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Formulation and Evaluation of Herbal Hair Oil Using Betel Leaf

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Abstract- — Herbal cosmetics have gained significant importance due to their safety, effectiveness, and minimal side effects compared to synthetic products. The present research project focuses on the formulation and development of herbal hair oil using Betel Leaf as the major active ingredient. Betel leaf is traditionally known for its antimicrobial, antifungal, antioxidant, and anti-inflammatory properties, which are beneficial for maintaining healthy hair and scalp conditions The herbal hair oil was prepared using betel leaf along with other natural ingredients such as coconut oil, curry leaves, hibiscus, and aloe vera. The formulation was developed by heating the herbal materials with the base oil to extract the active constituents effectively. The prepared oil was filtered and evaluated for various physicochemical parameters including color, odor, pH, viscosity, specific gravity, irritation test, and stability study. The formulated herbal hair oil showed satisfactory physical appearance, good stability, and acceptable consistency without causing skin irritation. The presence of betel leaf in the formulation may help reduce dandruff, scalp infections, and hair fall due to its medicinal properties. The study concludes that the prepared herbal hair oil can serve as a safe, economical, and natural alternative for hair care management. This research supports the growing demand for herbal cosmetic products and highlights the potential. [1]

Keywords— Herbal hair oil, Betel Leaf, dandruff control, herbal formulation

I. INTRODUCTION

Hair is one of the important appendages of the skin and plays a significant role in maintaining the physical appearance and overall personality of an individual. Healthy and attractive hair is considered an important aspect of beauty and self-confidence. Hair not only enhances appearance but also performs several physiological functions in the human body.

Hair mainly consists of a protein called keratin, which is produced by specialized cells present in hair follicles. Hair follicles are located in the dermal layer of the skin and are responsible for the growth and development of hair. The condition of hair reflects the health status of an individual and may be affected by various internal and external factors.

Hair serves several important functions in the body. It acts as a protective covering and helps protect the scalp from harmful environmental conditions such as ultraviolet radiation, dust particles, and extreme temperatures. Hair also plays an important role in maintaining body temperature by reducing heat loss from the body. Additionally, hair contributes significantly to social appearance and emotional well-being.

The quality and health of hair depend upon several factors including genetics, age, nutritional status, hormonal balance, environmental conditions, and lifestyle habits.

In recent years, hair-related disorders have become increasingly common because of changes in lifestyle, stress, pollution, poor dietary habits, and excessive use of synthetic cosmetic products.

Healthy hair is generally characterized by smooth texture, adequate thickness, strength, shine, elasticity, and proper growth. Maintaining healthy hair has therefore become an essential aspect of personal care and healthcare management [3]

Structure and Anatomy of Hair and Scalp:

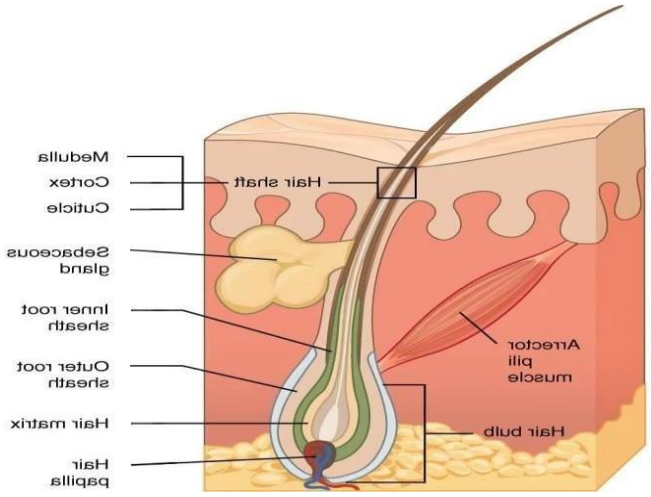

Fig No1: Structure and anatomy of hair and scalp.

The scalp is the soft tissue covering the upper part of the skull and serves as the foundation for hair growth. It consists of multiple layers containing blood vessels, nerves, sebaceous glands, sweat glands, and hair follicles. The scalp plays an important role in protecting the skull, nourishing hair follicles, regulating temperature, and maintaining healthy hair growth.

The scalp contains thousands of hair follicles that continuously produce hair throughout life. Healthy scalp conditions are essential for proper nourishment, strength, and growth of hair. Poor scalp health can lead to dandruff, itching, infections, excessive hair fall, and other hair disorders. [3]

Layers of the Scalp
The scalp is anatomically divided into five layers.

Skin
The outermost layer of the scalp is the skin, which contains hair follicles, sebaceous glands, sweat glands, and melanocytes. The scalp skin is thicker than the skin on most other parts of the body and contains numerous blood vessels and nerves.

Functions:
Protects underlying tissues Supports hair follicles Produces sebum for lubrication Helps in temperature regulation

Connective Tissue
This is a dense layer of connective tissue located beneath the skin. It contains blood vessels and nerves that supply nutrients and oxygen to the scalp and hair follicles.

