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Research Article

DESIGN and Performance Evaluation of Cosmetic HAIR Gel USING Ficus Benghalensis and Hibiscus Rosa-Sinensis

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ABSTRACT

The present study aims to formulate and evaluate a herbal hair gel using Ficus benghalensis (Banyan aerial root) and Hibiscus rosa-sinensis (Hibiscus flower) extracts. Herbal ingredients are increasingly used in cosmetic preparations due to their natural origin and potential therapeutic properties. The selected plants contain various phytoconstituents such as flavonoids, tannins, phenolic compounds, saponins and glycosides, which are associated with antioxidant, antimicrobial and antifungal activities. The banyan aerial root extract was prepared using ethanol, while the hibiscus flower extract was prepared using methanol. Phytochemical screening was carried out to identify the bioactive constituents. Three different herbal hair gel formulations (F1, F2 and F3) were prepared using Carbopol 940 in varying concentrations along with polyethylene glycol, glycerine, methyl paraben and triethanolamine. The prepared formulations were evaluated for physical appearance, homogeneity, pH, spreadability, washability, and antifungal activity. The formulations showed satisfactory physical characteristics, with pH values ranging from 6.23 to 6.47. F1 exhibited the highest spreadability of 8.33 cm/sec, followed by F2 (7.5 cm/sec) and F3 (6.66 cm/sec). Antifungal evaluation against Candida albicans showed a zone of inhibition of 30 mm for the prepared gel. The study indicates that the combination of Ficus benghalensis and Hibiscus rosa-sinensis extracts has potential for developing herbal hair gel with promising antifungal activity. Further studies are recommended to establish its long-term stability and clinical effectiveness.

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INTRODUCTION

The term "cosmetic" means any article intended to be applied to the human body by means of rubbing, sprinkling, or by similar application for cleaning, beautifying, promoting attractiveness, altering the appearance of the human body, and for maintaining the health of the skin and hair; provided that the cosmetic has a mild effect on the human body. [1]

CLASSIFICATION

Classification of cosmetics based on their usage.

For Skin

- Skin Care Cosmetics

Usage	Main Products
Cleansers	Face Cleansing Creams, Foams
Conditioners	Lotions, Packs, Massage Creams
Protectors	Milky Lotions, Moisture Creams

- Makeup Cosmetics

Usage	Main Products
Base makeups	Foundations, Face Powders
Point Makeups	Lipstick, Blushers, Eye Shadow, Eye Liners
Nail Care	Nail Enamels, Nail Polish Removers

- Body Cosmetics

Usage	Main Products
Bath	Soaps, Liquid Cleansers
Suncares and Suntans	Sunscreen Creams, Sun Oils
Antiperspirants and Deodorants	Deodorant Sprays
Bleaching, Depilatory	Bleaching Creams, Depilatory Creams
Insect Repellents	Insect Repellent Lotions and Sprays

For Hair and Scalp

- Hair Care Cosmetics

Usage	Main Products
Cleansing	Shampoos
Treatments	Rinses, Hair Treatments
Hair Styling	Hair Mousses, Hair Liquids
Permanent Waves	Permanent Wave Lotions (Agent No.l, No.2)
Hair Colors and Bleaches	Hair Colors, Hair Bleaches, Color Rinses

- Scalp Care Cosmetics

Usage	Main Products
Hair Growth Promoters	Hair Growth Promoters, Hair Tonics
Treatments	Scalp Treatments

For Oral

- Oral Care Cosmetics

Usage	Main Products
Toothpastes	Toothpastes
Mouthwashes	Mouthwashes

Fragrances

Table 01: Classification of Cosmetics

Usage	Main Products
Fragrances	Perfumes, Eau de Colognes [2]

HAIR

Hair is a derivative of the skin. On the outside, it takes the form of slender, elastic tubes composed of dead, fully keratinized epithelial cells, but below the skin's surface, it consists of living hair follicles, cylindrical epithelial structures that extend to the dermis and the layer of fat under the skin. [3]

The hair shaft contains:

1) The medulla:mid-dermal area of wool consists of the pith or parenchyma of the hair, being made up of dispersed cells.it is in the center of the shaft while the cortex is the part that makes the most distance.
2) The cortex:It is the second area of the hair. The cortex is the outer covering and makes up to about 50-60% of the composition of hair like there are rods of the microfibrils together with the other components of the hair shaft.
3) The cuticle:outermost portion of the hair shaft. layer which encloses the whole hair shaft and is made of flat cells overlapping each other. Each cuticle cell can be around 0.3 to 0.5 micrometer in thickness and can be 50 micrometers long. The role of the cuticle is great in the protection of the cortex from

any impact and also in the keeping the hair in clean and combed condition. [32]

One of the important structures of hair is the follicle. Historical structures in terms of their placement on the hair follicle are:

1. the outer root sheath (ORS): which is believed to be a place of stem cells which can differentiate into keratinocytes and melanocytes. ORS has a bulge other than the insertion of the arrector pili muscle and duct of the sebaceous gland. Beneath the ORS, on the dermal side, lies a wavy arrangement of two spin simultaneously oriented layers of collagen fibers which is called a glassy layer which is termed as dermal sheet of the collagen fiber.
2. The inner root sheath (IRS): made up of three layers by, Henle's layer, Huxley's layer and the cuticle layer may which connects the cuticle of the hair shaft and therefore connects the hair shaft with the follicle. The IRS cells produce substances such as keratins and trichohyalin which act intracellularly to bind the parts of the IRS together and allows them to support the hair shaft and bring it upwards. The IRS forms a barrier between the hair shaft and the ORS. The bulb is the part of the follicle that the hair production occurs actively. [4]

