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DEVELOPMENT AND ASSESSMENT OF A POLYHERBAL HAIR GEL: FORMULATION, CHARACTERIZATION AND EFFICACY EVALUATION

Akshay A. Bhelave*, Anuja S. Bhonge, Kartik K. Chaudhari, Atharva D. Deshmukh, Dr. B. V. Bakade
P. Wadhwani College Of Pharmacy, Yavatmal, Maharashtra, India.

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ABSTRACT

This study focused on the development and evaluation of a polyherbal hair gel formulated using natural ingredients—curry leaves, wheat, flaxseed, and aloe vera—as a safer and more effective alternative to synthetic hair gels for managing scalp and hair issues such as dandruff, hair fall, and dryness. The herbal components were extracted through specific methods: maceration for curry leaves, aqueous extraction for wheat, hydrothermal extraction for flaxseed mucilage, and cold-process extraction for aloe vera gel. Phytochemical screening confirmed the presence of key bioactive compounds such as alkaloids, flavonoids, and saponins. The gel was formulated using a Carbopol 940 base combined with the herbal extracts, along with glycerin, triethanolamine, and sodium benzoate. Evaluation parameters included pH, viscosity, spreadability, homogeneity, washability, extrudability, thermal stability at 25°C and 4°C, and antimicrobial activity against common scalp pathogens. The final formulation exhibited optimal physicochemical characteristics—pH of 6.97, viscosity ranging from 31,400 to 40,200 cps, and good spreadability (13.11 g•cm/s). It showed no signs of skin irritation and maintained excellent stability under both temperature conditions. The gel demonstrated significant antimicrobial and antifungal activity against *Malassezia furfur* and *Staphylococcus aureus*, attributed to the presence of therapeutic phytochemicals like mahanimbine, omega-3 fatty acids, and acemannan. Overall, the polyherbal gel proved to be a safe, stable, and multifunctional product with moisturizing, anti-dandruff, and hair-strengthening properties, offering a sustainable, chemical-free alternative to conventional hair care products.

Corresponding author
Akshay A. Bhelave
P. Wadhwani College Of Pharmacy, Yavatmal, Maharashtra, India.

P. Wadhwani College Of Pharmacy, Yavatmal, Maharashtra, India.

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INTRODUCTION:

Recently, there has been a rise in the number of men and women globally afflicted with hair thinning or hair loss. Alopecia or hair loss is a frequent patient complaint and cause of much physical and psychological distress. Androgenetic alopecia happens to both men and women and manifests as a pattern of progressive hair loss from the scalp. About 70% of men and 30% of women suffer from alopecia, the most common condition in contemporary societies with significant psychological and economic ramifications. One of the main causes of hair loss is dandruff. However, dandruff is a very common, non-contagious hair problem that affects people of all ages. Pityriasis simplex capitis is the medical term for the shedding of dead skin from the scalp. It may be greasy or dry. Numerous herbal remedies are used in the Indian traditional medical system to encourage hair growth. Herbs are a priceless gift from God to humanity, and they have become oversupplied in the global market in recent years.[1]

Five percent of people worldwide suffer from dandruff, a common and embarrassing disorder.[2] Dandruff is a ubiquitous condition that affects the majority of adults from regions, ethnic groups, and societies. The most exposed age group is in the post-pubertal age group (18-60 years age group). Not only does it affect the appearance by making the hair (and the scalp) dry and lacking lustre, but it is also accompanied by scalpcitis or itching of the scalp. In terms of seasonal effects, it has been established that the severity of dandruff can increase during winter. It has also been found that individuals suffering from dandruff are more likely to lose hair quicker than individuals to whom dandruff has not occurred. It was found that in a day study, the dandruff-affected individuals lost at least double the number of hairs in comparison to individuals without the disorder.[3] Additionally, the detergent treatment has a temporary effect, and the patient may experience a recurrence of the dandruff. The key reason for recurrence is that the specific cause for dandruff development has not been determined. As a result, the treatment is symptomatic, temporal and directed primarily at conferment of transient relief from scaling and itching although in most cases, there is no inflammation connected with dandruff. As a result, the traditional treatment is largely cosmetic. Androgen sensitivity of human scalp rich in sebum is reported in the literature. Sebum formation that is simultaneous with puberty accounts for the association of age with dandruff formation. [4]

Malassezia is most frequently found in patients exhibiting increased sebaceous secretion, as Malassezia feeds on lipids. Folliculitis is a common skin condition that causes inflammation of the skin. Different microbes can cause Folliculitis, but most people with it have Staphylococcus aureus. Candida albicans and Staphylococcus aureus are opportunistic bacteria. This infection happens more often and causes hair problems more often when people don't keep things clean or have a weaker immune system. There are a lot of treatments like this on the market, but herbal treatments are always the best choice. Even after a full recovery, the infection can come back.[5]

Hair Gel:[6]

Definition: Hair gel is a hairstyling product that provides hold and texture to hair. It is made from water, polymers, thickening agents, and preservatives. Hair gels are available in various strengths, from light to firm hold.

Properties of hair gel:

1. The gel has to be see-through.
2. The gel formulation should not be greasy or sticky.
3. The gelling agent must be safe and not react with anything.
4. The gelling agent must not react with the active ingredients or any other excipients.
5. It should go on the skin smoothly. The swelling property trapped the drug.