Functions:
Provides nourishment to hair roots Supports blood circulation Connects skin to underlying structure.

Aponeurosis (Galea Aponeurotica)
The aponeurosis is a tough fibrous sheet connecting the frontalis muscle in the forehead to the occipitalis muscle at the back of the head.

Functions:
Provides movement to the scalp Maintains structural support Helps in scalp flexibility.

Loose Areolar Tissue
This soft connective tissue layer lies below the aponeurosis and allows free movement of the scalp over the skull bones.

Functions:
Acts as a cushioning layer Allows scalp mobility Contains small blood vessels

Pericranium
The pericranium is the deepest layer of the scalp and covers the outer surface of the skull bones. Functions:

Protects skull bones
Provides attachment to skull structures Supports bone nourishment

Hair Follicles in the Scalp
Hair follicles are tiny tubular structures embedded within the scalp skin. Each follicle produces a hair shaft through continuous cell division.

The follicle contains several important parts:
Hair Bulb
The enlarged lower portion of the follicle where active cell division occurs.

Dermal Papilla
A small structure containing blood vessels that supply nutrients and oxygen for hair growth.

Sebaceous Gland
Oil-producing glands attached to hair follicles that secrete sebum to lubricate the scalp and hair.

Arrector Pili Muscle
A small smooth muscle attached to the follicle that causes hair to stand upright during cold or emotional conditions, producing goosebumps. [4]

Functions of the Scalp
Supports and protects hair follicles
Provides nourishment through blood circulation Protects the skull from physical injury Maintains moisture and oil balance

Helps in temperature regulation
Provides sensory perception through nerve endings

Importance of Healthy Scalp
A healthy scalp is essential for strong, shiny, and healthy hair. Factors such as pollution, stress, poor hygiene, excessive use of chemicals, dandruff, fungal infections, and nutritional deficiencies can disturb scalp health and negatively affect hair growth. Herbal ingredients such as betel leaf, neem, hibiscus, aloe vera, and curry leaves are commonly used in herbal hair oils because they help nourish the scalp, reduce dandruff, improve blood circulation, and strengthen hair roots.

II. HAIR GROWTH CYCLE

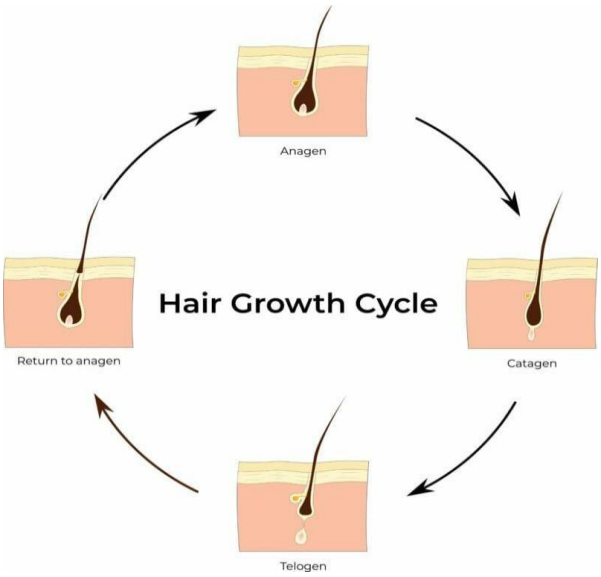

Fig No2: Hair growth Cycle

Hair growth is a continuous and complex biological process that occurs through a cyclic pattern involving different stages. The normal growth of hair depends on the healthy functioning of hair follicles and proper supply of nutrients. Hair does not grow continuously throughout life; instead, it passes through a series of phases known as the hair growth cycle. The hair growth cycle consists of three major phases namely Anagen phase, Catagen phase, and Telogen phase.

Anagen Phase (Growth Phase):
The anagen phase is the active growth stage of hair and is considered the longest phase of the hair growth cycle. During this phase, cells in the hair follicle divide rapidly and continuously produce new hair fibers. Hair grows approximately 1 cm per month during this stage. This phase may last for about 2 to 6 years depending on genetic and physiological factors. Around 80–90% of scalp hair normally remains in the anagen phase.

Catagen Phase (Transition Phase):
The catagen phase is a short transitional period between the growth and resting stages. During this phase, active cell division stops and the hair follicle gradually shrinks. Blood supply to the hair follicle decreases and hair growth slows down significantly. This phase generally lasts for about 2–3 weeks.

Telogen Phase (Resting Phase):
The telogen phase is considered the resting stage of the hair growth cycle. During this phase, the hair follicle remains inactive and old hair eventually falls out. Simultaneously, new hair begins developing beneath the follicle and later replaces the old hair. Normally, around 10–15% of scalp hair remains in this phase.