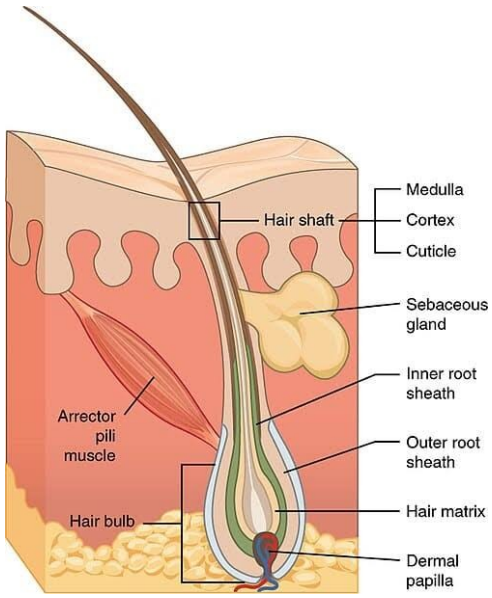


Figure 01: Structure of Hair

Hair Growth Cycle

There are three distinct phases of hair development

i. anagen or growth phase

ii. catagen or transitional phase

iii. telogen or resting phase.

In the **anagen phase**, the hair follicle actively grows and becomes larger and takes on the characteristic onion shape along with the formation of the hair fiber. The anagen phase contains six stages (I-VI). In anagen stages I-V, the hair progenitor cells divide, surround the growing dermal papilla, become deep into the skin and begin differentiation into the hair shaft and internal root sheath. This is followed by the formation of the hair shaft at stage VI when the process of restoration of hair-producing unit occurs by creating the epithelial hair bulb of the dermal papilla deep in the subcutaneous layer, where from the hair fiber appears at the surface of the skin. The process can take years in the hair follicle to complete.

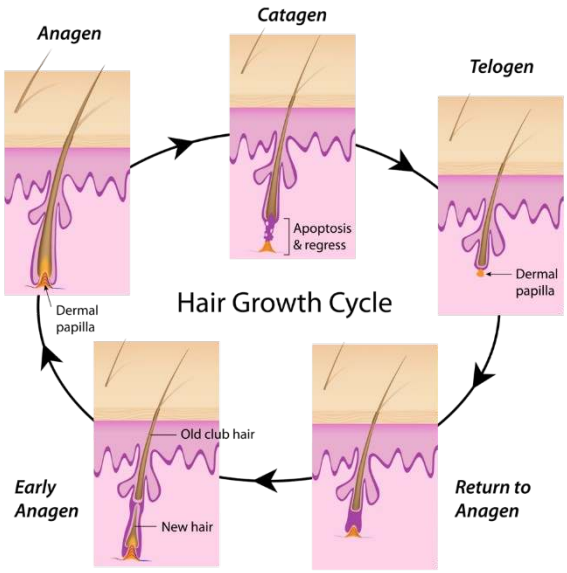


Figure 02: Hair Growth Cycle

The **catagen phase** begins with the finalization of the hair growth phase known as anagen. The catagen phase is characterized by considerable reductions in the activity of hair matrix keratinocytes and melanocytes leading to the completion of the process of hair shaft creation. At the same time, the hair follicle is subjected to degeneration that causes its size to shrink as the normal hair diameter reduces by approximately one-sixth. The process of catagen formation results in the formation of a special structure known as the club hair. A special keratin structure located at the base of the club hair becomes surrounded by epithelial cells of ORS and fixes the hair in the follicle telogen period. The dermal papilla turns into the group of resting cells situated near the contracted hair follicle epithelium and moves from the subcutis area to the border between dermis and subcutis so that it could retain the contact with the end part of the hair follicle. The stage lasts for few weeks.After the catagen phase, the **telogen phase** starts. From this time on the hair is in a quiescent state, which can last for several weeks (in the case of eyelashes) or as long as eight months (in the case of scalp hair). For the hair, however, there won't be any paintings during this stage. Moreover, the dermal papillae remain in the preceding state. A hair that is in the telogen phase does not show pigmentation, and the internal root sheath is absent. The dermal papillae of a hair in the telogen phase are tightly associated with a small cap of keratinocytes of the secondary hair germ along with the presence of hair follicle stem cells. About 10 to 15% of the hair currently is in the telogen phase. After this phase is over, the hair starts to shed (**exogen phase**). The hair follicle will return to the growth phase after some weeks with assistance from the stem cells of the bulge region. [5]

CONCEPT OF HAIR GEL

Gel is a semi-rigid, translucent, homogeneous mixtures of a liquid medium with cross-linked polymer molecules form via physical and chemical means depending on user choice of gelling agents. The term "gel" stems from the Latin word gelatinus meaning ‘like gelatin’. Thus, both the terms gel and jelly were defined in Latin. The origin of both words illustrates that all liquids are in fact solid states having the ability of proper type of deformation such that they maintain certain proportions of both liquids and solids. [6]

Structure of gel:

The gel's hardness results from a network of connected granular gelling agents. The coupling between the oil and other ingredients in the product (or something else) determines what type of structure the gel will exhibit, as well as what product will have a certain type of gel structure.