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Composition of Conventional Hair Gels:

1. Water (Aqua) – The base of most gels.
2. Polymers (e.g., PVP, VP/VA Copolymer) – Provide hold by forming a film around the hair strands.
3. Thickeners (e.g., Carbomer, Xanthan Gum) – Give the gel its consistency.
4. Humectants (e.g., Glycerin, Propylene Glycol) – Retain moisture.
5. Alcohols (e.g., Ethanol, Isopropanol) – Help in quick drying.
6. Preservatives (e.g., Parabens, Phenoxyethanol) – Prevent microbial growth.
7. Fragrances and Colors – Enhance aesthetic appeal.

Advantages of Conventional Hair Gel:

1. Strong Hold: Provides long-lasting hairstyles.
2. Wet Look: Gives a glossy, sleek finish.
3. Easy to Apply & Wash Out: Most gels are water-soluble.
4. Available in Various Strengths: Light, medium, and stronghold options.

Disadvantages of Conventional Hair Gel:

1. Hair Dryness & Damage: Alcohol-based gels can cause excessive dryness.
2. Scalp Irritation: Some synthetic ingredients can lead to itching or dandruff.
3. Residue & Flakiness: Cheap gels may leave white flakes after drying.
4. Chemical Exposure: Continuous use of synthetic chemicals may lead to long-term hair damage.

Polyherbal Hair Gel: A Natural Alternative [7]

Definition: Polyherbal hair gel is a styling gel formulated using a combination of herbal extracts and natural polymers. These gels aim to provide hold and nourishment without the side effects of chemical-based gels.

Common Ingredients in Polyherbal Hair Gel:[8]

1. Aloe Vera (Aloe barbadensis) – Moisturizes hair and scalp.
2. Curry leaves (Trigonella foenum-graecum) – Strengthens hair and prevents dandruff.
3. Wheat (Eclipta alba) – Promotes hair growth.
4. Flaxseed Extract (Linum usitatissimum) – Provides a natural hold to hair.
5. Guar Gum / Xanthan Gum – Natural thickening agents.

Advantages of Polyherbal Hair Gel: [9]

1. Natural & Chemical-Free: Does not contain synthetic polymers or alcohol.
2. Moisturizing & Nourishing: Contains herbal extracts that promote hair health.
3. Scalp-Friendly: Less chance of irritation and dandruff.
4. Non-Toxic & Eco-Friendly: Biodegradable and free from harmful chemicals.
5. Suitable for All Hair Types: Can be used on sensitive scalps.

Disadvantages of Polyherbal Hair Gel:[10]

1. Weaker Hold: Natural ingredients may not provide as strong a hold as synthetic gels.
2. Shorter Shelf Life: Lacks strong preservatives, so it may expire quickly.
3. Costlier: Herbal formulations can be more expensive.
4. Varied Performance: Different natural ingredients may react differently based on hair type.

Comparison Table: Hair Gel vs. Polyherbal Hair Gel [11]

Table No. 01: - Hair Gel vs. Polyherbal Hair Gel

Feature	Conventional Hair Gel	Polyherbal Hair Gel
Hold Strength	Strong to extra strong	Light to medium
Moisturizing	No, often drying	Yes, herbal extracts
Scalp Health	May irritate.	Gentle and soothing
Residue/Flakiness	Can leave residue	Minimal or no residue
Chemical Content	Contains synthetic ingredients	Natural & chemical-free
Eco-Friendliness	Less eco-friendly	Biodegradable
Cost	Affordable	Can be expensive
Shelf Life	Long due to Preservatives	Shorter due to natural preservatives

Hair Problems and Treatment with Polyherbal Hair Gel [12-14]

Table No. 02: - Hair Problems Treatment with Polyherbal Hair Gel

Hair Problem	Characteristics	Suitable Herbal Ingredients	Additional Care
Dandruff (Seborrheic Dermatitis)	Flaky, itchy scalp, white/yellowish flakes, irritation	Neem (*Azadirachta indica*) – Antifungal, Tea Tree Oil – Soothes scalp, Fenugreek (Trigonella foenum-graecum) – Anti-inflammatory	Use mild herbal shampoo, avoid excessive oiling, and maintain scalp hygiene
Hair Fall & Thinning	Excessive shedding, weak roots, visible scalp	Bhringraj (*Eclipta alba*) – Strengthens roots, Amla (Phyllanthus emblica) – Rich in Vitamin C, Brahmi (*Bacopa monnieri*) – Reduces stress-induced hair fall.	Regular scalp massage, balanced diet, avoid heat styling
Dry & Frizzy Hair	Rough texture, lack of moisture, difficulty in styling	Aloe Vera (*Aloe barbadensis*) – Hydrates, Coconut Oil – Deep conditioning, Hibiscus (*Hibiscus rosa-sinensis)* – Smoothens hair	Use sulfate-free shampoos, deep conditioning, avoid excessive brushing
Oily & Greasy Scalp	Excessive sebum production, limp hair, scalp odour	Lemon Extract (*Citrus limon*) – Controls oil, Green Tea Extract – Antioxidant, Mint (*Mentha spicata*) – Refreshes scalp	Wash hair regularly, avoid heavy oils, maintain a balanced diet
Split Ends & Breakage	Fragile hair, split strands, brittle ends	Flaxseed (*Linum usitatissimum*) – Strengthens hair, Castor Oil – Promotes elasticity, Argan Oil – Nourishes hair shaft	Trim hair regularly, avoid excessive heat styling, and use silk pillowcases.
Pre Hair Problem mature Graying	Early greying, loss of natural pigment	Amla (*Phyllanthus emblica*) – Rich in antioxidants, Henna (*Lawsonia inermis*) – Natural dye, Curry Leaves (*Murrayakoenigii*) – Enhances melanin production	Reduce stress, avoid chemical dyes, eat iron & protein-rich foods
Scalp Infections	Redness, irritation, fungal/bacterial infections	Neem (*Azadirachta indica*) – Antimicrobial, Turmeric (*Curcuma longa*) – Anti-inflammatory, Tea Tree Oil – Natural antiseptic	Keep the scalp clean, avoid excessive sweating, use herbal scalp rinses
Alopecia (Bald Patches)	Patchy hair loss, receding hairline	Onion Extract (*Allium cepa*) – Stimulates follicles, Ginseng (*Panax ginseng*) – Promotes hair growth, Rosemary Oil – Improves circulation.	Avoid stress, use herbal oils, consult a specialist for severe cases
Heat & Chemical Damage	Weak, dull hair, breakage from styling tools	Argan Oil – Repairs damage, Coconut Oil – Deep conditioning, Aloe Vera – Soothes the scalp	Minimize heat exposure, use natural styling products, and protect your hairstyles.