The proper functioning of the hair growth cycle is essential for maintaining healthy hair growth. Various factors such as stress, nutritional deficiencies, hormonal imbalance, environmental pollution, and disease conditions may disturb the normal hair cycle and lead to excessive hair fall and other hair disorders. components are essential for maintaining healthy hair growth and preventing hair damage.[7]

Hair Health and Common Hair Problems:
Healthy hair is considered an important indicator of overall health and well-being. Hair health mainly depends on the condition of the scalp, proper nutrition, hormonal balance, genetic factors, and lifestyle habits. A healthy scalp provides a suitable environment for the growth and development of hair follicles. Proper blood circulation and an adequate supply of nutrients are essential for maintaining healthy hair.

Hair and scalp require various nutrients such as proteins, vitamins, minerals, and essential fatty acids for normal growth and maintenance. Deficiency of these nutrients may weaken hair roots and negatively affect hair growth. In addition, environmental and lifestyle factors also influence hair quality and condition.

Nowadays, hair-related problems have become increasingly common among individuals due to changing lifestyles and increased exposure to environmental factors.

Some common hair problems include:

Fig No3: some common hair problems

Hair Fall:
Hair fall is one of the most frequently observed hair disorders. Excessive hair loss may occur due to stress, hormonal imbalance, nutritional deficiencies, medications, or genetic factors.

Dandruff:
Dandruff is a common scalp condition characterized by the shedding of dead skin cells from the scalp. It may lead to itching, irritation, and discomfort.

Premature Greying:
Premature greying refers to early loss of natural hair color due to reduced melanin production.

Split Ends:
Split ends occur when the protective outer layer of hair becomes damaged, resulting in breakage of hair strands.

Hair Thinning:
Hair thinning involves reduction in hair density and volume and may eventually lead to baldness.

Scalp Infections:
Microbial infections involving bacteria or fungi can affect scalp health and interfere with normal hair growth. Therefore, maintaining healthy hair and scalp has become an essential part of personal care and preventive healthcare practices. [7]

Causes of Hair Problems and Introduction to Hair Care Products:
Hair disorders can occur due to several internal and external factors that affect the normal structure and growth cycle of hair. These factors may weaken hair follicles, damage the scalp, and lead to various hair-related problems. Understanding the causes of hair disorders is important for developing suitable treatment and preventive approaches.

Several factors responsible for hair problems include:
Environmental Pollution:
Exposure to dust, smoke, harmful chemicals, and environmental pollutants can damage hair and reduce its natural strength and shine.

Stress and Anxiety:
Physical and emotional stress may disturb the normal hair growth cycle and contribute to excessive hair loss.

Hormonal Imbalance:
Hormonal changes associated with age, pregnancy, or medical conditions can influence hair growth and hair quality.

Nutritional Deficiencies:
Deficiency of proteins, vitamins, minerals, and essential nutrients can weaken hair roots and negatively affect hair growth.

Genetic Factors:
Certain hair conditions such as baldness and premature greying may occur due to hereditary factors. [7]

Excessive Use of Chemical Products:
Frequent use of synthetic shampoos, dyes, hair sprays, and styling products may cause scalp irritation and hair damage.

To maintain healthy hair and prevent hair-related disorders, various hair care products are commonly used. Hair care products help improve hair quality and protect hair from environmental damage.

Common hair care products include:
- Hair oils
- Shampoos
- Conditioners
- Hair serums
- Hair masks

Among these products, hair oil is considered one of the most commonly used and traditional methods for maintaining healthy hair because it provides nourishment and supports scalp health.

Hair Oil and Herbal Hair Oil:
Hair oil is one of the most widely used hair care products for maintaining healthy hair and scalp condition. Hair oil has been used since ancient times as a traditional remedy for nourishing the scalp, strengthening hair roots, and improving the overall quality of hair. Regular application of hair oil helps provide essential nutrients to the hair follicles and supports healthy hair growth.

Hair oil plays an important role in protecting hair from environmental damage and maintaining proper moisture balance in the scalp. It improves blood circulation in the scalp and helps strengthen hair follicles. Hair oils also reduce dryness, improve texture, and enhance the appearance of hair.

The major benefits of hair oil include:
- Nourishment of hair roots
- Strengthening of hair follicles
- Reduction of hair fall
- Improvement of hair growth
- Prevention of dryness
- Improvement of hair texture and shine
- Protection against scalp damage

Nowadays, there is growing interest in herbal hair oils because of the increasing awareness regarding the side effects associated with synthetic hair products. Herbal hair oils are formulations prepared using medicinal plants and natural ingredients possessing therapeutic properties.

Herbal formulations have been widely used in traditional systems of medicine such as Ayurveda for the treatment of various hair and scalp disorders. Medicinal plants contain different bioactive compounds such as alkaloids, flavonoids, tannins, phenolic compounds, and essential oils that provide beneficial effects on hair health.