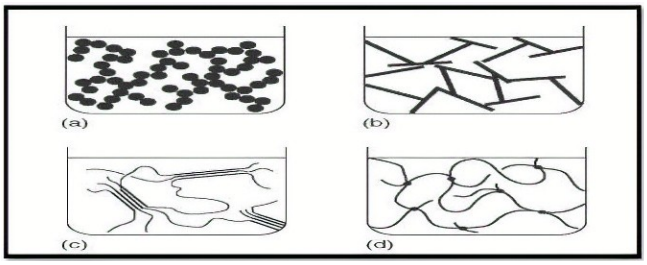


Figure 03: Structure of Gel

Some products contain only one hydrocolloid, which may consist of clusters (spherical or equidistant) either containing small or single macromolecules. These products are prepared in gel waxes.[7]

Ideal properties of gel:

- Ideally, gelling agents should be inert, safe and non - reactive with the other ingredients in the formulation.
- The gelling agent should develop a sharp solid-like property during storage, easily fracturing when subjected to shear forces from squeeze tubes, shaken bottles or topical application.
- Proper antibacterial agents should be available.
- The gel for external use should not be sticky.
- The ophthalmic gel should be sterile.
- The apparent viscosity or strength of the gel increases with increasing productive Cross-linking density of the gel. [8]

Advantages:

- Gels are simple to prepare when compared to other formulations.
- Gel is sleek, non-greasy formulation.
- Gels stick well to where they are applied.
- Gels are tissue-compatible and eco-safe.
- Have remarkable acceptability to stress conditions.

Disadvantages:

- Gels have a prolonged and gradual effect.
- Additives in the gel can cause some irritation.
- Gels with high water content are more prone to contamination like microbial or fungal growth.
- Gels can dry out due to solvent evaporation.
- Some gels become unstable due to flocculation. [9]

LITERATURE REVIEW

- **Hafiz Abdul Khaliq (2017)** reviewed the ethnomedicinal, phytochemical, and pharmacological properties of Ficus benghalensis L. (Banyan tree). Various parts of the plant, including aerial roots, bark, leaves, fruits, and latex, are traditionally used for treating diabetes, wounds, ulcers, inflammation, and other ailments. The plant contains flavonoids, phytosterols, triterpenoids, phenolics, fatty acids, and other bioactive compounds. Reported pharmacological activities include anti-inflammatory, analgesic, antibacterial, antifungal, antioxidant, antidiabetic, and hepatoprotective activities. The review highlights the therapeutic potential of F. benghalensis and supports its traditional medicinal uses.
- **Asmaa Missoum (2018)** reviewed the phytochemistry, pharmacological activities, and medicinal uses of Hibiscus rosa-sinensis (China rose). The plant contains bioactive constituents such as flavonoids, tannins, terpenoids, saponins, and alkaloids, which contribute to its therapeutic properties. Various extracts of the plant have demonstrated antioxidant, antibacterial, anti-inflammatory, wound-healing, antidiabetic, and other pharmacological activities. The review also reported that most extracts showed low toxicity at higher doses, although some biochemical and hematological changes were observed. The authors suggested further research to identify active compounds and clarify their mechanisms of action.
- **Sarvjeet Singh (2019)** investigated the antibacterial and antioxidant activities of methanolic and ethanolic flower extracts of Hibiscus rosa-sinensis L. collected from the western Himalaya. Using the disc diffusion method, both extracts showed antibacterial activity against pathogenic bacteria, with the ethanolic extract showing greater activity against Pseudomonas aeruginosa (13.60 ± 2.1 mm) compared with the methanolic extract (11.4 ± 1.7 mm). The antioxidant activity assessed by the DPPH assay showed an IC_{50} value of 19.54. The

study concluded that H. rosa-sinensis flowers possess significant antimicrobial and antioxidant potential and may be useful in herbal drug formulation.

- **Kaveri Son (2024)** studied the anti-inflammatory activity of Ficus benghalensis (Banyan) aerial roots in relation to gingivitis. Pharmacognostical and physicochemical parameters such as loss on drying, ash values, and extractive values were evaluated. Phytochemical screening of the aqueous extract revealed the presence of flavonoids, phenolics, saponins, proteins, and carbohydrates. The study found that the EMM extract at 400 mg/kg showed greater paw-edema inhibition than the other tested extracts, although its activity was lower than that of the positive control. The findings indicate that Ficus benghalensis aerial roots possess significant anti-inflammatory potential and may have therapeutic value in inflammatory conditions.
- **Tejaswini S. Shinge (2023)** formulated a herbal hair oil using Ficus benghalensis roots and coconut oil to address hair fall and dandruff. The roots contain beneficial phytoconstituents such as proteins, flavonoids, phenolics, and glycosides, which may support hair growth and reduce hair loss. The prepared hair oil was evaluated for colour, odour, pH, viscosity, and acid value, and showed satisfactory physicochemical properties. The study concluded that the formulated herbal hair oil had promising potential for maintaining hair health and reducing hair-related problems.
- **Smrita Shastri (2024)** reviewed the antifungal potential of Ficus benghalensis based on its phytochemical constituents and mechanisms of action. The plant contains bioactive compounds such as flavonoids, tannins, and sterols, which may exert antifungal effects through membrane disruption, enzyme inhibition, and oxidative stress. Advanced analytical techniques such as HPLC, LC-MS, and FTIR have been used to identify its phytoconstituents. The review also highlighted the potential of nanoparticles and topical gel formulations for improving therapeutic efficacy and delivery. Overall, F. benghalensis shows promising antifungal potential and warrants further clinical and formulation studies.
- **Zulfiqar Ali Khan (2014)** evaluated the antioxidant and antibacterial activities of different solvent extracts of Hibiscus rosa-sinensis Linn. The methanolic and ethanolic extracts showed significant phenolic and flavonoid contents, along with strong DPPH free-radical scavenging and inhibition of linoleic acid oxidation. The extracts also exhibited antibacterial activity against Staphylococcus sp., Bacillus sp., and Escherichia coli. The study concluded that H. rosa-sinensis possesses promising antioxidant and antibacterial properties and may be useful in the development of herbal preparations for oxidative stress and infectious conditions.
- **Borhan Uddin (2010)** evaluated the antibacterial activity of leaf and flower extracts of Hibiscus rosa-sinensis against clinical bacterial isolates using agar-well diffusion and bacteriological enumeration methods. The flower extracts showed greater antibacterial activity than the leaf extracts, with Staphylococcus aureus being the most sensitive organism, while Klebsiella pneumoniae showed no sensitivity to the flower extract. The study suggested that H. rosa-sinensis flowers have promising antibacterial potential, particularly against S. aureus and Salmonella typhimurium, and may have applications as herbal antibacterial agents.