Figure No. 01: - Different types of hair problems

PLANT PROFILE

Herbal Ingredients:

CURRY LEAVES.[15]

Murrayakoenigii are small to medium-sized tropical evergreen trees. They exhibit moderate growth, reaching heights of 13-20 ft (4-6 meters) at maturity. The leaves are pinnate, with a 1-2.5 cm (0.3-0.9 in) petiole and 10-22 leaflets. Each leaflet is 2-4 cm (0.8–1.8 in) long, oblong-lanceolate, and glossy green, emitting a distinct citrusy aroma when crushed.

Figure No 02: - Curry leaves (Murrayakoenigii)

Synonyms - Curry leaves, Sweet Neem, Kadi Patta, Kariveppilai

Biological name - *Murraya koenigii*

Family - Rutaceae

Genus - Murraya

Active constituents - Alkaloids-Mahanimbine, Koenimbine (Hair growthstimulation)

Flavonoids – Quercetin, Kaempferol (Antioxidant, UV protection)
Glycosides & Tannins – Strengthen hair, delay premature greying
Essential Oils – Linalool, α-Pinene (Antimicrobial, scalp soothing)
Vitamins & Minerals – Vitamin A, B6, C, Iron (Nourish scalp & hair)
Proteins & Amino Acids – Support hair follicle Regeneration

Uses

1. Hair Growth Stimulation: Curry leaves are rich in antioxidants and essential nutrients that may help stimulate hair follicles, strengthen hair roots, and promote hair growth. They can help reduce hair thinning.
2. Hair Conditioning: The oils from curry leaves can be used to moisturize and condition the hair, giving it a soft texture.
3. Prevention of Premature Graying: Curry leaves are often used in hair treatments to delay premature greying by promoting melanin production in hair follicles.
4. Anti-Dandruff: The antimicrobial properties of curry leaves help fight dandruff and scalp infections, improving scalp health.

WHEAT (*Triticum Aestivum)*[16]

Triticum aestivum is an annual grass growing 60–130 cm (2–4.5 ft) tall. It has linear, alternate leaves with a sheath enclosing the stem. The leaf blade is 15–40 cm (6–16 in) long and 0.5–2 cm (0.2–0.8 in) wide, featuring a membranous ligule and auricles at the base. A staple cereal crop, it is cultivated globally for its nutrient-rich grains.

Figure No 03: - *Wheat (Triticum Aestivum)*

Synonyms - Common Wheat, Bread Wheat, Triticum aestivum
Biological name -*Triticum Aestivum*
Family - Poaceae
Genus - Triticum

Active constituents - Proteins: Glutamine, Proline (Strengthenshair)

Vitamins: Vitamin E, B-complex (Nourishes scalp)
Minerals: Zinc, Iron (Promotes hair growth)
Antioxidants: Ferulic acid, Lignans (Prevents hair damage)

Figure No 04: - *Flax Seeds (Linum usitatissimum)*

Uses[17]

1. Contains wheat protein, which strengthens and repairs damaged hair
2. Forms a protective barrier to retain moisture and prevent dryness
3. Adds smoothness and elasticity to hair
4. Nutritional Benefits: Wheat is a staple grain rich in carbohydrates, providing essential energy for daily activities. It is also a good source of proteins and fibre.
5. Digestive Health: Whole wheat is high in dietary fibre, aiding digestion, preventing constipation, and promoting gut health.
6. Heart Health: The presence of dietary fibre and phytochemicals in wheat helps lower bad cholesterol levels, reducing the risk of cardiovascular diseases.
7. Skin Care: Wheat germ oil, extracted from wheat kernels, is used in skincare products due to its high vitamin E content, which nourishes and protects the skin.
8. Helps reduce frizz and improve hair texture

FLAX SEED *(Linum usitatissimum)*[18]

Linum usitatissimum is a slender annual herb reaching 1.6-3.9 ft (0.5–1.2 meters) in height. The leaves are lanceolate, alternate, and 0.8–1.2 in (2-3 cm) long, with smooth margins and a bluish-green hue. Valued for its seeds (linseeds) and fibrous stems, it thrives in temperate climates.

Synonyms - Linseed, Alsi, Flax
Biological name- *Linum usitatissimum*
Family - Linaceae
Genus - Linum
Active constituents - Omega-3 Fatty Acids: Alpha-linolenic acid (ALA)
Lignans: Antioxidant & anti-inflammatory
Proteins & Amino Acids: Hair follicle regeneration
Vitamins: Vitamin E, B-complex(Moisturizing & scalpnourishment)

Uses[19]

Cardiovascular Health: Flaxseed is rich in alpha-linolenic acid (ALA), an omega-3 fatty acid that helps reduce inflammation and lower the risk of heart diseases.

Digestive Benefits: The high fibre content in flaxseed aids digestion, prevents constipation, and promotes healthy bowel movements.

