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FORMULATION AND EVALUATION OF A HERBAL HAIR CREAM CONTAINING FERMENTED RICE WATER FOR THE REDUCTION OF DANDRUFF AND HAIR LOSS

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ABSTRACT
The most common problem these days is dandruff and hair loss, so the primary goal of the study is to reduce dandruff and hair loss and promote hair growth. The essential element of this study is fermented rice water (Oryza sativa), which includes significantly extra antioxidants than pure rice water. Inositol is the main component that helps reduce hair loss and dandruff in hair. Fermented Rice water help balance the pH of the scalp which reduces dandruff and irritation. The cream also incorporates Ginger for antimicrobial and antiseptic properties, Vitamin E for antioxidant protection, rosemary oil for stimulating hair growth and natural preservative, coconut oil for deep conditioning, aloe vera gel for soothing and moisturizing, rose water for its hydrating and aromatic properties and peppermint oil for anti-inflammatory property and natural preservative. This research aims to develop a hair cream that effectively reduces dandruff, improves hair texture, and stimulates hair growth.

KEYWORDS: Rice Water, Hair Cream, Natural Ingredients, Hair Health, Antioxidant Protection, Rosemary Oil, Dandruff Treatment.

I. INTRODUCTION

HERBAL COSMETICS

The word 'Cosmetic' derived from a Greek word 'kosmesticos' that means to adorn. It is referred as Products, are formulated, using various permissible cosmetic ingredients to form the base in which one or more herbal ingredients are used to provide defined cosmetic benefits only, shall be called as "Herbal Cosmetics.[1]

Herbal cosmetics also known as natural cosmetics. Now these days, people become more health conscious then before, so, they prefer best. Now a days, herbal cosmetics are growing countries like United States, Canada, United Kingdom, Australia, Germany and France as well as in other developing countries like the Philippines, China and India etc. Herbal cosmetic products containing natural components have showed increasing trend in the market. In a market demand of herbal cosmetics are raised. With globalization, there have been changes in many fields such as improvisation in products, innovation, competition, brand image etc. On the other hand, people are drawn to herbal cosmetics because of their natural qualities and low risk of negative effects. Market analysts predict that the herbal cosmetics sector is about to enter a new stage of growth.[2,3]

The current global market for herbal cosmetics is valued at $1500 billion, and it is projected to expand at a rate of 25% annually. Among all product categories, natural skin care products hold the largest market share in European nations.[2,3]

For over 5000 years, people in China and India have been aware of the medical benefits of many plants and herbs. India holds the second position in the global market share of herbal cosmetics, while China is the world's largest exporter of these products.[4]

Pharmaceutical and therapeutic aspects of cosmetics

Cosmetics are such preparations which are being utilized by every age group. The market of cosmetics has existed all over the world and proves economically beneficial. Today the market is flooded with various cosmeceutical preparations including baby preparations, bath preparations, cleansing preparations etc. The public's interpretation of what constitutes a drug or a cosmetic may differ somewhat from that of regulatory agencies. The ingredients used in cosmetics to a large extent are the same as those employed in drugs. According to US law, cosmetics may contain ingredients that treat or prevent disease or alter the structure or function of the human body. The objective of cosmetics is limited to the enhancement of appearance.[5,6]

HAIR CREAM

Hair creams are used for protecting, styling, and refining the feel and look of hair. These cosmetic products obtain their desired properties through their many different ingredients. Hair creams are emulsion products providing nourishment and high gloss to hair. They may also be O/W or W/O emulsions, which break down easily on application. Creams can simply be oil in water emulsions with a 10-25% oil phase. The cream is a hybrid of the clear gel and an oil treatment or the emulsion. It can be a polymer-stabilized cream or simply a dispersion of oils, esters, or fatty products in a gelling matrix. The emulsion-stabilizing polymer thickener and stabilizer can be shear thinning for easier distribution and a lighter feel on the hands and the hair. The choice and concentration of esters, oils, silicones, fatty alcohols, or waxes determines the final feel and look of the product after dry-down. The higher the viscosity or melting point of the oils and waxes, the greasier the feel will be on the hair after dry-down and perhaps during the wet application.[7,8]

FUNCTIONS OF HAIR CREAM[9]

Promote hair growth.
Hair cream provides nourishment to your hair.
It gives medium hold to your hair and helps to get a wet look.

- ❖ It moisturizes the hair.
- ❖ Helps fight hair fall.
- ❖ Makes hair soft, shiny.
- ❖ Control Dandruff and hair damage.
- ❖ It improves the feel, texture and appearances and manageability of hair.

