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FORMULATION AND EVALUATION OF HAIR SERUM BY USING *CLITORIA TERNATEA* AND *MURRAYA KOENIGII*

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ABSTRACT

The cosmetics industry has expanded rapidly in recent years, with increasing consumer preference for herbal products due to their safety, efficacy, and minimal side effects. Hair care formulations play an important role in maintaining scalp health and improving hair appearance, particularly in the management of dandruff. The present study aimed to formulate and evaluate a hair serum for daily use using extracts of *Murraya koenigii* (curry leaves) and *Clitoria ternatea* (butterfly pea flower), both of which are widely recognized for their traditional medicinal and cosmetic properties. Butterfly pea flowers are rich in anthocyanins, flavonoids, and phenolic compounds that exhibit antioxidant, antifungal, and hair-strengthening activities. Curry leaves contain alkaloids, vitamins, flavonoids, and essential minerals that support hair growth, reduce dandruff, and nourish the scalp. The plant extracts were prepared using decoction and hot water extraction methods and incorporated into three different hair serum formulations (F1, F2, and F3) using excipients such as glycerine, xanthan gum, tween 80, lavender oil, phenoxy ethanol, and rose water. The formulated serums were evaluated for physical characteristics, pH, homogeneity, spreadability, and antifungal activity using the agar well diffusion method against Candida albicans. Among all formulations, F3 exhibited optimal physicochemical properties and a maximum zone of inhibition of 22 mm, indicating strong antifungal activity. The developed hair serum was lightweight, non-greasy, and effective in dandruff management and scalp care. Further preclinical and clinical studies are recommended to confirm its long-term safety and therapeutic efficacy.

KEYWORDS: Hair serum; *Murraya koenigii*; *Clitoria ternatea*; Dandruff; Antifungal activity.

INTRODUCTION

Cosmetics are defined as substances applied to the human body for cleansing, beautifying, promoting attractiveness, or altering appearance, with their effects limited to mild actions that help maintain the health of the skin and hair. Although the legal definition of cosmetics may vary slightly between countries, their primary purpose remains the care and enhancement of external body surfaces such as the skin, hair, and teeth, as well as deodorizing or perfuming to eliminate unpleasant odour. The term “cosmetic” originates from the Greek word *kosmos*, meaning “order” or “ornament,” reflecting the role of cosmetics in preserving appearance and maintaining the integrity of the body’s outer surfaces. These products are often classified as quasi-drugs, as they are not intended to alter the body’s structure or physiological functions or to treat diseases. Since cosmetics are commonly used on a daily basis over extended periods, ensuring their safety and absence of side effects is of most importance.[1]

Hair plays a vital role in both appearance and bodily functions. It provides support and sensory input. Hair has two main parts: the visible hair shaft and the hair root under the skin. The root gets nourishment from the hair bulb and papilla. Each follicle connects to sebaceous glands, nerves, and the arrector pili muscle, which helps hair respond to changes in the environment. Hair grows in a cycle that includes four phases: anagen (active growth), catagen (transition), telogen (resting), and

exogen (shedding). The duration of each phase varies by body region, affecting hair length and thickness. Taking proper care and maintaining a healthy cycle are crucial to preventing hair loss and encouraging growth.[2]

HAIR SERUM

"A liquid hair care item that has a greater viscosity than water is known as a hair serum". It is intended to cover the surface of the hair and enhance its appearance and health. Although it is frequently used for styling, its advantages go beyond simply shaping the hair. Dryness, frizz, dullness, split ends, and unruly strands are just a few of the problems that hair serums may solve. A serum may help straighten hair or give shine and smoothness, depending on the components. The silicone found in the majority of hair serums forms a barrier that protects the hair shaft. This barrier protects the hair from external elements including heat from styling equipment, pollutants, and humidity while sealing in moisture.

Additionally, some serums contain nourishing components that permeate the hair shaft to strengthen and restore it from the inside out, such as vitamins, plant extracts, or essential oils. After washing, damp hair is typically treated with hair serums to ensure uniform distribution prior to styling. Over time, they can lessen frizz and damage while making hair softer, easier to manage, and more aesthetically pleasing.[3]

Benefits and Functions of Hair Serum

1. Smoothens and softens hair: Hair serum helps to make hair feel softer, smoother, and silkier.
2. Protects from environmental damage: It forms a protective layer that shields hair from external aggressors like pollution, heat, and humidity.
3. Pre-styling and finishing use: Hair serum can be applied before styling as a treatment or after styling as a finishing product.
4. Heat styling protection: It can be used before or after heat styling tools to reduce damage.
5. Frizz control: Hair serum control frizz, improving hair texture and manageability.
6. Enhances smoothness: Regular use increases overall hair smoothness and softness.
7. Reduces tangles and improves shine: It helps detangle hair while giving it a natural shine.
8. Supports hair shape: Hair serum enhances straightness or curl definition, depending on hair type.
9. Prevents hair damage: By forming a protective barrier, it minimizes hair breakage and strengthen weak strands.
10. Promotes healthy appearance: Overall, hair serum contributes to stronger, healthier, and more vibrant hair.[13]