Hormonal Balance: Lignans present in flaxseed have phytoestrogenic properties, helping regulate hormonal imbalances, particularly in women.

Skin and Hair Health: The essential fatty acids and antioxidants in flaxseed nourish the skin and hair, reducing dryness and improving elasticity.

ALOE VERA (*Aloe barbadensis miller)*[20]

Aloe barbadensis miller is a stemless or short-stemmed succulent perennial. Its fleshy, serrated leaves grow in a rosette, reaching 16–20 in (40-50 cm) long and 2.4–3.9 in (6-10 in) wide. The grey-green leaves contain a gel-like pulp used for medicinal and cosmetic purposes. It prefers arid, sunny environments.

Figure No 05: - *Aloe vera (Aloe barbadensis miller)*

Synonyms - Aloe, Ghritkumari, Kumari
Biological name - *Aloe barbadensis Miller*
Family - Asphodelaceae
Genus - Aloe
Active constituents - Polysaccharides: Acemannan (Hydration & scalp healing)
Enzymes: Proteolytic enzymes (Cleanses scalp, removesdead cells)
Vitamins: Vitamin A, C, E, B12 (Hair growth &antioxidant)
Minerals: Calcium, Magnesium, Zinc (Strengthensfollicles)

Uses [21]

1. Hair Gel: Aloe vera gel is commonly used as a natural hair gel, providing moisture, soothing the scalp, reducing dandruff, and enhancing hair shine and softness.
2. Skin Care: Aloe vera gel is widely used for its soothing, anti-inflammatory, and moisturizing properties, helping to treat sunburn, acne, and dry skin.

3. Digestive Aid: Aloe vera juice supports digestion, relieves acid reflux, and may help with irritable bowel syndrome (IBS).
4. Wound Healing: The gel accelerates wound healing by stimulating collagen production and reducing inflammation.
5. Immune Boosting: Aloe contains polysaccharides that support immune function by enhancing white blood cell activity.

MATERIALS AND METHODOLOGY:

Preparation of Herbal Extract:

Curry Leaves (*Murrayakoenigii*) Extraction.[22]

Methods: Maceration (Cold Extraction)

Procedure:

Took green curry leaves.

Soaked in ethanol (70%) or distilled water for 24-48 hours with occasional shaking.

Filtered, and the extract is evaporated to obtain a concentrated solution.

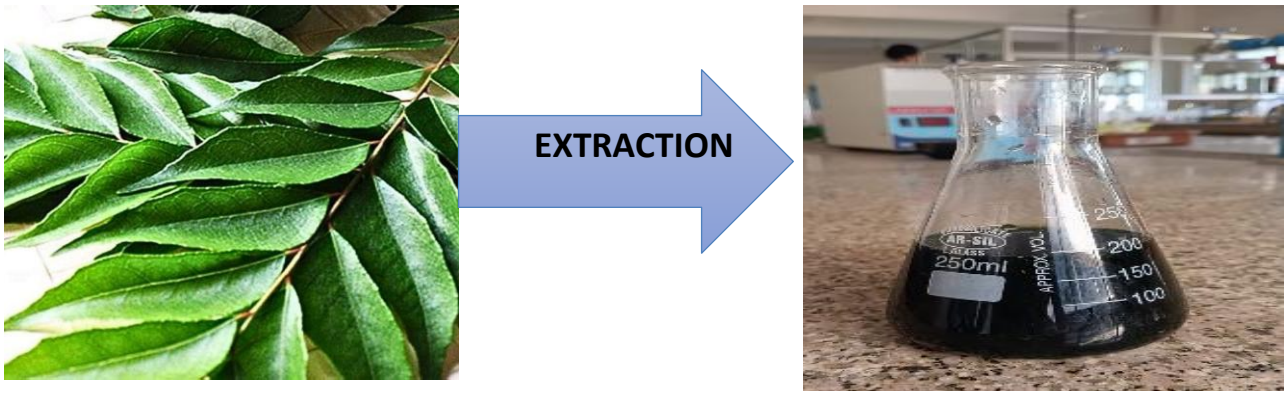

Figure No 06: *- Curry leaves Extraction*

Wheat (*Triticum aestivum*) Extraction [22]

Methods: Aqueous Extraction (Cold Pressing)

Procedure:

Wheat grains are soaked in water (1:3 ratio) for 12–24 hours.

Ground into a paste and filtered to extract proteins and antioxidants.

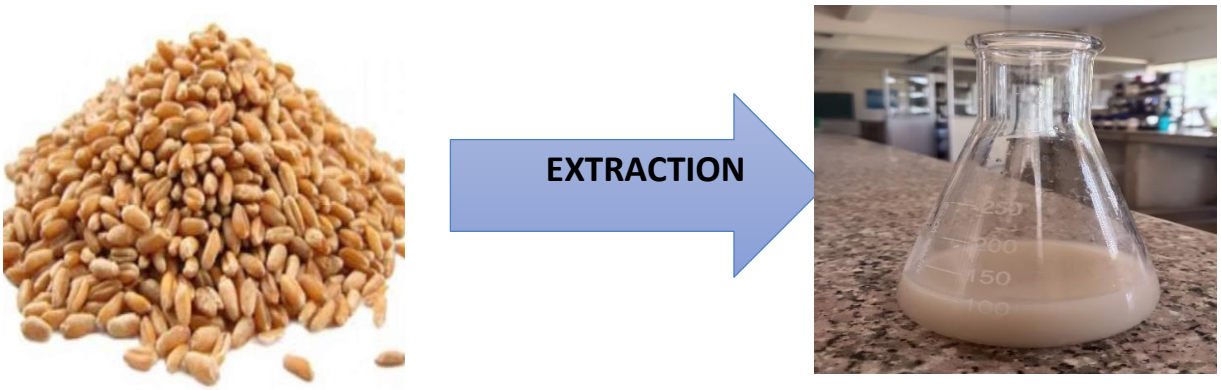

Figure No 07: - Wheat Extraction

Flaxseed (*Linum usitatissimum*) Extraction [23]

Methods: Hydrothermal Extraction (Gel Extraction)

Procedure:

Flaxseeds are boiled in water (1:10 ratio) at 80-90°C for 30 minutes.