Advantages of Hair Cream[9,10]

Moisturizes Hair and Scalp

- Prevents dryness, especially in frizzy or curly hair.

Improves Hair Manageability

- Helps detangle and smooth hair, making styling easier.

Reduces Frizz and Split Ends

- Coats hair strands to reduce breakage and frizz.

Provides Mild Hold for Styling

- Keeps hairstyles in place without making hair stiff like gel.

Protects from Environmental Damage

- Forms a barrier against UV rays, dust, and pollutants.

Nourishes Hair

- Often enriched with vitamins, proteins, or natural extracts like coconut oil, shea butter, etc.

Non-Greasy (Water-Based Creams)

- Lighter than oils; suitable for everyday use.

Disadvantages of Hair Cream[9,10]

Build-Up with Excessive Use

- Can make hair look greasy or heavy if not washed regularly.

May Not Suit All Hair Types

- Some formulations may weigh down fine or oily hair.

Contains Synthetic Ingredients

- Some products may have parabens, silicones, or artificial fragrances that can irritate sensitive scalps.

Temporary Results

- Effects are not long-lasting and need reapplication after washing.

Allergic Reactions

- Certain ingredients may cause scalp irritation or allergic reactions in some users.

Applications of Hair Cream[9,10]

1. **Daily Hair Care**
   - ♥ Used as a leave-in conditioner or for everyday moisture and shine.
2. **Styling Aid**
   - ♥ Offers light hold for casual hairstyles without stiffness.
3. **Pre-Heat Treatment**
   - ♥ Used before blow-drying or ironing to protect hair from heat damage.
4. **Frizz Control**
   - ♥ Ideal for humid environments to keep hair smooth and controlled.
5. **Treatment Base**
   - ♥ Used as a base for medicated or herbal treatments (e.g., anti-dandruff or hair growth formulations).
6. **Post-Wash Nourishment**
   - ♥ Applied after shampooing to retain moisture and prevent dryness.

HAIR

A vital component of the human body is the hair. Its related issues include hair loss, frizz, unmanageable hair, low volume, conditioning, premature greying, dandruff, hair thinning, dullness, etc. The form, length, diameter, texture, and colour of hair can all differ. There is also a chance that the hair's cross section round. triangular, asymmetrical, or compressed, affecting the hair's curl. Every mammal has hair. Its primary function is to control body temperature. It also seeks to function as a way organ, reduce friction, and protect against sunlight. Hair is a person's greatest asset and has a significant impact on their lives. In the past, hairs on the scalp were thought to provide protection. Additionally, hair

contributes to the self-assurance and pride in an individual, regardless of their gender. A person's dream has always been to have black, healthy, glossy, and high-quality hair. Regardless of how long or short they are, everyone prioritizes keeping and maintaining them.[11]

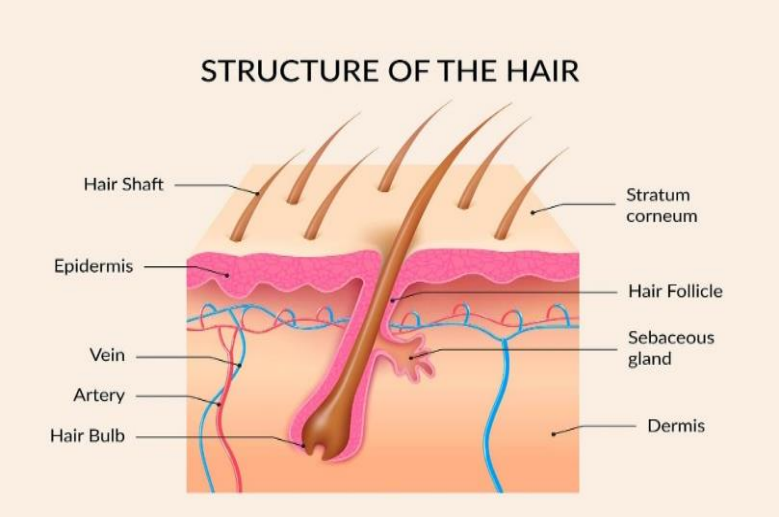

Fig. 1: Structure of hair.