Side Effects of Hair Serum

1. Overuse may cause dryness: Applying hair serum too frequently or in large amounts can make hair dry, brittle, and less healthy over time.
2. Avoid direct scalp application: Hair serum should be applied mainly to hair strands, as using it directly on the scalp can cause irritation, redness, or inflammation.
3. Silicone build-up: Many hair serums contain silicones, which can accumulate on hair over prolonged use, potentially making it heavy, dull, or difficult to manage.
4. May weaken hair if misused: Excessive or improper application can weigh down hair, interfere with natural moisture balance, and cause breakage.
5. Risk of allergic reactions: Some ingredients in hair serums may cause mild allergic reactions or sensitivity in certain individuals.
6. Reduced effectiveness over time: Continuous use without proper hair washing can reduce the serum's effectiveness and make hair appear greasy or lump.
7. Heat and chemical interactions: Using serum along with high heat or harsh chemical treatments may sometimes lead to damage if the product is not designed for such purposes.[3]

MATERIALS AND METHODS

Plant profile

- ***Clitoria ternatea***

Clitoria ternatea, commonly referred to as butterfly pea, is a perennial climbing plant that belongs to the family Fabaceae and is taxonomically placed under the division Magnoliophyta, class Magnoliopsida, and order Fabales. With adequate support, the plant can grow to a height of about 3–4 meters.

Fig No. 1: Butterfly pea.

It is characterized by pinnately compound leaves that range from ovate to elliptic in shape, displaying reticulate venation, well-defined petioles, and a thin, membranous texture. The plant bears large, visually striking flowers with a papilionaceous form, consisting of five petals and exhibiting colors such as deep blue, light blue, violet, or white. The fruit is a flat, elongated pod that dehisces upon maturity and contains several seeds. Butterfly pea is indigenous to tropical Asia, especially India and Southeast Asia, and is widely distributed across tropical

and subtropical regions, including Africa, Australia, and America. In India, it commonly grows in warm environment along roadsides, fences, hedges, and in gardens. The plant is rich in diverse phytochemicals such as flavonoids, alkaloids, terpenoids, anthocyanins, saponins, tannins, and phenolic compounds, which account for its significant medicinal and cosmetic applications.[4]

Benefits

- Encourages hair growth: Butterfly pea has natural compounds that improve scalp circulation and nourish hair follicles. This supports healthy and continuous hair growth.
- Help to control dandruff: Its antifungal property helps to reduce dandruff-causing microorganisms. This keeps the scalp clean and balanced.
- Minimize hair fall: The antioxidants in the plant protect hair roots from damage by free radicals. This helps to reduce breakage and excessive hair loss.
- Improves hair strength: Regular use reinforces the hair shaft. This makes hair less likely to become brittle, develop split ends, and suffer mechanical damage.
- Protects hair and scalp: The antioxidant properties of butterfly pea protect hair from environmental stressors like pollution and UV exposure. This helps to maintain overall hair health.[5]

➢ ***Murraya koenigii***

Murraya koenigii, commonly referred to as the curry leaf plant, is a part of the Rutaceae family and is classified under the division Magnoliophyta, class Magnoliopsida, and order Sapindales. It typically develops into a small, bush-like tree with a widespread structure, reaching heights between approximately 1 and 16 feet.

Fig No. 2: Curry leaves.

This plant features pinnately compound leaves consisting of 11 to 21 leaflets, each measuring about 2–4 cm in length and 1–2 cm in width. The stem usually appears dark green to brown and showcases distinct markings; when the bark is removed, the inner wood reveals a white colour. Curry leaf is found throughout most regions of India, excluding high-altitude areas of the Himalayas, and thrives in warm, tropical climates.