Strained using a fine sieve to extract flaxseed mucilage (natural hair gel).

Cooled and preserved.

Figure No 08: - Flaxseed Extraction

Aloe Vera *(Aloe barbadensis)* Extraction [22-23]

Methods: Gel Extraction (Cold Process)

Procedure:

Fresh aloe vera leaves are washed and cut open.

The inner gel is scraped and filtered through a muslin cloth.

The gel is stabilized with ascorbic acid (0.1%) to prevent oxidation.

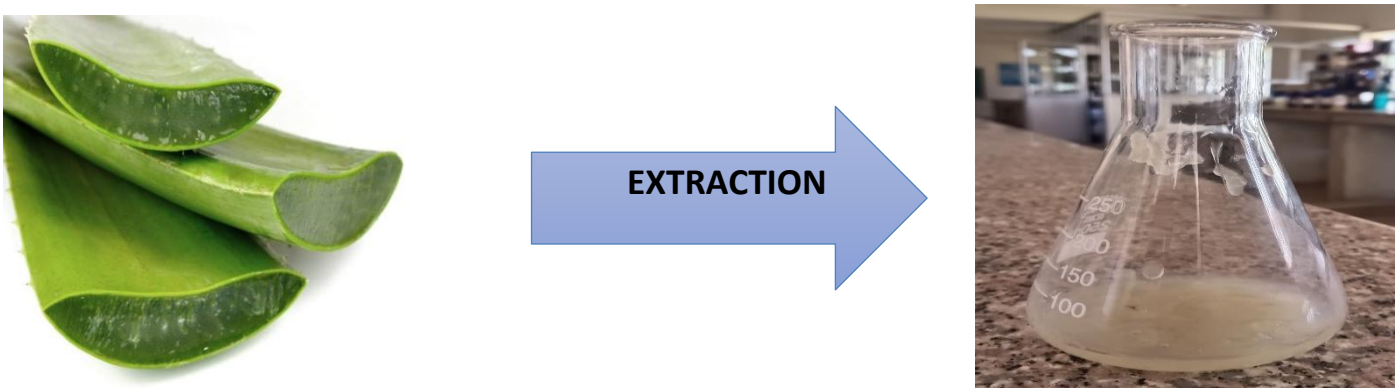

Figure No 09: - Aloe Vera Extraction

Table No. 03: - Material and Source

SR NO.	MATERIAL	SOURCE
1.	Curry leaves	Botanical garden of P. Wadhawani College of Pharmacy, Yavatmal
2.	Wheat	Local Market
3.	Flax Seeds	Local Market
4.	Aloe Vera	Botanical garden of P. Wadhawani College of Pharmacy, Yavatmal
5.	Carbapol 940	Yarrow Pharma, Pvt. Ltd.
6.	Triethanol Amine	Research lab fine chem-industries, Mumbai.
7.	Glycerin	Thermosil fine chem-industries, Charholi, Pune.
8.	Sodium Benzoate	Modern Chemicals Corporation, Bombay.
9.	Almond oil	Local Market
10.	Distilled Water	Chemical Store of P. Wadhawani college of pharmacy, Yavatmal

Table No. 04: - List of equipment used while formulation

SR NO.	NAME OF EQUIPMENT	MADE BY
1.	Weighing Balance	Nitiraj engineers, Pvt. Ltd.
2.	pH meter	VSI, Pvt. Ltd.
3.	Heating mantle	EIE, Pvt. Ltd.
4.	Homogenizer	REMI, Germany
5.	Brookfield viscometer	Brookfield engineers, USA

Phytochemical Screening of Curry Leaves Extract:[24]

1. **Alkaloids:** We mixed 1 ml of aqueous curry leaves extract with 2–3 drops of Dragondorff reagent and looked for the formation of orange and red colour.

2. **Flavonoids:** 1 ml of concentrated hydrochloric acid, 1 ml of magnesium chloride, and 1 ml of aqueous curry leaf extract were mixed together and checked for pink or tomato red colour.
3. **For cardio glycoside:** 1 ml of aqueous curry leaves extract, 2–3 drops of glacial acetic acid, 0.4 ml of Ferric chloride, and 2–3 drops of Con. H2SO4 were mixed together. There was a brown ring in the solution.
4. **Tannins:** 1 ml of curry leaves extract and 2 to 3 drops of 0.1% ferric chloride were mixed and looked for a blue, black, or brownish green colour.
5. **Saponins:** 2 millilitres of water and 1 millilitre of aqueous curry leaf extract were added, shaken vigorously, and the appearance of foam was assessed.
6. **Proteins:**Two to three drops of Bradford reagent were mixed with one milliliter of aqueous curry leaf extract, and the formation of a blue hue was monitored.
7. **Steroids:** One millilitre of 10% Con. H2SO4 and one millilitre of aqueous curry leaf extract were mixed, and the appearance of a green tint was assessed.