There are two sections to hair

1. A follicle: The follicle is a structure in the skin that resembles a blub. A network of blood arteries that supply nutrients to nourish and promote hair growth may be located near the apex of the follicle. We refer to this as the papilla. The epidermis and dermis interact to produce each follicle. The follicle is segmented into three parts: The infundibulum of a follicle extends from its surface opening to the level of its sebaceous gland entrance. Isthmus: Stretches from the level of the arrector Pilli muscle insertion to the infundibulum. Subordinate segments: Dermal papilla, a loose band of vascularized connective tissue, invaginates the base of the bulb. The hair's papilla is full of blood vessels and offers Inferior segments: A tuft of loose, vascularized connective tissue known as the dermal papilla invaginates the base of the bulb. Numerous blood vessels can be found in the papilla of the hair, which also nutrients for hair development.[12]

2. Shaft: Three layers comprise the hair shaft:

a) Medula: The medulla is the centre of the hair. It will either be continuous or doubled, segmented or broken apart. It is frequently a cell-filled tube or hollow. While some hairs have discontinuous or fractured medullas, the majority of hairs do not. It shapes the hair shaft's midsection. Particularly fine hairs typically lack this layer.

b) Cortex: The greatest portion of the hair shaft, or melanin (hair pigment), is what gives hair its color.[12]

c) Cuticle: There are a few possible Cortex: The greatest portion of the hair shaft, or melanin (hair pigment), is what gives hair its color. The hair shaft's transparent outer coat may be called the cuticle. It is composed of overlapping scalp that shield the hair's inner layers. The hair's proximal end, which is closest to the scalp, and distal end are where the scales point.[12]

CYCLE OF HAIR

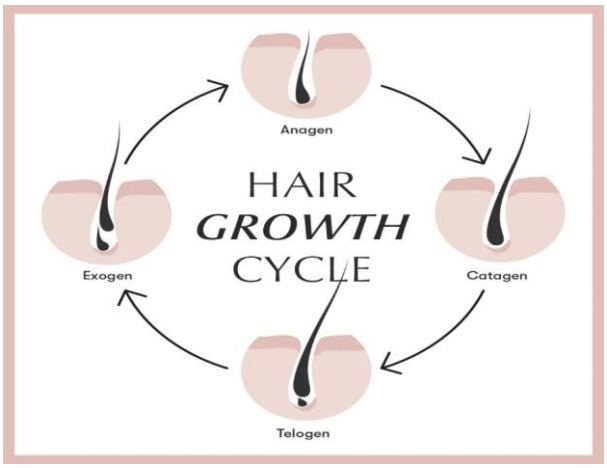

Fig. 2: Cycle of Hair.

Every type of hair passes through a recurring cycle of active growth and rest. Each cycle's relative length varies depending on the person's age and the body part involved. the area where hair grows. The follicle's cycle phase is distinguished by three distinct stages: anagen, or active growth, catagen, or intermediate period, and telogen, or resting stage. A. Phase of anagen as the follicle reaches its maximum length, the matrix cells proliferate and create the internal root sheath, hair shaft cortex and medulla, as well as the cuticular layers that cover the hair shaft and inner sheath. The inner and outer sheaths of epilated anagen hair are still attached and encircle the hair B. Phase of Catagen Two characteristics set involutional hair apart from telogen (clubbed) hair: Compared to clubbed hair, the keratinized (proximal) portions of it are darker. Its exterior and inner sheaths are

in better condition C. Phase of telogen the remnants of an epithelial sac, which are absent from nongrowing, spontaneously shed clubbed hair, can also encase hair. Of an adult's 100,000–105,000 scalp hairs (irrespective of gender), 90% are in the growing or anagen phase. 10% of the population is still in the resting (telogen) phase.[12,13]

HAIR'S ANATOMY AND PHYSIOLOGY

Between 80,000 to 120,000 essential terminal hairs grow on the scalp of healthy men and women. Keratin, which makes up hair, is created in hair follicles. Every hair follicle has recurrent cycles of growth and rest. For two to six years, a hair grows at a pace of around 0.3 mm per day, or 1 cm per month, during the growth (anagen) phase. The length of the anagen phase determines the maximum length of hair that can be achieved. The hair then falls out after a brief transitional (catagen) phase and a resting (telogen) phase that lasts for two to four months. The approximately 100,000 hairs on a person's head typically grow apart from one another.[12,13]

HAIR FUNCTIONS[12,13]

A. Controlling one's body temperature.
B. Reduces the friction.
C. Defends against solar radiation.
D. Serves as an organ of senses.

HAIR DISEASE

Mycotic condition: it is recognized that dandruff and seborrheic dermatitis represent opposite extremes of a same disease spectrum resulting from Malassezia species. Parasitic capitis: Pediculosis humanus capitis infection is the cause of pediculosis capitis.

Conditions characterized by inflammation: distinct erythematous plaques coated in silver-grey scale are the hallmark of psoriasis. The bacterial pathogen Staphylococcus aureus is frequently accountable for folliculitis.[14,15]

HAIR LOSS

Hair loss (alopecia) is a fairly common occurrence. While it's more prevalent in older adults, anyone can experience it, including children.