Compared to synthetic formulations, herbal hair oils are considered safer, economical, easily available, and associated with fewer side effects. [10]

Types of Herbal Hair Oil:
Herbal hair oils are classified based on the herbal ingredients used and their therapeutic benefits for hair and scalp care. Different herbal oils are prepared to treat various hair problems such as hair fall, dandruff, dryness, premature greying, and scalp infections.

Amla Hair Oil
Amla hair oil is prepared using Indian Gooseberry (Amla) extract. It is rich in vitamin C and antioxidants which help in promoting hair growth, preventing premature greying, and strengthening hair roots.

Coconut Herbal Hair Oil
This oil is prepared using coconut oil as a base along with medicinal herbs. It deeply nourishes the scalp, reduces protein loss, and improves hair softness and shine.

Hibiscus Hair Oil
Hibiscus hair oil is made using hibiscus flowers and leaves. It helps in reducing hair fall, stimulating hair growth, and conditioning the hair naturally.

Neem Hair Oil
Neem hair oil possesses antimicrobial and antifungal properties. It is mainly used for treating dandruff, scalp infections, itching, and lice problems.

Aloe Vera Hair Oil
Aloe vera hair oil provides moisturizing and soothing effects to the scalp. It helps in reducing dryness, dandruff, and scalp irritation while promoting healthy hair.

Curry Leaf Hair Oil
Curry leaf hair oil is rich in proteins and antioxidants. It helps in strengthening hair follicles, reducing hair thinning, and preventing premature greying.

Fenugreek Hair Oil
Fenugreek hair oil contains proteins and nicotinic acid which help in controlling hair fall, dandruff, and dry scalp conditions.

Onion Hair Oil
Onion hair oil is rich in sulfur compounds which help in improving blood circulation to the scalp and promoting hair growth.

Bhringraj Hair Oil
Bhringraj hair oil is considered one of the best Ayurvedic oils for hair care. It helps in reducing hair loss, promoting hair growth, and improving scalp health.

Betel Leaf Hair Oil
Betel leaf hair oil is prepared using betel leaves (Piper betel). It possesses antimicrobial, antioxidant, and anti-inflammatory

properties which help in reducing scalp infections, dandruff, itching, and hair fall. indicants importance in modern hair care practices. [10]

Need of Herbal Hair Oil

Herbal hair oil is widely used for maintaining healthy hair and scalp naturally. Nowadays, hair problems such as hair fall, dandruff, dryness, scalp irritation, premature greying, and hair damage are increasing due to pollution, stress, unhealthy lifestyle, and excessive use of chemical-based cosmetic products. Synthetic hair oils and shampoos may produce side effects such as scalp irritation, hair dryness, and allergic reactions after long-term use.

Herbal hair oils are prepared using natural plant materials that possess medicinal and therapeutic properties. These oils provide nourishment to the scalp, strengthen hair follicles, improve blood circulation, and promote healthy hair growth. Herbal ingredients such as betel leaf, hibiscus, neem, aloe vera, and fenugreek contain antimicrobial, antioxidant, and anti-inflammatory properties which help in protecting the scalp from infections and dandruff.

The need for herbal hair oil has increased because people prefer safe, natural, economical, and chemical-free cosmetic products. Herbal hair oils are considered beneficial due to their fewer side effects and better compatibility with the scalp and hair. Therefore, the formulation of herbal hair oil using betel leaves can be an effective natural remedy for maintaining healthy and strong hair.

demand for natural products has increased interest in the development of herbal formulations for effective hair care management.

Advantages of Herbal Hair Oil:

Promotes Hair Growth

Herbal hair oils nourish the hair roots and improve blood circulation to the scalp, which helps in promoting healthy hair growth.

Reduces Hair Fall

Natural herbs strengthen hair follicles and reduce hair breakage and excessive hair fall.

Prevents Dandruff

Many herbal ingredients possess antifungal and antimicrobial properties that help in controlling dandruff and scalp infections.

Nourishes the Scalp

Herbal oils provide essential nutrients, vitamins, and minerals that maintain scalp health and prevent dryness.

Conditions the Hair

Regular application of herbal hair oil makes hair soft, smooth, shiny, and manageable.

Prevents Premature Greying

Certain herbs like amla and curry leaves help in maintaining natural hair color and delaying premature greying.

Reduces Scalp Irritation

Herbal oils have soothing and anti-inflammatory properties that help in reducing itching, redness, and irritation of the scalp.

Free from Harmful Chemicals

Herbal hair oils are mainly prepared from natural ingredients and contain fewer synthetic chemicals, making them safer for long-term use.

Improves Hair Texture

Continuous use of herbal hair oil improves hair strength, thickness, and overall texture.

Provides Relaxation and Stress Relief

Massaging herbal hair oil on the scalp provides a calming effect, reduces stress, and improves relaxation.

Economical and Easily Available

Most herbal ingredients are inexpensive and easily available, making herbal hair oils cost-effective.

Suitable for All Hair Types

Herbal hair oils are generally mild and suitable for dry, oily, damaged, and normal hair types.