8. **Quinones:** Two or three drops of aqueous ammonia were mixed with one milliliter of aqueous curry leaf extract, and the colour of the aqueous layer was observed to change from light brown to red, pink, or violet.
9. **Terpenoids:** 1 ml of aqueous curry leaves extract and 2-3 drops of Con. H2SO4 was combined and checked for the appearance of yellow colour.
10. **Phenols:** 1 ml of aqueous curry leaves extract, 2 ml of distilled water and 2-3 drops of Ferric chloride were combined and checked for the formation of green or blue colour.

Phytochemical Tests for Wheat Extract (*Triticum aestivum*) [24]

1. **Alkaloids Test (Mayer's Test):** Mix a few drops of Mayer's reagent (Potassium mercuric iodide) with the wheat extract. If a creamy white precipitate is formed, then alkaloids are present.
2. **Flavonoids Test (Shinoda Test):** Mix a few drops of concentrated HCl and magnesium turnings with the wheat extract. Pinkish or red colour formation is an indication of the presence of flavonoids.
3. **Tannins Test (Ferric Chloride Test):** Place a few drops of ferric chloride ($FeCl_3$) solution in the wheat extract. Blue-black or greenish-black coloration indicates the presence of tannins.
4. **Saponins Test (Foam Test):** Shake 2 mL of wheat extract with 5 mL distilled water for 5 minutes. Frothing persistency indicates the presence of saponins.
5. **Phenols Test (Ferric Chloride Test):** Pour $FeCl_3$ solution into the amber-coloured wheat extract. Blue or green colouration shows the presence of phenols.

Phytochemical Tests for Aloe vera Extract [24]

1. **Anthraquinones Test (Bontrager Test**): Boil the Aloe vera extract in 10% sulfuric acid, filter, and mix an equal volume of benzene. Shake and mix with ammonia solution. Pink, red, or violet colour in the layer of ammonia is positive for anthraquinones.
2. **Alkaloids Test (Dragendorff's Test):** A few drops of Dragendorff's reagent (potassium bismuth iodide) are added to the Aloe vera extract. The reddish-brown precipitate indicates the presence of alkaloids.
3. **Keller-Kiliani Test (Glycosides Test):** Mix glacial acetic acid, $FeCl_3$, and conc. sulfuric acid with the Aloe vera extract. The presence of cardiac glycosides is indicated by a brown ring of colour at the interface.
4. **Saponins Test (Foam Test):** Shake 2 mL of Aloe vera extract with water and note froth formation. Frothing that persists shows the presence of saponins
5. **Flavonoids Test (Alkaline Reagent Test):** Add a few drops of NaOH to the Aloe vera extract. The intense yellow colour, which disappears on acidification, confirms flavonoids.

Phytochemical Screening of flaxseed extract:[25]

1. **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 pink.
   (b) Million's test: Mix 3 ml of T.S. White PowerPoint with 5 ml of Million's reagent. Warm. Ppt. It either turns brick red or dissolves to reveal a red solution.
2. **Alkaloids Test (Mayer's Test**: Add a few drops of Mayer's reagent (potassium mercuric iodide) to the flaxseed extract. The formation of a creamy white precipitate confirms the presence of alkaloids.
3. **Flavonoids Test (Shinoda Test)**: Add a few drops of concentrated HCl and a small piece of magnesium ribbon to the flaxseed extract.A pink, red, or orange colouration confirms the presence of flavonoids.

4. **Tannins Test (Ferric Chloride Test)**: Add a few drops of $FeCl_3$ (ferric chloride) solution to the extract. A blue-black or greenish-black colour indicates the presence of tannins.
5. **Saponins Test (Foam Test)**: Shake 2 mL of flaxseed extract vigorously with 5 mL ofdistilled water for 5 minutes. Persistent froth formation indicates the presence of saponins.
6. **Phenols Test (Ferric Chloride Test)**: Add $FeCl_3$ solution to the flaxseed extract. A blue or green colouration indicates the presence of phenolic compounds.
7. **Glycosides Test (Keller-Kiliani Test for Cardiac Glycosides)**: Add glacial acetic acid**,** $FeCl_3$, and concentrated sulfuric acid to the extract. A brown ring at the interface confirms the presence of cardiac glycosides.
8. **Lignans Test (Acid Hydrolysis Test)**: Treat the flaxseed extract with hydrochloric acid and heat for a few minutes, followed by cooling and adding sodium hydroxide.A colour change (often yellow to brown) indicates the presence of lignans, which are major bioactive compounds in flax seeds.

FORMULATION OF PLACEBO BATCH: [26]

Table No. 04: - formulation of placebo batch

Sr. NO.	INGREDIENTS	ROLE	QUANTITY (50gm)
1.	Carbamor 940	Gelling agent	1.0gm
2.	Triethanol Amine	Thickening agent	0.5gm
3.	Glycerin	Moisture	2.0gm
4.	Sodium Benzoate	Preservative	1.0gm
5.	Almond oil	Perfume	2 drops
6.	Distilled Water	Base	Q. s.

FORMULATION POLYHERBAL GEL:

Table No. 05: - Formulation of Polyherbal Gel

SR NO.	INGREDIENTS	ROLE	QUANTITY \100gm)
1.	Curry leaves	Strengthening hair	10.0gm
2.	Wheat	Texture & Anti-frizz	5.0gm
3.	Flax Seeds	Hydration & Moisture	10.0gm
4.	Aloe Vera	Smoothing & Anti-dandruff	20.0gm
5.	Carbamor 940	Gelling agent	2.0gm
6.	Triethanol Amine	Thickening agent	1.0gm
7.	Glycerin	Moisture	4.0gm
8.	Sodium Benzoate	Preservative	1.0gm
9.	Almond oil	Perfume	2 drops
10.	Distilled Water	Base	Q.S.