AIM:

To formulate and evaluate hair gel using *Ficus benghalensis* (root) and *Hibiscus rosa-sinensis* (flower) extracts and to carry out the evaluation and comparison study of three different formulation (F1, F2, F3) with varying composition of gelling agent.

OBJECTIVES:

- Extraction of *Ficus benghalensis* (root) and *Hibiscus rosa-sinensis* (flower).
- Phytochemical screening of the extracts.
- Formulation of hair gel.
- Evaluation of hair gel.

PLANT PROFILE

HIBISCUS FLOWERS [10]



Figure 04: Hibiscus Flowers

Table 02: Plant Profile of Hibiscus

Common Name	China rose, Jasum, Jaba
Scientific Name	*Hibiscus rosa-sinensis L.*
Family	*Malvaceae*
Division	*Magnoliophyta*
Class	*Magnoliopsida*
Order	*Malvales*

Distribution: The plant can be found growing in its natural environment in tropical and subtropical regions of the world. *Hibiscus rosa sinensis* is of Tropical Asian origin. Indigenous to the southeast part of Asia (China), this type of hibiscus is commonly used as an ornamental plant in various parts of the world and as a houseplant. The majority of the varieties that are grown as decorative plants are hybrids. [11]

Morphology: Macroscopic viewpoint: Red flowers, unique smell, mucilaginous taste. Microscopic viewpoint: Presence of multi-cellular hairs, angular epidermis, and calcium oxalate crystals.Powder characteristics: Reddish color, apparent mucilage, and fiber structures. [12]

Chemical Constituents: It has been said that it has Tannins, Flavonoids, Steroids, Alkaloids, Saponins, Total Phenol, and Total Flavonoids. It is also reported to have plenty of Anthocyanins and flavonoids; cyanidin-3,5-diglucoside, cyanidin-3-sophoroside-5-glucoside, quercetin-3,7-diglucoside and quercetin-3-diglucoside. [13]

Uses

a. <u>In pharmaceutical uses:</u>

1. **Hair growth stimulant:** Hibiscus extracts stimulate hair follicle growth and decrease hair loss.
2. **Healing agent:** Helps speed the formation of epithelial cells and collagen.
3. **Protection against ulcers:** Protects stomach lining by means of flavonoids and antioxidants.
4. **Protecting the heart:** Helps decrease cholesterol levels and improves heart activity.
5. **Antimicrobial effect:** Effective against both Gram-positive and Gram-negative bacteria.
6. **Antioxidant and anti-inflammatory properties:** The plant extracts have lots of polyphenols and anthocyanin, which help to fight free radicals.
7. **Blood pressure regulator:** Hibiscus has been used as a natural means to lower blood pressure.
8. **Lipids lowering:** Some studies showed that hibiscus helps to decrease cholesterol and triglycerides, thus improving the cardiovascular health.
9. **Antimicrobial action:** The flower extracts have antibacterial and antifungal properties, which are helpful in medicines containing hibiscus.

b. <u>In Cosmetics and Cosmeceutical uses:</u>

1. For making face packs
2. For preparing anti-aging gels
3. Mucilage and antioxidants, it improves skin texture and strengthens hair
4. In hair care products, hibiscus extracts are included in the formula of shampoos/ hair oils/ conditioners to stimulate hair growth and minimize hair loss
5. For skin care, hibiscus has high alpha hydroxy acids and antioxidant content which helps exfoliate the skin; it makes skin brighter and reduce the signs of aging
6. For making natural dyes because the red color can be obtained from hibiscus flowers. [14], [15]

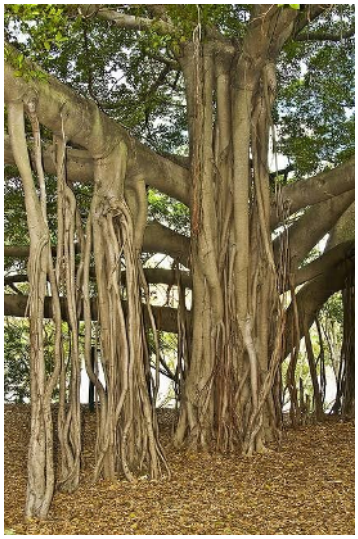


Figure 05: Banyan Aerial Root

BANYAN AERIAL ROOT [16]

Table 03: Plant Profile of Banyan Tree

Common Name	Banyan tree
Scientific Name	*Ficus bengalensis*
Family	*Moraceae*
Division	*Magnoliophyta*
Class	*Magnoliopsida*
Order	*Urticales*

Distribution: *Ficus benghalensis* is endemic to India in the wild where it thrives at elevations ranging from sea level to 610 meters and mainly in arid habitats.