It's typical to lose between 50 and 100 hairs a day, according to the American Academy of Dermatology (AAD). With about 100,000 hairs on your head, that small loss isn't noticeable. New hair normally replaces the lost hair, but this doesn't always happen.

Hair loss can develop gradually over years or happen abruptly. Depending on the underlying cause, it may be temporary or permanent.[14,15]

CAUSES OF HAIR LOSS

1. Reduction in hair follicle function due to male hormones.
2. Reduction in metabolic function of hair follicles and hair bulb.
3. Reduction in scalp physiological functions.
4. Local impairment of the circulation due to tension in the scalp.
5. Common causes of hair fall such as stress, eating habits, lack of protein.
6. Hormonal changes and medical conditions.
7. Radiation therapy to the head

a) Hairstyles and treatments
b) Medications and supplements.[14]

TYPES OF HAIR LOSS[14,15]

There are various types of hair loss

1. Noncicatricial (potentially reversible)
2. Cicatricial
3. Due to hair shaft abnormalities

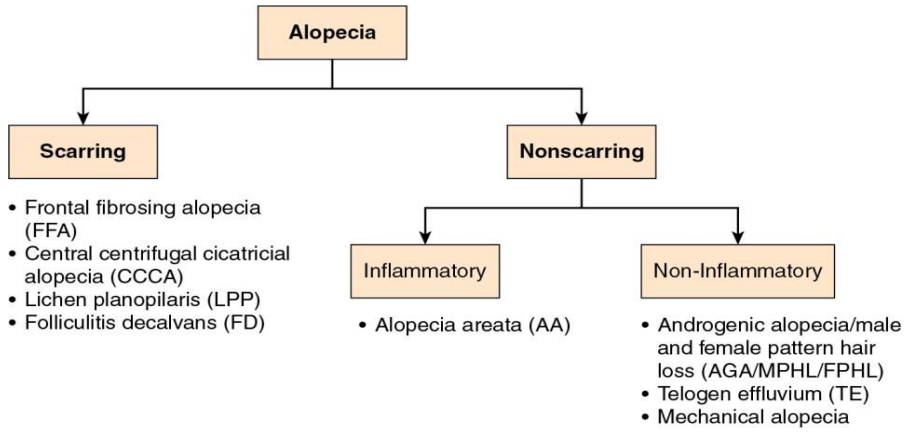

Fig. 3: Types of Hair Loss.

Scarring alopecia is the result of active destruction of the hair follicle. The follicle is irreparably damaged and replaced by fibrotic tissue. Several hair disorders show a biphasic pattern in which nonscarring alopecia occurs early in the course of the disease, and then scarring alopecia and permanent hair loss occurs as the disease progresses. Scarring alopecia's can be subdivided further into primary forms, where the target of inflammation is the follicle itself, and secondary forms, where the follicle is destroyed as a result of nonspecific inflammation.[14,15]

Fig. 4: Scarring alopecia.

Nonscarring alopecia results from processes that reduce or slow hair growth without irreparably damaging the hair follicle. Disorders that primarily affect the hair shaft (trichodystrophies) also are considered nonscarring alopecia.[14,15]

Fig. 5: Nonscarring alopecia.

DANDRUFF

Dandruff is a common hair condition that is affecting millions of people every day. While most of us experience this at some point in our lives. Often dandruff is considered as the major cause of hair loss in most people. While they seem unrelated, there is said to be a link between the both suggesting a strong connection. In this article, we will look into the complex relationship of hair fall due to dandruff, exploring the underlying causes and understanding the effective solutions.

White flakes that accumulate and fall off your scalp are known as dandruff. This prevalent ailment can affect any type of hair. Dandruff can worsen over time and cause constant itching and inflammation of the scalp if left untreated.[14,15]

Fig. 6: Dandruff.

TYPES OF DANDRUFF[15]

There are various types of Dandruff.

1. Dry Skin–Related Dandruff

This type of dandruff usually occurs in winter and results from cold, dry weather.

Hair care products that strip too much oil from the scalp can also result in dry skin. It is also linked with using hot water to shampoo the hair. Hot water dries out the scalp, which can cause flakes.

2. Oil- and Fungal-Related Dandruff

If sebum (oil) is overproduced by the hair follicles, it can build up on the scalp. The result is the clumping together of sebum and dead skin cells on the scalp. The clumps of dead skin cells—along with dirt on the scalp—form the

itchy dandruff flakes, which are oily and yellowish in colour.