The leaves are rich in various phytochemical constituents, including alkaloids such as girinimbine, mahanimbine, and isomahanimbine, as well as flavonoids, saponins, phenolic compounds, and tannins. These bioactive compounds significantly contribute to the plant's protective and medicinal properties. Additionally, curry leaves are rich in essential vitamins that promote hair health, such as vitamin C, which improves scalp circulation; B-complex vitamins, which strengthen hair strands and helps to reduce split ends; and vitamin A, which nourishes hair follicles and supports the growth of healthy hair.[6]

Benefits

- Reinforces hair roots: Curry leaves supply essential nutrients that nourish the scalp and enhance the strength of hair roots.
- Facilitates hair growth: The natural compounds found in curry leaves stimulate hair follicles, encouraging healthy and continuous hair growth.
- Reduces hair fall: The presence of proteins and beta-carotene helps decrease hair breakage and manage thinning.
- Enhances scalp health**:** Antioxidant and antimicrobial properties keep the scalp clean and reduce dandruff and irritation.
- Improves hair quality: Regular use of curry leaves can help repair damaged hair, fortify the hair shaft, and boost softness and volume.[12]

Excipients used in the hair serum[9]

1. Glycerine

Glycerine is a common humectant in hair serums. It draws in and holds moisture from the hair, which helps keep hair hydrated, soft, and smooth.

By balancing moisture, glycerine cuts down on dryness, frizz, and brittleness. This makes hair easier to manage and gives it a shiny appearance.

2. Xanthan gum

Xanthan gum is used in hair serum formulations primarily as a thickening and stabilizing agent. It improves the viscosity and texture of the serum, ensuring easy application and uniform spread on the hair.

3. Lavender oil

Lavender oil is used to impart a pleasant, natural fragrance to the formulation. It has soothing, antimicrobial, and conditioning properties. It helps maintain scalp health, reduces dryness and dandruff, and adds shine and softness to hair.

4. Tween 80

Tween 80 (Polysorbate 80) is commonly used in hair serums as an emulsifying and solubilizing agent. It helps uniformly disperse oils, essential oils, and other oil-soluble ingredients into water-based formulations, preventing phase separation and ensuring product stability.

5. Rose water

Rose water is used as a vehicle in hair serums to dissolve and uniformly deliver active ingredients while providing hydration and a soothing effect to the scalp. It acts as a gentle aqueous base that enhances product freshness, improves spreadability, and adds a mild natural fragrance to the formulation.

6. Phenoxyethanol

Phenoxyethanol acts as a preservative in hair serums. It inhibits the development of bacteria and fungi, ensuring the product remains safe and prolonging its longevity. It contributes to the serum's stability and quality while not affecting its efficacy. Frequently, it serves as a substitute for parabens in hair care formulations.

Preparation of plant extract

❖ ***Murraya koenigii*:** The curry leaves were shade-dried for one day and milled into a powdered form. 10 g of powder was boiled in 100ml of deionized water for 1 hour. After complete maceration, the mixture was filtered using a muslin cloth to get the extract.[7]

Fig No. 3: Extraction of curry leaves.

❖ ***Clitoria ternatea*:** After collecting and drying the fresh flowers of *Clitoria ternatea* in the shade for several days, finely ground them and mixed them with distilled water at a ratio of 1:20 (w/v) using a magnetic stirrer on low speed for 40 seconds. Kept the blend in a thermostatic water bath at 60°C for 1 hour. Afterward, filtered the mixture using Whatman filter paper. We stored the collected filtrate at a low temperature.[8]

Fig No. 4: Extraction of butterfly pea.

Formulation Table

Table No. 1: Formulation table.

Sl No.	Ingredients	Official formula (30ml)	Working formula		
			F1	F2	F3
1	Butterfly pea	10ml	10 ml	10 ml	10 ml
2	Curry leaves	10ml	10 ml	10 ml	10ml
3	Glycerine	1.5 ml	1.5 ml	1.5 ml	1.5 ml
4	Xanthan gum	0.1g	0.02 g	0.05 g	0.1 g
5	Lavender oil	0.3 ml	0.3 ml	0.3 ml	0.3 ml
6	Tween 80	0.3ml	0.3 ml	0.3 ml	0.3 ml
7	Rose water	7.5ml	7.5 ml	7.5 ml	7.5 ml
8	Phenoxyethanol	0.3ml	0.3 ml	0.3 ml	0.3 ml

Procedure

To prepare the water phase, mix the required amount of rose water and glycerine in a clean beaker. Gradually sprinkle in xanthan gum while stirring for about 10-15 minutes until the gum is fully hydrated. Next, add the active ingredients by mixing butterfly pea extract and curry leaf extract into the water phase. Stir well to ensure an even mix. For the oil phase preparation, combine lavender oil with tweens 80 in a separate beaker. Mix thoroughly to get a clear oil phase. To emulsify, slowly add the oil phase to the water phase drop by drop while stirring continuously until you achieve a smooth, uniform emulsion. Finally, include phenoxy ethanol as a preservative.[9]