III. MATERIAL AND METHOD

1. Materials

Pharmacognostical Profile of Herbal Ingerdients:

Role of selected drug in herbal oil

Betel Leaf

Fig No4: Betel Leaf

Biological Name and Taxonomy Biological Name: Piper betel **L. Family: Piperaceae**
Synonyms: Betel pepper, Paan, Tambula, Siri

Morphology
Leaves are heart-shaped with a pointed apex.
The surface is smooth, glossy, and deep green in color. Leaves show 5–7 prominent veins arising from the base.

Betel leaves possess a characteristic aromatic odor and pungent taste.

Geographical Location
Betel leaf is native to South and Southeast Asia. It is widely cultivated in India, Bangladesh, Sri Lanka, Malaysia, Indonesia, Thailand, and the Philippines.

The plant grows well in warm, humid, and tropical climatic conditions with sufficient moisture and shade.

Chemical Constituents
Betel leaves contain volatile essential oil rich in:

- Chavibetol
- Eugenol
- Chavicol
- Hydroxychavicol
- Other constituents include:
- Vitamin C
- Carotene
- Calcium
- Thiamine

Uses
Traditional Uses
Used as “Paan” in many Asian countries. Used in religious and cultural practices. Medicinal Uses

Acts as a digestive stimulant and carminative. Possesses antimicrobial and antiseptic properties. Helps in the treatment of cough and congestion.

Shows antioxidant activity and helps reduce bad breath. [15]

Curry Leaf

FigNo5: Curry Leaf

Biological Name and Taxonomy Biological Name: Murraya koenigii L. Family: Rutaceae
Synonyms: Curry patta, Sweet neem leaves, Karivepaku.

Morphology
Curry leaves are small, dark green, and aromatic.

Leaves are pinnately compound with multiple leaflets arranged on a stem. The plant is a small shrub or tree with a characteristic pleasant aroma.

Leaves possess a slightly bitter and pungent taste.

Geographical Location
Curry leaf plant is native to India and Sri Lanka.
It is widely cultivated in India, Bangladesh, Nepal, and other tropical Asian countries. The plant grows well in warm tropical and subtropical climates.

Chemical Constituents
Curry leaves contain various bioactive compounds such as:

- Carbazole alkaloids
- Flavonoids
- Glycosides
- Tannins
- Other constituents include:
- Vitamin A
- Vitamin C
- Calcium

Uses Traditional Uses
Widely used as a flavoring agent in Indian cuisine. Used in traditional Ayurvedic preparations.

Medicinal Uses
Helps reduce hair fall and premature greying. Possesses antioxidant and antimicrobial properties. Aids digestion and improves metabolism.

Helps nourish scalp and strengthen hair roots.

Hibiscus

Fig No6: Hibiscus flower

Biological Name and Taxonomy Biological Name: Hibiscus rosa-sinensis L. Family: Malvaceae
Synonyms: China rose, Shoe flower, Gudhal

Morphology
Hibiscus is a flowering shrub with large and colorful flowers. Leaves are dark green, glossy, and ovate with serrated margins. Flowers are usually red, large, and trumpet-shaped.
The plant possesses a mild characteristic odor.

Geographical Location
Hibiscus is native to tropical and subtropical regions of Asia. It is widely cultivated in India, China, Malaysia, Sri Lanka, and other tropical countries. The plant grows well in warm climates with moderate rainfall and sunlight.

Chemical Constituents
Hibiscus contains several active constituents such as:

- Flavonoids
- Anthocyanins
- Tannins
- Saponins
- Other constituents include:
- Vitamin C
- Calcium
- Iron
- Organic acids

Uses Traditional Uses
Used as an ornamental flowering plant.
Used in traditional herbal preparations and hair care remedies.

Medicinal Uses
Promotes hair growth and strengthens hair roots. Helps reduce dandruff and scalp irritation.
Possesses antioxidant and anti-inflammatory properties. Used for conditioning and improving hair texture. [15]

Neem

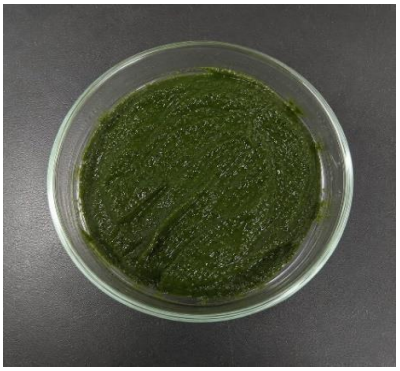

Fig No7: Neem

Biological Name and Taxonomy Biological Name: Azadirachta indica A. Juss. Family: Meliaceae
Synonyms: Indian lilac, Margosa tree, Nimba

Morphology
Neem is a medium to large evergreen tree with spreading branches. Leaves are compound, dark green, and serrated in appearance.
The plant bears small white fragrant flowers and olive-like fruits. Neem leaves possess a bitter taste and characteristic odor.