A type of fungal yeast called *Malassezia* is part of the skin's natural flora (microorganisms that live naturally on the skin). When there is excess sebum, Malassezia is known to proliferate because it grows in sebum. This type of yeast also produces a by-product that causes the skin cells to clump together, forming the flakes commonly seen in dandruff.

3. Skin Condition–Related Dandruff

Several skin conditions cause skin flaking. The skin condition most often linked with dandruff is seborrheic dermatitis (SD), which causes:

- Severe redness
- Red scaly patches
- Itching
- Inflammation of the scalp (and other areas of the body, such as the face and ears)

SD causes visible signs of inflammation, whereas dandruff symptoms usually involve mildly reddened skin.

SD occurs more frequently in those with oily skin and is considered a type of oily dandruff. It appears in areas of the skin containing oil glands.

There are other types of skin conditions that can cause flaking of the scalp, such as:

- Eczema
- Psoriasis
- Sebopsoriasis (a skin condition that has some symptoms of seborrheic dermatitis and some symptoms of psoriasis)

Fig. 7: Types of Dandruff.

CAUSES OF DANDRUFF

1. Dry Skin
2. Sensitive to certain Hair Products.
3. Oily, irritated skin.
4. Fungal Infection on scalp
5. Certain conditions like Psoriasis.[15]

FERMENTED RICE WATER

Fermented rice water is the liquid obtained after soaking or boiling rice that has been left to ferment for 12–48 hours.[16,17]

The fermentation process converts the starches into beneficial organic acids, enhancing the bioavailability of nutrients.[16,17]

Chemical Composition

- **Carbohydrates** – mainly inositol, which strengthens hair and reduces surface friction.
- **Amino acids** – arginine, serine, cysteine, which repair and nourish hair.
- **Vitamins** – B1, B2, B3, B5, B6, B9, B12, Vitamin E.
- **Minerals** – zinc, iron, magnesium, potassium, selenium.
- **Organic acids** – lactic acid, acetic acid (formed during fermentation) with antimicrobial properties.
- **Antioxidants** – phenolic compounds that reduce oxidative stress on the scalp.[16,17]

Process of Fermentation

1. Soaking Method

- Wash rice thoroughly to remove impurities.
- Soak ½ cup rice in 2 cups water for 24–48 hours at room temperature.
- After fermentation, strain the water and store it in a clean container.

2. Boiling Method

- Cook rice with excess water.
- Use the leftover starchy water; allow it to cool and ferment overnight.

❖ **pH changes**: During fermentation, pH drops from ~6–7 to ~4–5, creating an acidic environment beneficial for scalp health.[16,17]

Mechanisms of Action

❖ **For Hair Health**

- **Strengthening Hair Fibers**: Inositol repairs damaged hair and prevents future damage.

- **Improving Elasticity**: Amino acids enhance hair resilience.
- **Reducing Hair Breakage**: Nutrients penetrate the cuticle, reducing split ends.

❖ **For Scalp and Dandruff**

- **Antifungal:** Lactic acid inhibits the growth of ***Malassezia* species** (dandruff-causing fungi).
- **Exfoliating:** Removes dead skin cells, preventing flakiness.
- **Sebum Regulation:** Balances oil production, reducing greasy scalp conditions.[18,19]

Benefits

- Controls **dandruff** and **itchy scalp**.
- Reduces **hair loss** by strengthening follicles.
- Promotes **hair growth** due to improved nutrient delivery.
- Adds **shine** and **smoothness** to hair.
- Restores **scalp microbiome balance**.[18,19]

Scientific Evidence

- Research shows **inositol** in rice water penetrates hair shafts, reducing friction and enhancing elasticity.
- Studies on **fermented products** confirm their antimicrobial and scalp-soothing properties, beneficial for dandruff and seborrheic dermatitis.[18,19]

II. MATERIALS AND METHOD

Taxonomical Classification of Curry Leaves and Ginger

Table 1: Taxonomical classification of curry leaves.

Taxonomic Rank	Curry Leaves (*Murraya koenigii*)	Ginger (*Zingiber officinale*)
Kingdom	Plantae	Plantae
Clade	Angiosperms, Eudicots, Rosids	Angiosperms, Monocots
Order	Sapindales	Zingiberales
Family	Rutaceae	Zingiberaceae
Genus	*Murraya*	*Zingiber*
Species	*Murraya koenigii* (L.) Spreng.	*Zingiber officinale* Roscoe
Common Name	Curry Leaf Tree	Ginger
Medicinal Uses	Antioxidant, antimicrobial, hair and skin health	Anti-inflammatory, antimicrobial, digestive aid, hair growth

Uses

Table 2: Uses of curry leaves and ginger.