Evaluation Studies

1. **Physical evaluation:** The physical appearance was assessed through observation of the texture, colour, and fragrance of the formulated cosmetic serum.[10]
2. **Homogeneity assesment:** A clean and dry glass slide was coated with the herbal hair serum and subsequently covered with a cover slip. "The sample was examined under appropriate lighting conditions to assess the presence of coarse particles and overall homogeneity". Visual inspection was employed to evaluate the consistency of the herbal hair serum, specifically looking for any lumps, flocculates, or aggregates present in the formulation.
3. **Measurement of pH:** The pH of the serum formulation was measured with a digital pH meter. The probe was placed in the serum sample, and the pH value was recorded.[9]
4. **Determination of spreadability**: A traditional plate method was used to assess the spreadability of semisolid formulations in this research. Specifically, 1 gram of hair serum was placed between two vertical plates, each measuring 20 cm by 20 cm. We applied a weight of 125 grams. After one minute, we measured the spread perimeter. We calculated the spreadability using the following formula.

$S = (M \times L) / T$

In this formula, S represents spreadability. L is the distance covered by the glass slide. M is the weight on the upper plate. T is the time (in seconds) needed to completely separate the plates.[11]

5. **Phase separation:** All three formulations were kept in a closed container at a room temperature of 25°C away from light. Then, phase separation was checked after 24h. Any change in the three formulations was observed.
6. **Antifungal activity:** Sabouraud's Dextrose Agar (SDA) is made using 15 lbs. and autoclaved at 121° C for 15 minutes. After cooling to 45°C to 50°C, pour the agar into a sterile 90mm petri dish. Using a sterile swab, apply the selected organism onto the agar plate. Then, take a sterile cork borer to create a well and add the sample. After 48 hours of incubation at room temperature, measure the diameter of the inhibition zone.

RESULT AND DISCUSSION

1. Chemical test

Table No. 2: Chemical test.

Herbs	Phytoconstituents	Chemical Tests	Result
Murraya koenigii	Tannins	Lead acetate test	+
	Terpenoids	Salkowski test	+
	Flavonoids	Alkaline reagent test	+
	Alkaloids	Dragendorff's test	+
Clitoria ternatea	Flavonoids	Shinoda test	+
	Alkaloids	Dragendorff's test	+
	Phenolic acid	Ferric chloride test	+
	Anthocyanins	Sulphuric acid test	+

2. Physical Characteristics

Table No. 3: Physical Characteristics.

Parameter	Result
Colour	Dark greenish blue
Odour	Aromatic
Smoothness	Excellent

3. Homogeneity assessment, Measurement of pH, Spreadability, Phase separation

Table No. 4: Homogeneity assessment, Measurement of pH, Spreadability, Phase separation.

Parameters	Result
Homogeneity	Excellent
pH	5.14
Spreadability	Easily spreadable
Phase separation	No phase separation

4. Antifungal activity

The agar well diffusion technique was used to assess the antifungal properties against Candida albicans. The size of the inhibitory zone shows how sensitive the microorganism is to the tested chemical. A 22 mm inhibitory zone was noted for the hair serum containing *Clitoria ternatea* and *Murraya koenigii*, showing antifungal effectiveness against Candida albicans. These results suggest that even at high concentrations, the formulation can effectively prevent dandruff caused by Candida fungi.

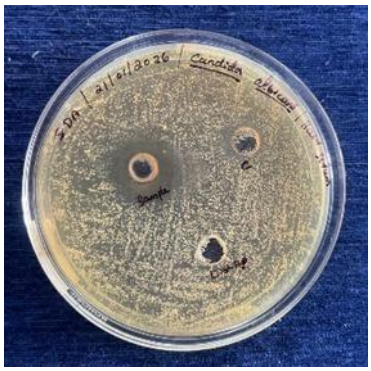

Fig No.5: Antifungal activity against Candida albicans.

CONCLUSION

This study presents the development and testing of an herbal hair serum made from extracts of *Murraya koenigii* and *Clitoria ternatea*. The goal was to examine the cosmetic properties of the serum and find the best formulation among three variants (F1, F2, and F3). These variants were created using different amounts of excipient. Each formulation was evaluated through tests for physical appearance, pH, homogeneity, phase stability, and antifungal effectiveness. The results showed that formulation F3 outperformed the others, meeting all evaluation criteria. F3 also showed strong antifungal activity against Candida albicans, as confirmed by the agar well diffusion technique. Overall, the study highlights the potential of F3 as a stable and effective herbal cosmetic product. Its promising antifungal activity, along with good physicochemical properties, supports its use as a natural alternative to synthetic hair care products. Further research is needed, including clinical evaluation, formulation improvement, and market comparison, to enhance its therapeutic benefits and commercial potential.

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