C.

Uses:

- Promotes Hair Growth: Contains antioxidants and flavonoids (like quercetin) that improve blood circulation to the scalp and stimulate hair follicles.
- Reduces Hair Fall: Strengthens hair roots and prevents breakage due to antimicrobial and anti-inflammatory properties.

- Controls Dandruff: Antibacterial and antifungal properties help maintain scalp hygiene and reduce dandruff.
- Improves scalp hairs: Reduces itching and inflammation.

2. CURRY LEAVES

Figure 3. Curry leaves

Synonyms: Curry leaf, kadhi patta, meetha neem

Biological source: Curry leaves consist of the fresh and dried leaves of *Murraya koenigii* (L.) Spreng.

Family: Rutaceae

Chemical constituents: The Chemical constituents of curry leaves are carbazole alkaloids (mahanine, koenine, girinimbine), essential oils (caryophyllene, phellandrene), flavonoids, tannins and glycosides. They also contain high levels of vitamins A, B, C, and E, plus iron, calcium, and phosphorus,

Uses:

- Promote hair growth by strengthening hair follicles.
- Reduce hair fall and nourish the scalp.
- Prevent premature greying of hair.
- Improve natural hair pigmentation.
- Also support better blood circulation to hair roots.

3. AMLA

Figure 4. Amla

Synonyms: Amla, Indian gooseberry, Emblica.

Biological source:

This consist of fresh as well as dried fruits of plants, *Phyllanthus emblica Linn* (syn. *Embilica officinalis Gaertn*)

Family: Euphorbiaceae.

Chemical constituents: The chemical constituents of amla are vitamin C (ascorbic acid is highly stable in amla), Tannins (Emblicanin A & B, Punigluconin), Flavonoids (Quercetin, kaempferol), Phenolic compounds, gallic acid, ellagic acid & Minerals (iron, calcium).

Uses:

- Strengthens hair roots: Rich in Vitamin C and antioxidants that nourish the scalp.
- Promotes hair growth & hair nourishment.
- Prevents dandruff: Has antimicrobial and anti-inflammatory effects.

- It also used as antifungal and antioxidant.
- Prevents premature graying of hairs.

Figure 5. Aloe vera

4. Aloe vera

Synonyms: Aloe

Biological source: Aloes is the dried juice of the leaves of various species of Aloe;*Aloe barbadensis, Aloe ferox, Aloe officinalis, Aloe vulgaris*

Chemical constituents: The chemical constituents of aloe vera are Polysaccharides, Anthraquinones (Aloin, barbaloin), Enzymes (Amylase, catalase, cellulose), Vitamins (A, C, E, B12, folic acid) Minerals (Calcium, magnesium), Saponins, amino acids, lignin, salicylic acid.

Uses:

- Moisturizes Hair and Scalp: Hydrates dry hair and soothes itchy, flaky scalp.
- Promotes Hair Growth: Contains enzymes that help stimulate hair follicles and reduce hair fall.
- Reduces Dandruff: Its antifungal and antibacterial properties help combat dandruff and scalp infections.
- Adds Shine and Smoothness: Makes hair softer, shinier, and more manageable.
- Reduces Frizz: Helps tame frizz and flyaway by locking in moisture.
- Natural Styling Gel: Provides a light hold for natural hairstyles without chemicals.

Methods:

1. Preparation of Guava leaves extract:

The fresh curry leaves were thoroughly washed with water and dried in shade for 3 days. After drying, leaves were ground into coarse powder using a mechanical grinder. Phytochemical extract of guava is obtained by immersion extraction method. The methanol extract is prepared by mixing 10 grams of guava leaf powder with 70 ml of methanol and 30 ml of distilled water. This mixture is kept in a dark place to avoid sunlight for 3 days at room temperature. Beakers are used for storage; the clone bottle is sterilized and wrapped in aluminum foil to prevent evaporation. After the 3-day soaking process, the mixtures were filtered with filter paper, and the solvent was allowed to evaporate at 37 °C.

Figure 6. Guava leaves extract

2. Preparation of Curry leaves extract:

The fresh curry leaves were thoroughly washed with water and dried in shade for 3 days. After drying, leaves were ground into coarse powder using a mechanical grinder. About 10 grams of the powdered plant material was subjected to extraction. The leaves were extracted using ethanol (150 mL) by the maceration process for 3 days at room temperature. The obtained extracts were filtered using filter paper, and the solvent was allowed to evaporate at 37 °C.

Figure 7. Curry leaves extract

3. Preparation of Amla juice:

The fresh Amla fruit was collected and cut into small pieces. It was crush by using some required amount of water with the help of mixer to form juice. And then filtered through a clean cotton cloth and the Amla Juice was obtained.