It has a wide distribution across Asia in the Indian subcontinent through Myanmar, Thailand, Southeast Asia, southern China, and Malaysia. [17]

Morphology: The banyan tree is a towering and enduring evergreen tree measuring between 20 to 25 m in height. The tree possesses a broad struggle of branches that stretches horizontally across the sky and goes as far as about 100 m wide. The banyan tree originates as an epiphytic plant. Birds transport banyan tree seeds and deposit them at branch leaf forks where they later sprout as flowers. Consequently, this gives rise to aerial roots believed to take life away from the host tree, thus earning its title "strangler fig." The trunk is exceptionally very big and ribbed. The tree bark appears smooth but very soft when young. Each leaf measures anything between 8 cm to 25 cm long and about 6-20 cm wide. The tree's lamina has a leathery texture, very tough and bears a horse shape. The upper lamina surface is smooth while under it has some hair. The banyan tree produces sexual flowers of both genders separately. The banyan tree also has hollow flowers that are found in a pear-shaped structure. [18]

Chemical Constituents: *Ficus benghalensis* is composed of various important phytoconstituents responsible for the healing and pharmacological properties of the plant. The chemicals formed in the aerial roots include flavonoids, tannins, phenolic compounds, glycosides, saponins, steroids, carbohydrates, and proteins. [19]

Uses

- **Anti-fungal activity:** The aerial root extract of *Ficus benghalensis* exhibited excellent antifungal activity against some pathogenic fungi, including Malassezia species, which causes dandruff. This antifungal activity is due to the presence of flavonoids, tannins, and some phenolic compounds in the extract. Research showed that there was inhibition of fungal growth and reduction in scalp diseases.
- **Antimicrobial activity:** Different extracts of *Ficus benghalensis* exhibited antimicrobial activity against both Gram-positive and Gram-negative bacteria. Reports indicate the activity against microorganisms such as *Staphylococcus aureus* and *Escherichia coli*. This antimicrobial activity helps to maintain scalp hygiene and prevent microbial infections.
- **Anti-inflammatory activity:** Studies reported that extracts of *Ficus benghalensis* have powerful anti-inflammatory activity. This activity helps in the reduction of inflammation, redness, and irritation by inhibiting the process of inflammation.
- **Antioxidant activity:** The aerial root extract of *Ficus benghalensis* is effective in terms of antioxidant activity because of the presence of phenolic compounds and flavonoids. [20],[21]

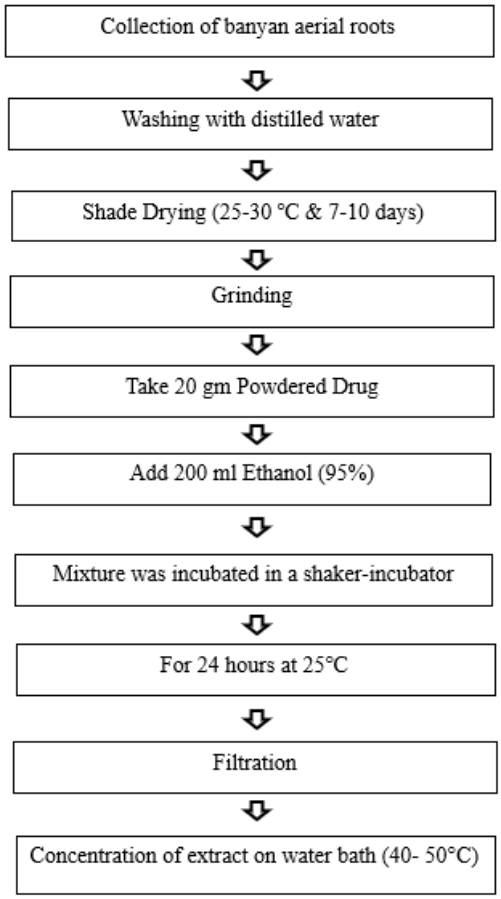
PLAN OF WORK

Phase 1: Selection and authentication of banyan aerial root and hibiscus flower.

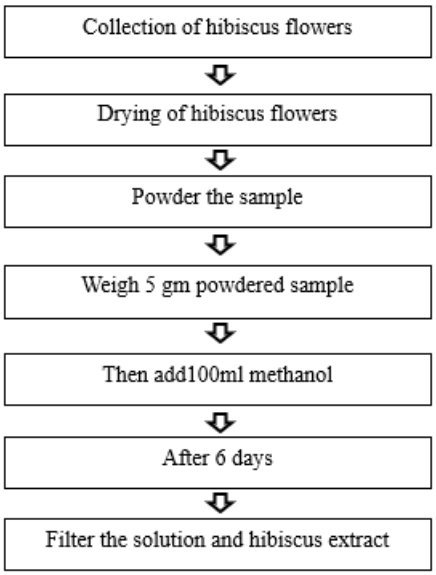
Phase 2:

Extraction: Extraction of banyan aerial root: [22]

Collection of banyan aerial roots Washing with distilled water Shade Drying (25-30 ℃ & 7-10 days) Grinding Take 20 gm Powdered Drug Add 200 ml Ethanol (95%) Mixture was incubated in a shaker-incubator For 24 hours at 25℃ Filtration Concentration of extract on water bath (40- 50°C) Collection of hibiscus flowers Drying of hibiscus flowers Powder the sample Weigh 5 gm powdered sample Then add100ml methanol After 6 days Filter the solution and hibiscus extract



i. Extraction of hibiscus flower: [23]



Phase 3:

Phytochemical Screening

Banyan aerial root

Hibiscus flower

Phase 4: Formulation of herbal hair gel using carbopol of F1, F2, F3 concentration.

Phase 5: Evaluation of Herbal Hair Gel

- Physical appearance
- Spredability
- Measurement of PH
- Washability
- Homogenisity
- Anti-fungal activity

MATERIALS AND METHODS:

COLLECTION AND AUTHENTICATION OF PLANT MATERIALS

The banyan aerial root and hibiscus flowers were collected from Perumbavoor and authentified as *Ficus benghalensis* and *Hibiscus rosa-sinensis* by Dr. Justin R Nayagam, HOD Department of Botany, Union Christian College Aluva, Kerala.

PREPARATION OF PLANT EXTRACT

Banyan Aerial Root: Collected banyan aerial roots are washing with distilled water, Shade drying at 25-30°C for 7-10 days. Grinded to obtain a coarse powder. [4] Soaking 20 g of the powdered sample in one of the different solvents (ethanol, ethyl acetate, chloroform, methanol, acetone or water) at 200 ml. The mixtures were left to incubate in a shaker incubator for 24 h at 25°C. After incubation, the samples were filtered using Whatman filter paper and dried. [22]



Fig.no 06: Dried banyan aerial root



Fig.no 07: Powdered banyan aerial root



Fig. no 08: Extraction of Banyan Aerial Root

Hibiscus Flower: Collection of hibiscus flowers, drying and powdered. Weigh 5gm powdered sample and add100ml methanol. Filter the solution to obtain hibiscus extract. [23]



Fig. no 09: powdered Hibiscus Flower



Fig. no 10: Filtration Hibiscus Extract



Fig no. 11: Hibiscus flower Extract

EXCIPIENTS USED IN THE HERBAL HAIR GEL

Carbopol 940: Carbopol 940 is a gelling-agent which can modify the physical properties of gel preparations. The concentration of carbopol 940 as a gelling-agent can be adjusted to obtain preparations which meet the requirements for the physical properties of gel, namely pH, viscosity, adhesion, spreadability, organoleptic and stability. Carbopol 940 can modify the release of active drug substances by their viscosity value. The higher the viscosity of a preparation, the more difficult the drug is released. This makes the use of carbopol 940 more focused on controlled release preparations [24]



Fig. no 12: Carbopol



Fig. no 13: Polyethylene Glycol

Polyethylene Glycol (PEG): PEGs have different kinds of PEG derived mixtures due to their terminal hydroxyl groups that can easily be linked with a lot of other chemicals and compounds including ethers, fatty acids, castor oil, amines, and propylene glycol among others. PEGs are extensively used in cosmetics as surfactants, emulsifiers, cleansing agents, humectants, and skin conditioners; however, information regarding such PEG-derived mixtures evaluated in this review is very limited**.** [25]

Glycerine: Glycerine has evolved from just being a simple moisturizer. Today, it is a multifunctional ingredient that plays an important role in modern

cosmetic and cosmeceutical sciences, supported by solid biochemical and clinical evidence. Its functions as an agent for hydration, barrier repair, texture modification, and even the assistance of microbiome, accompanied by an excellent safety profile and sustainability, make it an indispensable component of modern and upcoming skincare innovations. Further researches and developing new products will most likely focus on aquaporin ingredients, systems cooperating with microbiome, improvement of utilization methods. [26]



Fig. no 14: Glycerine



Fig. no 15: Triethanolamine

Triethanolamine: Triethanolamine is widely used in cosmetic formulation as a surfactant, pH adjuster, skin-conditioning agent, and hair-conditioning agent, while triethanolamine-sorbate function as preservative. In formulations, triethanolamine is commonly combined with fatty acids (such as stearic acid) to form emulsifiers, helping to stabilize creams and lotions. [27]

Methyl paraben: Methylparaben can be used by itself or in conjunction with other types of parabens in certain formulations because its impacts are synergistic.Because of their broad range of antimicrobial properties, low toxicity and stability, along with low volatility, parabens are great preservatives for cosmetics, pharmaceuticals and food against microbial and fungal growth. Hydroxybenzoates (parabens) are the alkyl esters derived from p-hydroxybenzoic acid, which is known to have



Fig. no 16: Methyl paraben



Fig. no 17: Rose Water

both antibacterial and antifungal properties. [28]

Distilled Water: Water plays a vital role in pharmaceutical industry as an excipient, extraction solvent, active ingredients producer and analytical reagents; it is also used for cleaning and heat transfer. Different water types are utilized in the manufacturing of pharmaceutical formulations, and the quality of the water must comply with the requirements depending on the properties of the drug and process in which the water is employed. [29]