Ingredient	Uses in Hair Cream
Curry Leaves (*Murraya koenigii*)	- Strengthens hair follicles and promotes hair growth - Reduces hair fall and premature greying - Antioxidant properties protect scalp from damage - Helps in reducing dandruff and scalp irritation
Ginger (*Zingiber officinale*)	- Improves blood circulation in the scalp, stimulating hair growth - Possesses antimicrobial and antiseptic properties, reducing dandruff - Prevents scalp infections - Adds natural shine and thickness to hair

METHODOLOGY[20,21]

1. Preparation of extract of Murraya koeinigii

The 20g of fresh curry leaves was collected, cleaned and chopped into small pieces. It was extracted by decoction technique, mix fresh curry leaves with 100 ml distilled water in a beaker. It boils for 20 minutes and then filtered and collected the extract.

2. Preparation of extract of *Zingiber officinale*

Fresh ginger rhizomes were washed, peeled, and ground into a fine paste with a small amount of distilled water. The paste was mixed with water (1:2) and heated at 40–50°C for 15–20 minutes to extract active compounds. The mixture was filtered using muslin cloth to obtain a clear extract, which was stored in a sterile amber bottle at 4°C. This extract is used (1–3% w/v) in hair cream for its antimicrobial and hair growth-promoting properties.

PRELIMINARY PHYTOCHEMICAL TEST [20,21]

1. Test for Carbohydrates

a) Fehling's test: Mix Fehling's A and Fehling's B solution boil for 1 minute. Add extract boil for 5-10 minutes Appearance of orange red precipitates indicates presence of carbohydrates.

b) Benedict's test Mix: Benedict's reagent and extracts heat in boiling water bath for 15 minutes. Solution appears green yellow or red indicate presence of reducing sugar.

2. Test for Flavonoids

a) Alkaline test: Test solution treated with sodium hydroxide solution. Increasing in the in the intensity of yellow color which become colourless on addition of dilute acid indicate presence of flavonoids.

b) Ferric Chloride test: To the alcoholic solution of extract add few drops of neutral ferric chloride solution.

Appearance of green color indicates presence of flavonoids.

3. Test for Protein

a) Ninhydrin test: Test solution treated with Ninhydrin reagent and warms the solution. Appearance of blue indicates the presence of protein.

b) Xanthoprotein test: Test solution treated with concentrated nitric acid and boiled. Appearance of yellow precipitate indicates presence of protein.

Materials

Table 3: Formulation chart of Hair cream.

SL No.	Content	Quantity (for 100 mL)	Properties
1	Curry Leaves Extract	2.5 mL	Antioxidant, reduces dandruff
2	Stearic Acid	4 g (4%)	Thickener, stabilizer
3	Shea Butter	3 g (3%)	Emollient, moisturizing
4	Cetyl Alcohol	2 g (2%)	Co-emulsifier, stabilizer
5	Lanolin	1 g (1%)	Emollient, conditioning
6	Ginger Juice	1 mL	Antimicrobial, Antiseptic, Reduces dandruff
7	Olive Oil	5 mL	Moisturizing, Nourishing
8	Almond Oil	3 mL	Conditioning, Softening
9	Propyl Paraben	0.02 g (0.02%)	Preservative
10	Triethanolamine	0.5 mL	pH adjuster
11	Fermented Rice Water	15 mL	Active ingredient, scalp health
12	Distilled Water	q.s. to 100 mL	Vehicle/base

FORMULATION OF HERBAL HAIR CREAM

Preparation Method:

1. Heat oil phase (stearic acid, shea butter, cetyl alcohol, lanolin, olive oil, almond oil) to ~70°C.
2. Dissolve propyl paraben in this phase.
3. Heat aqueous phase (distilled water + fermented rice water) to same temperature.
4. Slowly add the oil phase into aqueous phase with continuous stirring.
5. Add triethanolamine for emulsification.
6. When mixture cools to <40°C, add curry leaves extract and ginger juice.
7. Stir until uniform and transfer to containers.[22]

Packing of Cream: The prepared cream was packed in a wide mouth bottle with air tight closure.