Figure 8. Amla juice

4. Preparation of Aloe vera juice:

The aloe leaves were cleaned and placed upright in a beaker for 15-20 min to drain out all the yellow color sap present. The pulps from the aloe leaf were removed and collected in beaker and grind it into the mixer to form liquid foam. This liquid was filtered to remove any remaining particles.

Figure 9. Aloe juice

PHYTOCHEMICAL TEST FOR GUAVA LEAVES EXTRACT

Figure 10. Phytochemical screening of guava extract

Table1. Phytochemical analysis of the extract

Phytochemical	Reagents/ Test	Procedure	Observation	Inference
Alkaloids	Mayer's test	Add a few drops Mayer's reagent (potassium mercuric iodide) to the extract	White or creamy precipitate formation	Present

Saponins	Froth Test	Shake the extract with distilled water vigorously	Stable froth formation	Present
Tannins and Phenols	Ferric Chloride test	Add a few drops of 5% ferric chloride ($FeCl_3$) solution to the extract	Blue, green, or black coloration	Present
Flavonoids	Lead acetate test	Add few drops of 10% lead acetate solution to the extract	Formation of yellow precipitate	Present
Glycosides	Keller-Kiliani test	Extract + glacial acetic acid + $FeCl_3$ + conc. H_2SO_4	Formation of reddish-brown ring	Present
Terpenoids	Salkowski test	Extract mixed with chloroform and conc. sulfuric acid (H_2SO_4)	Reddish brown color at interface	Present

PREPARATION OF POLYHERBAL HAIR GEL

1) Weigh required quantity of Carbopol 940 and dispersed in 25 ml of distilled water in beaker.

2) Keep beaker aside for half an hour to swell Carbopol 940 & then start stirring at 1200 rpm by using mechanical stirrer for 30 min

3) **Solution A:** Take 2ml of guava extract and curry leaves extract, adding them to 5ml of propylene glycol in one beaker & stirred properly.

4) **Solution B:** Add aloe juice, Amla juice, Methyl paraben & propyl paraben in 5ml propylene glycol in another beaker.

5) Disperse solution A & B in Carbopol 940 with constant stirring.

6) Finally add remaining amount of distilled water (i.e. makeup the solution) to make 50ml of formulation & add triethanolamine dropwise to the formulation until pH becomes neutral and the gel get required consistency.

Table 2. Composition of Polyherbal hair gel

INGREDIENTS	Batch (F1)	Batch (F2)	Batch (F3)	USES
Guava leaves extract	1 ml	1.5ml	2ml	Antibacterial, Antifungal
Curry leaves extract	1 ml	1ml	2ml	Antioxidant, Antimicrobial
Amla juice	1ml	1.5ml	2ml	Hair nourishment
Aloe extract	1ml	1.5ml	2ml	Moisturizer
Carbopol 940	2g	0.45g	0.70g	Gelling agent
Propylene Glycol	10ml	10ml	10ml	Humectant
Propyl and methyl paraben	0.1g	0.1g	0.1g	Preservative
Triethanolamine	1-2drops	3-4drops	3-4drops	PH adjuster
Water	Q.S	Q.S	Q. S	Vehicle

Figure 11. Formulation of hair gel

➢ **Directions for use:**

Take a generous amount of gel and gently massage it into the scalp and damp hair roots. Leave it on for 20–30 minutes, then rinse thoroughly with fresh water. Use three times a week for best results.

➢ **Caution:**

• For external use only.

• Avoid contact with eyes.

• Store in a cool, dry, and dark place.

• Close the cap tightly after every use.

• Kindly do a patch test before regular use.

EVALUATION PARAMETERS

1. Organoleptic Evaluation

The organoleptic properties of the gel, including colour, odour, taste and special features such as texture, were analyzed using sensory organs. Parameters like touch and texture were also observed to ensure the gel's appeal and uniformity.

2. pH Measurement

The pH of the formulated herbal gels was determined using a calibrated digital pH meter. Approximately 0.5 g of the gel was dissolved in 50 mL of distilled water, and the pH of the solution was measured to ensure it is within an acceptable range for skin application. The pH of a polyherbal hair gel should ideally be in the range of 5.0 to 7.0, as this range is compatible with the natural pH of the scalp and hair.

Figure 13. PH measurement

3. Homogeneity

The homogeneity of the gel was assessed visually to check for uniformity and the absence of lumps, flocculates, or aggregates. Additionally, a qualitative evaluation was performed by sorting the gel between the thumb and forefinger to identify any aggregates or inconsistencies in texture.

4. Spreadability Test

The spreadability of the gel was determined using the parallel plate method. A specified amount of gel (approximately 1 g) was placed between two glass plates. A weight of 500 g was placed on the upper plate for 5 minutes to compress the gel into a uniform layer. The spread diameter of the gel was then measured. This method ensures the gel's ease of application and uniform distribution on the skin. Spreadability was determined using the following formula,

$S=M.L/T$

Where, S= Spreadability, M= Weight tied to upper slide, L= Length of glass slide,T= Time taken to separate the slide completely from each other.