Formulation of Polyherbal Hair Gel: [27]

Procedure:

- A 250 mL beaker was selected, thoroughly washed, and sterilized by autoclaving to ensure aseptic conditions.
- The empty beaker was weighed, and its weight was recorded for accurate measurement of ingredients.
- The required herbal extracts were accurately weighed, including:

10gm of *Curry leaf extract (Murrayakoenigii)*
5 g of *Wheat extract (Triticum aestivum)*
10g of *Flaxseed extract (Linum usitatissimum)*

20gm of *Aloe vera extract (Aloe barbadensis miller)*

- All the weighed herbal extracts were transferred into the 250 mL beaker and subjected to continuous stirring using an electric stirrer for 5 minutes to achieve uniform dispersion.
- The following excipients were then weighed and added to the mixture:

1gm of *Triethanolamine* (pH adjuster and emulsifier)
4gm of *Glycerin* (humectant)
1gm of *Sodium benzoate* (preservative)

- A sufficient quantity of distilled water was added to the beaker, and the mixture was stirred continuously for 10 minutes to ensure proper blending.
- 2 g of Carbopol 940 (gelling agent) was slowly incorporated into the mixture with vigorous stirring until the desired gel-like consistency and texture were achieved.

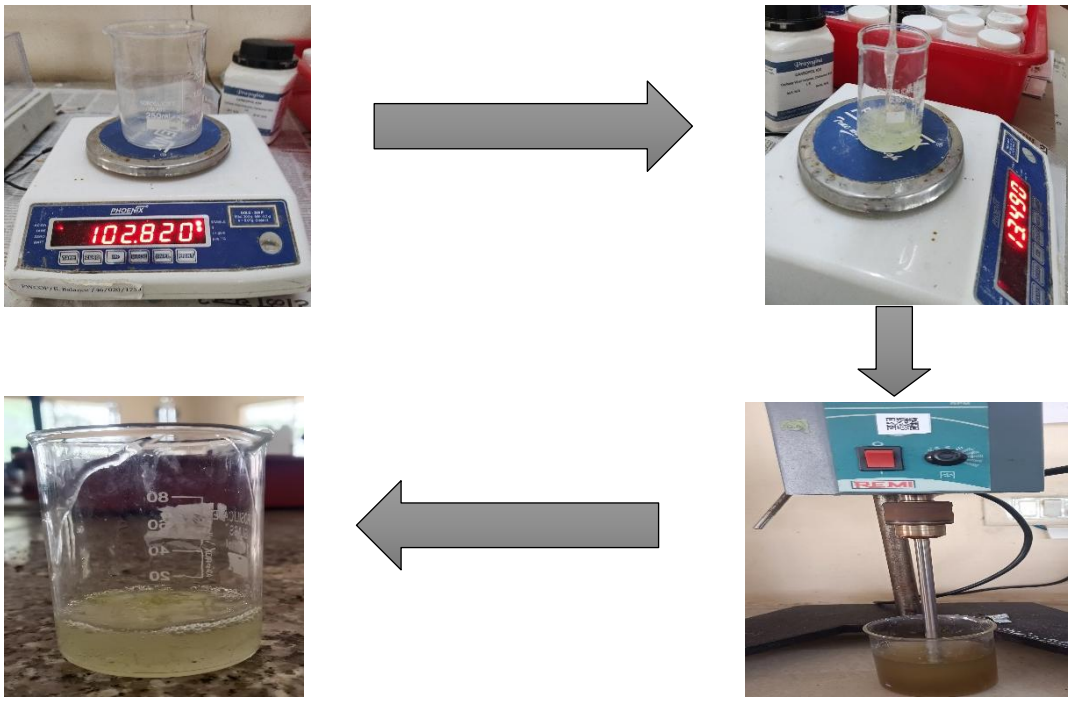

Figure No 10: - Process of Herbal hair gel formulation

Storage & Usage:

1. The prepared polyherbal hair gel was transferred into a sterile bottle.
2. It was stored in a cool, dry place or refrigerated for extended shelf life.
3. The polyherbal hair gel was applied to the wet hair for the best results
4. before use and applied to the hair rub well between the palm and then soft-handedly applied to the hair from root to tip and left to naturally dry.

Usage Instructions:

- Hair should be washed and dry.
- Palm should be washed and cleaned before using hair gel.
- Take hair gel between your palms and rub gently to activate the texture of the gel.
- The gel should be applied softly to the hair.
- The hair gel should be left for natural drying and best results.
- Apply once daily to enhance hair texture and growth.

Figure No 11: -Final product

EVALUATION OF HERBAL HAIR GEL FORMULATIONS: [28-30]

- **Physical appearance/ Visual inspection:** The formulated herbal hair gel was evaluated for colour, transparency, odour, 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, one 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

Figure No 12: - pH meter

- **Spreadability:** The spreadability of gel formulations was calculated on a glass slide, the gel is fixed between the two slides, a 20gm load is planted on the slide, the time to squeeze the sample to uniform

thickness, and the time to separate the two slides (seconds) was calculated.Spreadability was calculated using the following formula:

S= M × 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.
- **Homogeneity**: All created hair gels were checked for homogeneity by visual examination after the gel compositions were put within the container. They underwent examinations to check for lumps, flocculates, or aggregates as well as for visual appearance.
- **Skin irritation test**: Apply 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 independently. The gel in the jar should be high enough to allow the spindly to be dipped. The spindle was set to run at 2.5 RPM. The formulas' viscosities were noted.