Rose Water: Rose water appears as a clear liquid with the scent of rose. The percentage of extracted rose water from fresh rose flowers. Rose water contains high levels of flavonoids, anthocyanins, terpenes and glycosides. [30]

CHEMICAL TEST

Chemical Test for Banyan Aerial Root: [20]

Table 04: Chemical Test of Banyan Aerial Root

SL NO	PHYTOCONSTITUENTS	TESTS	OBSERVATIONS
	Alkaloids	Wagner's Test	Brown or reddish-brown precipitation

SL NO	PHYTOCONSTITUENTS	TESTS	OBSERVATIONS
	Glycoside	Keller-Killiani Test	Brown ring
	Flavonoids	Lead Acetate Test	yellow precipitate
	Phenols	Ferric Chloride Test	blue-green or dark coloration
	Tannins	Ferric Chloride Test	blue-black or greenish-black colour
	Saponins	Foam Test	Formation of stable foam
	Steroids	Salkowski Test	reddish-brown ring
	Carbohydrates	Benedict's Test	yellow or brick-red precipitate

Chemical Test for Hibiscus Flowers: [32]

Table 05: Chemical Test for Hibiscus Flowers

SL NO	PHYTOCONSTITUENTS	TESTS	OBSERVATIONS
	Alkaloids	Wagner's Test	Brown or reddish-brown precipitation
	Carbohydrates	Benedict's Test	yellow or brick-red precipitate
	Flavonoids	Ferric Chloride Test	blue-green or dark coloration
	Phenols	Ferric Chloride Test	blue-green or dark coloration

FORMULATION OF HERBAL HAIR GEL

Three herbal hair gels were formulated using a varying concentration of carbopol. Methylparaben, polyethylene glycol and glycerine were weighed and dissolved in water before mixing with carbopol. A magnetic stirrer was used for stirring the blend under high speed. At the end banyan aerial root extract and hibiscus flower extract were added to the above blend. Triethanolamine was added drop wise in order to neutralize the preparation. A gel was produced. The formulation of herbal hair gel was stored at normal temperature conditions. [33]

Table 06: Formulation of Herbal Hair Gel

SL NO	COMPOSITION	F1	F2	F3	CATEGORY AND USE
	Banyan aerial root Extract (ml)	1.5	1.5	1.5	Anti-fungal
	Hibiscus flower Extract (ml)	0.5	0.5	0.5	Soothing
	Carbopol (gm)	0.5	1	2	Gelling agent
	Methyl paraben (mg)	75	75	75	Preservative
	Polyethylene Glycol (ml)	6.25	6.25	6.25	Gelling agent, emulsifier
	Glycerine (ml)	3	3	3	Humectant
	Trietanolamine (ml)	0.5	0.5	0.5	Thickening agent, pH adjuster
	Rose water (ml)	q.s	q.s	q.s	Flavouring agent
	Distilled water (ml)	q.s	q.s	q.s	Vehicle

EVALUATION OF HERBAL HAIR GEL

Physical appearance: The next criteria were used to analyze the prepared herbal hair gel:

The gel formulation was evaluated for the physical properties such as, phase separation, color, odor changes, rheological properties.

Color: The formulated hair gel was evaluated for color against white background.

Smoothness: The gel can be picked between the fingers and can be felt smoothly.

Homogeneity: The developed gel was checked for homogeneity by visual inspection once the gel was

solidified in the jar/container. It was checked for the appearance, presence of any lumps.

pH: The pH of the gel formulation was measured using digital pH measurement. The probe was dipped into the gel formulation and the final pH was noted.

Washability: The gel prepared for use on hair has been applied to the body and then checked for how easily or extensively it can be washed off with the use of water.

Extrudability: After filling the hair gel formulation, it was poured in collapsible tubes and went through the process of extrudability assessment by fastening the tube in order to observe how easily it can be extruded.

Spreadability: An appropriate quantity of the gel formulation was put in between two pieces of glass slides, and a weight of 500 grams was applied for the period of five minutes. After the completion of the period of time, diameter of the spread formulation is assessed at different spots through calculation of the spread ability formula

S=M.L/T

S- Spreadability,

M- Weight tied to the upper slide

L-Length moved by the glass slide

T- Time in second taken to separate the slide completely each other. [32]

Anti-fungal activity: The antifungal qualities against *Candida albicans* were studied by the agar well diffusion method so as to determine the size of inhibitory zone, which is evidence of microorganism sensitivity to the chemical. [20]

Stability study: The studies of stability help in evaluating how drug quality varies during certain surrounding conditions, such as high humidity and sunlight etc., thus making it possible to define storage methods, shelf life and retesting period as the following. [33]

RESULT AND DISCUSSION

Phytochemical Screening of Banyan Aerial Root

Table 07: Phytochemical Screening of Banyan Aerial Root

SL NO	PHYTOCONSTITUENTS	TESTS	RESULT
	Alkaloids	Wagner's Test	+ve
	Glycoside	Keller-Killiani Test	+ve
	Flavonoids	Lead Acetate Test	+ve
	Phenols	Ferric Chloride Test	+ve
	Tannins	Ferric Chloride Test	+ve
	Saponins	Foam Test	+ve
	Steroids	Salkowski Test	+ve
	Carbohydrates	Benedict's Test	+ve