5. Washability

The washability of the gel was tested by applying it to the skin and assessing the ease and extent of removal with water under normal conditions.

7. Viscosity Measurement

The viscosity of the gel was measured using a Brookfield viscometer at 60 rpm with spindle number L3. 5gm of the gel were placed in a beaker, and the spindle was immersed in the gel for about 5 minutes before taking readings to ensure proper consistency.

Figure 14. Brookefield viscometer

6. Skin Irritation Test

The herbal gel formulation was applied to the skin, and the area was monitored for any signs of irritation, redness, or rashes over a specific period to ensure its suitability for topical use.

8. Stability study

The formulation was kept in batches of varies conditions of temperature. The system was stable at 25℃ & no changes were noticeable when kept at room temperature (30±2℃) & 2nd batch was kept at refrigerated (4±2℃). No changes were found in pH, viscosity, homogeneity, & spreadability.

9. Antimicrobial test

The microbial test for an herbal hair gel is carried out to evaluate its antimicrobial activity and to ensure that the formulation is free from harmful microbial contamination. In this test, the herbal hair gel is tested against common scalp microorganisms (Escherichia coliand Staphylococcus aureus) such as bacteria and fungi using microbiological methods like the agar well diffusion method or disc diffusion method. The formulation is introduced onto a culture medium inoculated with microorganisms, and the zone of inhibition around the sample is measured after incubation at 37°C For 24 h. A larger zone of inhibition indicates stronger antimicrobial activity. In addition, microbial limit tests may also be performed to confirm that the product does not contain excessive microbial load during storage. This test helps in assessing the effectiveness, purity, safety, and quality of the formulation. Antibacterial activity was evaluated by measuring the diameters of the zone of inhibitions**.**

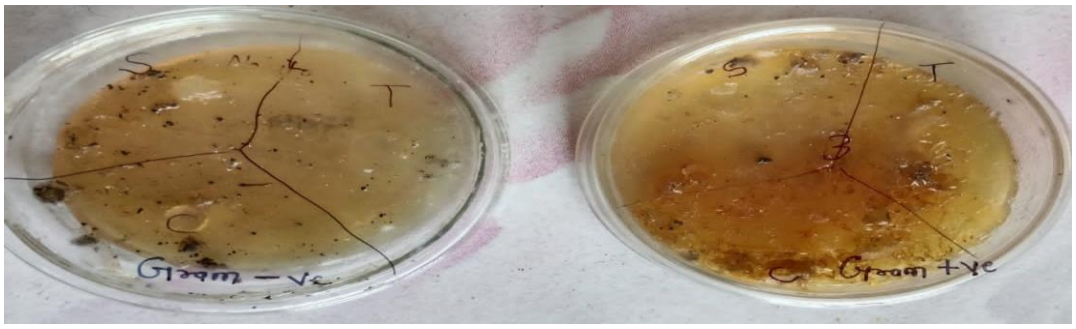

Figure 15. Zone of inhibition of Escherichia coliand Staphylococcus aureus.

Table 3.Zone of inhibition

Compound	Zone of inhibition (mm)	
	Escherichia coli	**Staphylococcus aureus**
Standard (Ciprofloxacin)	20	22
Sample	16	18

RESULT AND DISCUSSION

Table 4. Evaluation parameter

Sr. no	Parameters	Observations		
		F1	**F2**	**F3**
1	Colour	Dark green	Yellowish green	Olive/Pale green
2	Odour	Pleasant	Pleasant	Pleasant
3	Appearance	Smooth	Smooth	Smooth
4	pH	6.8	5.9	6.8
5	Viscosity	32130 cP	22085cP	22025cP
6	Homogeneity	Lump	Lump	Excellent
7	Spreadability	3 gmcm/sec	4 gmcm/sec	6 gmcm/sec
8	Stability	Stable	Stable	Stable
9	Skin irritation	No irritation	No irritation	No irritation
10	Washability	Easily washable	Easily washable	Easily washable
11	Antimicrobial activity	No microbial growth	No microbial growth	No microbial growth

CONCLUSION

The study evaluated the formulation and properties of herbal gels (F1 to F3) containing natural extracts like guava, curry leaves, aloe, and amla. The gels exhibited stable organoleptic characteristics, including consistent olive green colour, mild pleasant odour, and smooth texture, indicating effective preparation and ingredient blending. Most formulations had skin-compatible pH values, with F2 being slightly acidic. F3 showed the best performance in terms of spreadability, washability, and viscosity, making it the most effective formulation. The antimicrobial activity of the gels was confirmed by their ability to inhibit Escherichia coliand Staphylococcus aureus, with higher concentrations showing increased inhibition zones. Overall, F3 emerges as the most promising formulation, offering excellent therapeutic potential for effective and long-lasting topical treatment.

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