Geographical Location
Neem is native to the Indian subcontinent.
It is widely cultivated in India, Pakistan, Bangladesh, Sri Lanka, and tropical regions of Africa and Asia. The plant grows well in hot and dry climatic conditions.

Chemical Constituents
Neem contains several important bioactive compounds such as:

- Azadirachtin
- Nimbidin
- Gedunin
- Other constituents include:
- Flavonoids
- Tannins
- Fatty acids
- Essential oils

Uses Traditional Uses
Used in Ayurvedic and traditional medicine for various health conditions. Neem twigs are traditionally used for dental cleaning.

Medicinal Uses
Possesses strong antimicrobial and antifungal properties. Helps reduce dandruff and scalp infections.

Used in the treatment of skin disorders and wounds. Shows antioxidant and anti-inflammatory activities [16]

Aloe Vera

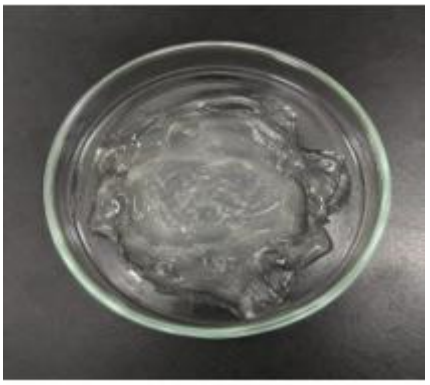

Fig No8: Aloe Vera

Biological Name and Taxonomy Biological Name: Aloe barbadensis Miller Family: Liliaceae
Synonyms: Aloe vera, Ghritkumari, Kumari

Morphology
Aloe vera is a succulent perennial plant with thick, fleshy leaves.

Leaves are green, lance-shaped, and contain transparent mucilaginous gel inside. The margins of leaves possess small spiny teeth.

The plant has a characteristic mild odor and slightly bitter taste.

Geographical Location
Aloe vera is native to North Africa and the Mediterranean region.

It is widely cultivated in India, Africa, America, and tropical as well as subtropical regions worldwide. The plant grows well in warm and dry climatic conditions.

Chemical Constituents
Aloe vera contains several biologically active compounds such as:

- Aloin
- Aloe-emodin
- Anthraquinones
- Saponins
- Other constituents include:
- Vitamins A, C, and E
- Amino acids
- Enzymes
- Minerals

Uses Traditional Uses
Widely used in herbal cosmetics and traditional medicine preparations. Used as a natural moisturizer and skin soothing agent.

Medicinal Uses
Provides moisturizing and cooling effect to scalp and hair. Helps reduce scalp irritation and dryness.
Possesses antimicrobial and anti-inflammatory properties.

Oil Base
INGREDIENT: Coconut oil
ROLE: Carrier Oil and Nourishment

Fig No 9: Cocont

Other Ingredients

- Vitamin E Capsule ROLE: Antioxidant
- Distilled Water

ROLE: Cleaning and Dilution

Chemicals Used for Evaluation:

Table No:1

SR. NO	CHEMICALS	WHERE USED	PURPOSE
1.	Ethanol	Acid Value Test	Solvent
2	Ether	Acid Value Test	Dissolves Oil
3	Potassium Hydroxide	Acid Value Test	Neutralization
4	Phenolphthalein Indicator	Acid Value Test	Endpoint detection

Equipment Required:
The following equipment are the most important and frequently used in the preparation and evaluation of herb al hair oil containing Betel Leaf.

Table No: 2

SR. NO	EQUIPMENT	USE
1	Beaker	Mixing and heating of ingredients
2	Measuring Cylinder	Measuring oils and liquids
3	Heating Mantle/Hot Plate	Heating the formulation
4	Grinder/Mortar and Pestle	Grinding leaves into paste
5	Glass Rod/Stirrer	Continuous stirring during heating
6	Weighing Balance	Accurate weighing of ingredients

7	Muslin Cloth/Filter Paper	Filtration of prepared oil
8	PH Meter	Measurement of pH
9	Viscometer	Determination of viscosity
10	Amber-Colored Bottle	Storage of final product [8]

Method

Table No: 3

SR. NO	INGREDIENTS	QUANTITY	ROLE
1	Betel Leaf Paste	20 g	Antimicrobial and scalp nourishing agent
2	Curry Leaf Pate	10 g	Prevents hair fall and premature greying
3	Hibiscus Paste	10 g	Promotes hair growth and conditioning
4	Neem Paste	5 g	Antifungal and antidandruff agent
5	Aloe Vera Gel	10 g	Moisturizing and cooling agent
6	Vitamin E Capsule	2 Capsule	Antioxidant Agent
7	Coconut Oil	100 ml	Base oil and hair nourisher

Method Of Preparation

Collection of Betel Leaves, Curry Leaves, Hibiscus, Neem and Aloe Vera
↓
Cleaning and Washing of Herbal Materials
↓
Shade Drying of Leaves
↓
Preparation of Herbal Paste
↓
Measurement of Ingredients
↓
Heating of Coconut Oil
↓
Addition of Herbal Paste into Oil
↓
Continuous Heating with Stirring (30–45 Minutes)
↓
Extraction of Active Constituents into Coconut Oil
↓
Cooling of Prepared Oil
↓
Filtration Using Muslin Cloth
↓
Collection of Clear Herbal Hair Oil
↓
Filling into Amber-Colored Bottles
↓
Labeling and Storage [17]

Procedure

Fresh Betel Leaf and other herbal ingredients were collected and washed thoroughly with clean water to remove dirt and impurities.