III. EVALUATION STUDIES

A. Organoleptic Properties of Hair Cream: Organoleptic properties such as color, odor, clarity and homogeneity of the herbal hair cream were observed by visual inspection.[23]

B. Determination Of pH: The pH meter was calibrated using standard buffer solution. About 0.5g of the cream was weighed and dissolved 50.0 ml of distilled water and its pH was measured.[23]

C. Viscosity: The viscosity of hair cream was measured using Brookfield viscometer, 100 ml of the hair cream was analysed using spindle no.64 at 12 RPM.[24]

D. Spreadability: Spreadability of formulation was determined by measuring the spreading diameter of one gram of sample between two horizontal glass plates. (10cm × 20cm) after one minute. Spreadability denotes the extent of area to which the formulation spreads on application to skin. The bioavailability efficiency of a formulation also depends on its spreading value. Two glass slides of standard dimensions were taken. For this purpose, cream was applied in between two glass slides and they were pressed together to obtain a film of uniform thickness by placing 1000 gm weight for 5 minutes. The spreadability (S) can be calculated using the

$$S = M.L/T$$

Where, M = weight tied to upper slide L = length to separate the slide T = time taken to separate the slide.[24]

E. Washability of cream

This was assessed by using running tap water to remove the cream that had been applied to a particular body area.[23,24]

F. In vitro diffusion study

The in vitro release of the active compounds from the fermented rice water hair cream was evaluated using a Franz diffusion cell. 500 mg of the cream formulation was uniformly applied to the egg membrane surface in the donor compartment. The receptor compartment was filled with 20 ml of phosphate buffer (pH 5.8) containing 0.5% Tween-80 to mimic scalp conditions and maintain sink conditions, kept at 37°C ± 0.5°C under constant stirring at 100 rpm. At predetermined intervals of 30, 60, 90, 120, 150, 180, and 240 minutes, 1 ml aliquots of the receptor medium were withdrawn and replaced with an equal volume of fresh buffer. The collected samples were analysed using a UV-VIS spectrophotometer at the specific λmax of the selected marker compound (e.g., inositol or phenolics) determined from fermented rice

water, and concentrations were calculated from a standard calibration curve.[23,24]

G. Drug release kinetics

The release kinetics of the hair cream formulation were evaluated by fitting the drug release data to various mathematical models, including Zero-order, First-order, Higuchi, and Korsmeyer–Peppas models. Regression analysis was performed to determine the best-fit model and to elucidate the mechanism of drug release.[23,24]

H. Anti-Microbial Activity

The antimicrobial activity of the fermented rice water hair cream was evaluated using the agar well diffusion method against the dandruff-causing fungus *Candida albicans*. Potato Dextrose Agar (PDA) medium was prepared and sterilized, then aseptically inoculated with a standardized suspension of *Candida albicans*. Sterile Petri plates (200 mm) were poured with the inoculated medium and allowed to solidify. Wells of 6 mm diameter were created aseptically in the solidified agar. The test samples, including the formulated hair cream, a standard antifungal agent (ketoconazole cream), and a control (base cream without active ingredients), were placed into the respective wells. The plates were incubated at 25°C for 72 hours under aerobic conditions. After incubation, the plates were observed for the zone of inhibition around the wells, which was measured in millimeters to determine the antifungal activity of the formulations.[23,24]

I. Stability study at room temperature: Optimized formulation kept in a tightly closed air tight container and stored at room temperature for 3 months and observed for any visible changes in colour, odour and physical state.[23,24]

IV. RESULT AND DISCUSSION

A. PRE-FORMULATION STUDIES

Table no.4: Preliminary phytochemical screening.

Test	Murraya koeinigii	*Zingiber officinale*
Fehling's Test	Orange-red precipitate – Positive	Orange-red precipitate – Positive
Benedict's Test	Green/yellow/red solution – Positive	Green/yellow/red solution – Positive
Alkaline Reagent Test	Yellow color disappearing with acid – Positive	Yellow color disappearing with acid – Positive
Ferric Chloride Test	Green color – Positive	Green color – Positive
Ninhydrin Test	Blue color – Positive	Blue color – Positive
Xanthoprotein Test	Yellow precipitate – Positive	Yellow precipitate – Positive

Fig. 8: Chemical test.

EVALUATION STUDIES

A. Organoleptic properties of herbal hair cream

Result showed that the organoleptic properties of herbal hair cream.

Table no. 5: Organoleptic properties.

SL. No.	Organoleptic Property	Inference
1	Colour	Light pink
2	Odour	Pleasant fragrance
3	Appearance	Smooth texture

B. Determination of pH

PH of the hair cream was observed by using digital pH meter and the pH of the cream was found to be 4.90 pH.

Fig. 9: Determination of pH.

C. Viscosity Evaluation

Viscosity of the hair cream was done by using Brookfield viscometer at temperature 250C using spindle No. 64 at 12 RPM. Viscosity of the hair cream was found to be 17600 CP.

Fig 10: Viscosity evaluation.

D. Spreadability

Table no. 6: Spreadability of cream was observed.

SL. No.	Sample	Length (cm)	Time Taken (s)	Spreadability (g·cm/s)
1	Cream	5	14	35.71

E. Stability study at room temperature

No visible changes in color, odor and physical state were observed upon 3-month storage at room temperature. This indicates stability of the Optimized formulation at room temperature.