Figure No. 13: - Brookfield Viscometer

- **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). Not much change of pH, Viscosity, Homogeneity, Spreadability and Extrudability.
- **Antibacterial activity** [31]

1. Prepare nutrient agar plates by pouring molten agar into Petri dishes and allowing it to solidify.
2. Inoculate the agar by streaking the surface evenly with the bacterial culture using a sterile cotton swab.
3. 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 wells. Incubate the plates at 37°C for 18–24 hours.
4. Observe and measure the zones of inhibition around the wells, indicating antibacterial activity.

- **Extrudability**: Metal tubes with foldable ends were filled with the hair gel formulas. The material was forced through the tubes, and the formulation's extrudability was evaluated. The formulations' ability to be extruded was examined. The formulations extrudability was assessed by calculating the weight in grams needed to extrude a 0.5 cm gel ribbon in 10 seconds.

- **Antifungal activity** [32]

1. 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.
2. Prepare Herbal Gel Sample: Ensure the gel is freshly prepared and may be diluted to different concentrations for comparative analysis.
3. 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.
4. Inoculate Fungal Strain: Spread the fungal inoculum on the agar surface evenly using a sterile swab or spreader.
5. Apply Herbal Hair Gel
6. Well Diffusion: Make wells in the agar and fill them with herbal gel. Incubation: Incubate the plates at 25°C to 30°C for 48 to 72 hours, depending on the fungal specie

RESULTS AND DISCUSSION:

Phytochemical screening of Curry leaves extract:

Table No. 06: - Phytochemical screening of Curry leaves extract

SR NO	CONSTITUENTS	PRESENCE (+)/ABSENCE (-)
1.	Alkaloids	**PRESENCE (+)**
2.	Flavonoids	**ABSENCE (-)**
3.	Cardio Glycosides	**PRESENCE (+)**
4.	Tannins	**PRESENCE (+)**
5.	Saponins	**PRESENCE (+)**
6.	Proteins	**PRESENCE (+)**
7.	Steroids	**ABSENCE (-)**
8.	Quinones	**ABSENCE (-)**
9.	Terpenoids	**PRESENCE (+)**
10.	Phenols	**ABSENCE (-)**

Phytochemical screening of Wheat extract:

Table No. 07: - Phytochemical screening of Wheat extract

SR NO	CONSTITUENTS	PRESENCE/ABSENCE
1.	Alkaloids	**PRESENCE (+)**
2.	Flavonoids	**PRESENCE (+)**
3.	Tannins	**PRESENCE (+)**
4.	Saponins	**PRESENCE (+)**
5.	Phenols	**PRESENCE (+)**

Phytochemical screening of Aloe Vera extract:

Table No. 08: - Phytochemical screening of Aloe Vera extract

SR NO	CONSTITUENTS	PRESENCE/ABSENCE
1.	Anthraquinones	**PRESENCE (+)**
2.	Alkaloids	**PRESENCE (+)**
3.	Glycosides	**PRESENCE (+)**
4.	Saponins	**PRESENCE (+)**
5.	Flavonoids	**PRESENCE (+)**

Phytochemical screening of Flax Seeds extract:

Table No. 09: - Phytochemical screening of Flax Seeds extract

SR NO	CONSTITUENTS	PRESENCE/ABSENCE
1.	Protein Test	**PRESENCE (+)**
2.	Flavonoid	**PRESENCE (+)**
3.	Tannins	**PRESENCE (+)**
4.	Alkaloids	**PRESENCE (+)**
5.	Carbohydrates	**PRESENCE (+)**
6.	Saponins	**RESENCE (+)**
7.	Phenols	**ABSENCE (-)**
8.	Glycosides	**ABSENCE (-)**
9.	Lignans test	**PRESENCE (+)**

EVALUATION RESULT

Table No. 10: - Evaluation Results

SR NO	PARAMETERS	RESULT
1.	Physical appearance/ Visual inspection: Colour Odour Appearance	Muted olive-green Nutty-earthy Smooth
2.	pH	6.97
3.	Spreadability	Spreadable (13.11)
4.	Washability	Washable with water
5.	Homogeneity	Homogeneous
6.	Skin irritation test	No irritation
7.	Viscosity	31400 cps at 16% torque 40200 cps at 20% torque 2754 cps at 46% torque
8.	Stability Studies	Stable
9.	Extrudability	Excellent

CONCLUSION:

With the understanding, herbal medicine have the less side effects than synthetic medicines. Polyherbal hair gel has various benefits over monoherbal hair gel. The present study successfully developed a polyherbal hair gel using natural ingredients, including curry leaves, flax seeds, wheat extract, and aloe vera, known for their synergistic hair-nourishing properties. Flaxseeds are rich in omega-3 fatty acids and antioxidants, curry leaves extract is rich in severalphytoconstituents, while wheat is rich in keratin. The inclusion of aloe vera and flaxseed provided moisture and hold, while curry leaves and wheat extract contributed to strengthening and hair growth

promotion and were used to treat problems like dandruff and alopecia. The formulation process was standardised, and the resultant gel exhibited excellent physicochemical characteristics such as optimal pH (6.97), high viscosity, good spreadability, homogeneity, washability, and stability under varying storage conditions. Phytochemical screening confirmed the presence of key bioactive compounds such as alkaloids, flavonoids, saponins, and antioxidants in the individual plant extracts, supporting their therapeutic efficacy. The polyherbal hair gel showed no signs of skin irritation, and making it a safe and effective natural alternative to synthetic hair products. Overall, the formulation represents a promising herbal approach to address common hair and scalp issues like dandruff, dryness, and hair fall without the adverse effects of synthetic chemicals.

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