Fig No10: Herbal ingredients

- The washed leaves were shade dried for removal of excess moisture.
- The dried leaves were ground separately to obtain a fine herbal paste.
- Accurately weighed quantities of betel leaf paste, curry leaves paste, hibiscus paste, neem paste, and aloe vera gel were taken for formulation.

Fig No11: Measurement of Herbal ingredients

- About 100 mL of coconut oil was taken in a clean beaker and heated gently on a heating mantle.
- The prepared herbal paste was added slowly into the heated coconut oil with continuous stirring.
- The mixture was heated at low temperature for about 30–45 minutes until the active constituents of the herbs were transferred into the oil.

FigNo12: Addition of Herbal paste into oil

- Heating was continued until moisture was completely removed and clear medicated oil was obtained. Avoid Overheating to Prevent degradation of Herbal Constituents
- Add Aloe Vera and Vitamin E Capsule content into the formulation and mix thoroughly.
- The prepared oil was allowed to cool at room temperature.
- The cooled oil was filtered using muslin cloth to remove unwanted plant residues.
- The filtered herbal hair oil was filled into clean amber-colored bottles, labeled properly, and stored in a cool and dry place for further evaluation studies. [20]

Fig No13: Prepared Hair oil

Evaluation Parameters

Organoleptic Evaluation:

Organoleptic evaluation is the preliminary assessment of the prepared herbal hair oil based on sensory characteristics such as color, odor, texture, appearance, and consistency. These parameters help in determining the acceptability and quality of the formulation.

Color: The prepared herbal hair oil showed a greenish-brown color due to the presence of betel leaf extract and herbal ingredients.

Odor: The formulation possessed a pleasant herbal aroma with a characteristic medicinal smell.

Texture: The oil was smooth, non-sticky, and slightly viscous in nature, making it suitable for hair application. Appearance: The formulation appeared clear and uniform without any suspended particles.

Consistency: The oil remained stable and homogeneous without phase separation.

pH Determination:

The pH of herbal hair oil was determined to evaluate its compatibility with scalp and hair. A suitable pH helps in preventing scalp irritation and maintains healthy hair conditions.

Procedure:

A small quantity of herbal hair oil was diluted with distilled water. The pH was measured using a digital pH meter or pH paper at room temperature.

Observation:

The pH of the prepared herbal hair oil was found to be 6.0, which is suitable for scalp application and indicates mild acidic nature beneficial for hair health.

Viscosity Measurement:

Viscosity is an important parameter that determines the flow property and spreadability of the herbal hair oil. Proper viscosity ensures easy application and better absorption on the scalp.

Procedure:

The viscosity of the prepared herbal hair oil was determined using an Ostwald Viscometer at room temperature. The flow time of the sample was compared with standard liquid and viscosity was calculated.

Observation:

The viscosity value obtained was 0.92, indicating that the oil possessed appropriate flow property and was easy to apply on hair.

Acid Value Determination:
Acid value is used to determine the amount of free fatty acids present in the oil. It helps in assessing the purity and quality of the formulation.

Procedure:
10 mL of herbal hair oil was mixed with ethanol and ether mixture. Phenolphthalein indicator was added and the solution was titrated against 0.1 M potassium hydroxide until a pale pink color appeared.

Observation:
The acid value of the prepared herbal hair oil was found to be 6.3, indicating acceptable quality and stability of the oil.

Specific Gravity:
Specific gravity indicates the density of herbal hair oil compared to water. It helps in evaluating purity and uniformity of the formulation.

Procedure:
Specific gravity was determined using a specific gravity bottle by comparing the weight of oil with the weight of water at room temperature.

Observation:
The specific gravity of the prepared herbal hair oil was found to be 1.09, indicating good consistency and formulation stability.

Stability Study
Stability study is performed to determine the physical and chemical stability of herbal hair oil during storage under different environmental conditions.

Procedure:
The prepared herbal hair oil was stored in tightly closed containers at room temperature and refrigerated conditions for a specified period. The formulation was observed periodically for changes in color, odor, appearance, consistency, and phase separation.

Observation:
No significant change in color, odor, texture, or consistency was observed during the study period. The formulation remained stable without any irritation or phase separation.