F. Antimicrobial activity

The Minimum Inhibitory Concentration (MIC) of the fermented rice water hair cream was determined against the test organism *Candida albicans* using the agar well diffusion method. Different concentrations of the hair cream (1 mg, 2 mg, 3 mg, and 4 mg) was tested to evaluate their antifungal efficacy. The zone of inhibition was measured in millimetres around the wells to assess the inhibitory activity.

Table no 7: MIC of Hair Cream Against *Candida albicans.*

Concentration of Hair Cream	Zone of Inhibition (mm) – Plate 1	Zone of Inhibition (mm) – Plate 2
1 mg	9	9
2 mg	10	11
3 mg	11	12
4 mg	12	12

Table 8: Zone of Inhibition of Positive Control Against Candida albicans.

Organism	100 µg	200 µg	300 µg	400 µg
C. albicans	23 mm	25 mm	26 mm	28 mm

Figure 11: Inhibitory activity of test sample against *candida albicans.*

G. Invitro diffusion studies`

Table no. 9: In Vitro Drug Release Profile of Hair Cream.

Time (min)	% Drug Release
0	0.00
30	6.66
60	19.99
90	34.66
120	50.66
150	69.33
180	90.66

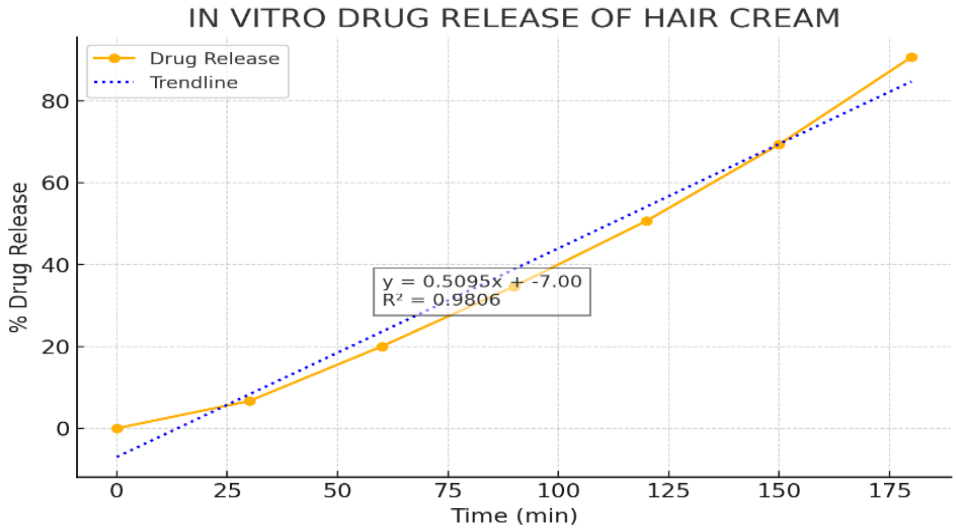

Figure no. 12: In vitro drug release.

V. CONCLUSION

The formulated herbal hair cream containing **fermented rice water, curry leaves extract, and ginger juice** demonstrated excellent physicochemical and functional properties. The product exhibited desirable organoleptic attributes such as a **light pink color, smooth texture, and pleasant odor**, enhancing consumer acceptability. Evaluation studies confirmed its **optimal spreadability** (35.71 g·cm/s) and **viscosity** (17600 cP), indicating ease of application and stability.[25]

The **pH** of the formulation was measured at **4.29**, which is within the slightly acidic range favorable for scalp health. This pH helps **maintain the scalp's acid mantle**, preventing microbial overgrowth and minimizing irritation, thus supporting scalp protection and hair cuticle integrity. The antifungal evaluation against **Candida albicans** revealed significant zones of inhibition, demonstrating the cream's efficacy in controlling dandruff-causing fungi. In vitro diffusion studies showed a sustained drug release, suggesting prolonged activity of the bioactive compounds.[25]

The combined effects of **fermented rice water (rich in inositol and antioxidants)**, **curry leaves extract (antioxidant and anti-dandruff activity)**, and **ginger juice (antimicrobial and circulation-promoting)** contribute to enhanced hair growth, reduced hair loss, and improved hair texture. Stability studies confirmed the cream's consistency over three months without any visible changes in color, odor, or texture.

Thus, this herbal hair cream is **safe, effective, and stable**, making it a promising natural alternative to synthetic anti-dandruff and anti-frizz products. With further clinical evaluation, it could be developed into a commercially viable product for scalp and hair health management.[25]

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