Fig. no 18: Wagner's Test



Fig. no 19: Keller-Killiani Test



Fig. no 20: Lead Acetate Test



Fig.no 21: Ferric Chloride Test



Fig. no 22: Ferric Chloride Test



Fig. no 23: Foam Test



Fig. no 24: Salkowski Test



Fig. no 25: Benedict's Test

Table 08: Phytochemical Screening of Banyan Aerial Root

SL NO	PHYTOCONSTITUENTS	TESTS	RESULT
	Alkaloids	Wagner's Test	+ve
	Carbohydrates	Benedict's Test	+ve
	Flavonoids	Lead Acetate Test	+ve
	Phenols	Ferric Chloride Test	+ve

Phytochemical Screening of Banyan Aerial Root **igure 28: Lead Acetate Test**



Fig. no 26: Wagner's Test



Fig. no 27: Benedict's Test

Fig. no 28: Lead Acetate Test



Fig. no 29: Ferric Chloride Test





Fig. no 31: F2



Fig. no 32: F3

EVALUATION TESTS

PHYSICAL APPERANCE:

Table 09: Physical Appearance of Hair Gel

PARAMETERS	F1	F2	F3
COLOUR	Orange-brown	Orange-brown	Orange-brown
SMOOTHNESS	Good	Very Good	Good

HOMOGENEITY: The thorough inspection of every herbal hair gel was done to check for the presence of lumps, flocculates, or aggregates. The homogeneity of the products was found satisfactory in each formulation. The results are indicated in Table no-6.

Table 10: Homogeneity of Hair Gel

FORMULATION	F1	F2	F3
RESULT	Good	Very Good	Bad

MEASUREMENT OF pH:



Fig no 33: pH of F1



Fig no 34: pH of F2



Fig no 35: pH of F3

Table 11: Measurement of pH

FORMULATIONS	pH
F1	6.47
F2	6.38
F3	6.23

The pH of the formulation (F1, F2, F3) were found to be nearer to the hair pH therefore these formulations are used on hair. The pH of all the hair gel formulations ranged between 6.2 to 6.5.

DETERMINATION OF SPREADABILITY:

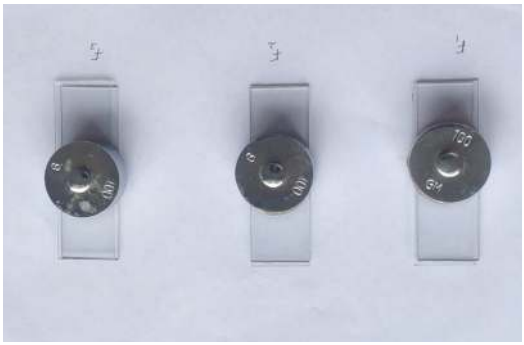


Figure 36: Spreadability of F1, F2, F3

Table 12: Spreadability of F1, F2, F3

FORMULATIONS	SPREADABILITY (cm/ sec)
F1	8.33
F2	7.5
F3	6.66

ANTI-FUNGAL ACTIVITY:

Antifungal Activity against *Candida albicans*	
Sample (100 µl)	**Zone of Inhibition in Diameter (mm)**
Solvent	Nil
Extract	Nil
Sample	30mm



Figure 37: Antifungal Activity Against *Candida albicans*

The hair gel contains *Ficus benghalensis* and *Hibiscus rosa-sinensis* showed an inhibition zone of 30 mm which reflects antifungal activity against *Candida albicans*. This indicates that this formulation is effective in treating dandruff caused by the *Candida fungus* at high concentrations.

Table 13: Antifungal Activity Against *Candida albicans*

STABILITY STUDY

The stability investigations were carried out for all formulations over a duration of 3 months. Significant changes were found in the evaluated criteria such as appearance, pH at both temperatures. There is no significant changes colour and pH of hair gels are observed.

SUMMARY AND CONCLUSION

The present study successfully demonstrated the formulation and evaluation of herbal hair gel incorporating *Ficus benghalensis* and *Hibiscus rosa-sinensis* extracts as natural active ingredients. The increasing demand for safer and plant-based cosmetic products formed the basis of this research, aiming to develop an effective herbal alternative to synthetic hair gels that

are often associated with adverse effects on hair and scalp health.

Neem and mint leaf extracts were effectively prepared using suitable extraction techniques and were confirmed through phytochemical screening to contain bioactive constituents such as alkaloids, flavonoids, tannins, phenols, glycosides, and terpenoids. These phytochemicals are known for their antifungal, antimicrobial, anti-inflammatory, and antioxidant properties, which contribute to improved scalp health and dandruff control. Three herbal hair gel formulations (F1, F2, and F3) were developed using Carbopol 940 as a gelling agent in varying concentrations.

All formulated gels exhibited satisfactory physical appearance, smooth texture, good homogeneity, acceptable washability, and ease of extrusion. The pH of the formulations was found to be within the suitable range for scalp application, indicating minimal risk of irritation. Among the three formulations, F1 demonstrated optimum spreadability and superior antifungal activity against *Candida albicans*, producing a notable zone of inhibition, thereby confirming its potential in managing dandruff and fungal scalp infections. Stability studies conducted over 30 days revealed no significant changes in physical characteristics or pH, indicating good formulation stability.

Overall, the findings suggest that the developed herbal hair gel, particularly formulation F1, is safe, stable, and effective. The study supports the potential use of *Ficus benghalensis* and *Hibiscus rosa-sinensis* based herbal formulations as natural, eco-friendly, and economical alternatives to conventional synthetic hair care products. Further studies involving long-term stability and clinical evaluation are recommended to substantiate its commercial applicability.

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