Irritancy Test
The irritancy test is performed to determine whether the prepared herbal hair oil causes irritation or allergic reactions on the skin. [22]

Procedure:
A small quantity of herbal hair oil was applied on a small area of skin and observed for redness, itching, irritation, or inflammation for 24 hours.

Observation:
No redness, itching, or irritation was observed, indicating that the formulation was safe for topical application.

Spreadability Test
Spreadability determines the ease with which the herbal hair oil spreads on the scalp and hair surface. Procedure:

A small amount of oil was placed between two glass slides and spread by applying slight pressure. The spreading behavior was observed.

Observation:
The prepared herbal hair oil showed good spreadability and uniform application on the scalp.

Evaluation Test

Table No:4

SR.NO	EVALUATION PARAMETER	RESULT
1	Color	Greenish Brown
2	Odor	Pleasant Herbal Aroma
3	Appearance	Clear and Uniform
4	pH Determination	6.0
5	Viscosity	0.92
6	Acid Value	6.3
7	Specific Gravity	1.09
8	Stability Study	Stable Formulation
9	Irritancy Test	No Irritation
10	Spreadibility	Good

Result
The prepared herbal hair oil using betel leaves was evaluated for various physicochemical parameters and the obtained results are shown below.

Discussion
The prepared herbal hair oil formulation showed satisfactory results for all evaluation parameters. The oil exhibited a greenish-brown color and pleasant herbal odor due to the

presence of natural herbal ingredients such as betel leaf, hibiscus, neem, and curry leaves.

The formulation was found to be smooth, homogeneous, and non-sticky, which indicates good consistency and easy applicability on the scalp and hair. The pH value of the formulation was found to be 6.0, which is suitable for scalp application and indicates that the oil is mild and skin friendly.

The viscosity of the herbal hair oil was found to be appropriate, providing good spreadablity and easy application. The acid value obtained was within acceptable limits, indicating good quality and low chances of rancidity of the oil. The specific gravity value confirmed the uniformity and purity of the prepared formulation. During the stability study, no significant changes in color, odor, texture, or consistency were observed, indicating that the formulation remained stable under storage conditions.

The irritancy test showed no signs of redness, itching, or irritation, which confirms that the prepared herbal hair oil is safe for topical application. The herbal ingredients present in the formulation may help in reducing dandruff, nourishing the scalp, strengthening hair follicles, and promoting healthy hair growth due to their antimicrobial, antioxidant, and conditioning properties. Overall, the prepared herbal hair oil demonstrated good stability, safety, and acceptable physicochemical properties, suggesting that it can be used as an effective natural hair care formulation

Future Scope

The formulated herbal hair oil containing Betel Leaf has considerable future potential in the field of herbal cosmetics and natural hair care products. With the increasing consumer preference for herbal and chemical-free formulations, the developed preparation may serve as a promising alternative to synthetic hair oils available in the market.

Further research can be carried out to improve the formulation by incorporating advanced herbal ingredients with proven hair growth promoting and antidandruff activities. Detailed phytochemical investigations and antimicrobial studies may help identify the active constituents responsible for therapeutic effects on the scalp and hair follicles.

The formulation can also be subjected to clinical evaluation on volunteers to study its effectiveness in reducing hair fall, controlling dandruff, improving scalp condition, and promoting healthy hair growth. Advanced analytical and stability studies may further enhance the quality, safety, and shelf life of the product.

In future, the developed formulation may be converted into various herbal cosmetic preparations such as:

- Herbal shampoo
- Hair serum
- Hair cream
- Scalp tonic
- Antidandruff hair mask

The project also possesses industrial and commercial significance due to the growing demand for Ayurvedic and herbal cosmetic products. Large-scale manufacturing and commercialization of the formulation may provide opportunities in the herbal cosmetic industry.

Additionally, the research may contribute to the development of eco-friendly and safe personal care products with reduced side effects compared to synthetic formulations. Thus, the present study offers wide scope for scientific research, product innovation, and commercial application in the field of herbal hair care.

IV. CONCLUSION

The present research work successfully focused on the formulation and development of herbal hair oil using Betel Leaf as the major active ingredient. The prepared formulation was developed using natural herbal ingredients and evaluated for different physicochemical parameters such as color, odor, pH, viscosity, specific gravity, irritation test, and stability study. The results obtained from the evaluation indicated that the formulated herbal hair oil possessed acceptable quality characteristics and showed good stability during storage conditions.

Betel leaf was found to be a valuable herbal ingredient due to its antimicrobial, antifungal, antioxidant, and scalp-nourishing properties. These medicinal activities may help in reducing dandruff, preventing scalp infections, minimizing hair fall, and improving overall hair health. The prepared herbal hair oil was also found to be safe for topical application without causing irritation.

The study concludes that herbal hair oil prepared from betel leaf can serve as a safe, economical, and effective natural hair care formulation. The research also supports the growing importance of herbal cosmetics as alternatives to synthetic products with fewer side effects.

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