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Review Paper

A Comprehensive Review on Herbal Hair Serum: Formulation and Evaluation Approaches

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ABSTRACT

Hair problems such as hair fall, dandruff, dryness, frizz and split ends have become increasingly common due to environmental pollution, stress, poor nutrition, and the frequent use of chemical– based hair products. Herbal hair serums have emerged as a natural and safer alternative because of their ability to nourish the scalp, strengthen hair, and reduce hair damage using plant–derived ingredients. This review summarizes the current literature on the formulation, preparation methods, phytochemical constituents, and evaluation of herbal hair serum. Herbal ingredients including aloe vera, hibiscus, amla, alkanet root, fenugreek, curry leaves, castor oil, and almond oil, are discussed for their pharmacological properties and their benefits in promoting hair growth, improving hair condition, and maintaining a healthy scalp. The review also outlines various extraction techniques, such as maceration, percolation, decoction, Soxhlet extraction and supercritical fluid extraction, along with key evaluation parameters, including physical appearance, PH, viscosity, Spreadability, stability and phytochemical. Overall, this review highlights the potential of herbal hair serums as effective, eco-friendly, and promising cosmetic formulations for maintaining healthy, strong, smooth and manageable hair

INTRODUCTION

1.1. Basic of Hair:

Hair is a filamentous structure composed mainly of keratin protein that grows from hair follicles present in the skin. (1). It plays an important role in protecting the scalp from environmental damage, regulating body temperature, and enhancing appearance. Healthy hair is characterized by strength, smoothness, shine, and elasticity. Hair growth occurs in three phases: anagen (growth phase), catagen (transition phase), and telogen (resting phase). (2)

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1.1.1. Anatomy of Hair:

The composition of hair is primarily 95% keratin, a fibrous protein with a helical structure that is a component of the skin and its derivatives (such as body hair and nails).

The structure of hair is divided into three distinct layers:

- The Medulla
- The Cuticle
- Cortex (3)

1.2. Hair Problem:

Hair Problems are common conditions that affect the health and appearance of hair. These include dandruff, hair loss, split ends, dry hair, oily hair, frizzy hair, and damaged hair. Such problems may arise due to genetic factors, hormonal imbalances, stress, nutritional deficiencies, pollution, and improper hair care, and the use of suitable hair products can help maintain healthy hair and prevent damage.

Various hair problems:

Hair loss: The primary cause of hair loss is Numerous hair style products, hormone fluctuations, stress, and medications can all cause hair loss.

Oily or greasy hair: The scalp produces too much sebum, or natural oil, which is the cause of oily hair. The sebaceous glands that create sebum occasionally "work overtime," producing an excessive amount of oil.

Dandruff: This mild, non-inflammatory skin ailment affects the scalp and may cause hair loss. It sticks to the hair's root and is scaly.

Dry hair: A lack of proteins in the diet causes dry hair. Dry hair can also result from menopause, anemia, hormonal imbalances, and birth control pills.

Spilt ends: These can happen when the hair ends become dry, and they can also happen as a result of exposure to harsh weather. Chemical hair treatments and hair care methods like curling and straightening might result in split ends.(4)

1.3. Hair Serum:

Hair serum is a liquid-based cosmetic preparation designed to coat the surface of hair strands with a protective layer. It helps reduce frizz, improve smoothness, add shine, detangle hair, and protect against environmental damage. Hair serums may contain silicone-based ingredients or natural herbal extracts that nourish and strengthen hair manageability and enhance overall hair appearance. (6) Hair serums can be classified based on their formulation and therapeutic action. Based on formulation, hair serums are categorized into water-based, oil-based, and emulsion-based serums. Based on therapeutic action, they include frizz control serums, hair growth serums, anti-hair fall serums, split-end repair serums, heat protection serums, scalp nourishing serums, color protection serums, and overnight repair serums. These serums help improve hair health by reducing damage, enhancing shine, promoting hair growth, and protecting hair from environmental and styling-related stress. (7)

1.3.1. Merits of Hair Serum:

- Controlling frizz and dryness
- Enhancing the hair’s natural look
- Protecting against damage (8)
- To guard against harm
- It protects hair from environmental aggressors. (9)

1.3.2. Demerits of Hair Serum:

- Regular use of hair serum may compromise scalp/hair health. (10)
- Accumulation on your scalp can cause dryness, Peeling, and skin irritation. (11)

- Applying serum directly to the scalp can potentially cause inflammation. (10)
- After several days of continued use, this build-up weights down your hair, making it appear flat and dully. (12)

1.3.3. Essential Properties of Herbal Hair Serum:

→ It should be light, smooth liquid that helps protect the hair.
→ It should have a lightweight, non-greasy texture.
→ It should be clear or slightly colored and spread easily through the hair.
→ It should leave the hair soft, smooth and shiny.
→ It should be a liquid-based formulation.
→ It should be easy to use and apply.
→ It should have smooth consistency for easy application.
→ It should help reduce hair fall and prevent hair damage.
→ It should be non-irritating to the scalp and skin.
→ It should help reduce hair frizz.
→ It should moisture and nourish dry hair.
→ It should improve hair manageability. (13)

2.1. Plant Profile of Commonly Used Ingredients in a Herbal Hair Serum:

Table:1. Plant profile of commonly used ingredients in a herbal hair serum:

S.no	Commonly used in ingredients	Biological source & Family	Pharmacological action	Chemical constituents	Uses
1.	Aloevera	Aloe barbadensis & Liliaceae	Anti-inflammatory agent	Anthraquinone glycoside	Improve the texture of hair.
2.	Hibiscus	Hibiscus rosa-sinensis l. & Malvacea	Cardiovascular, antioxidant, Anti diabetic.	Anthocyanins, Po lyphenols	Anti-dandruff
3.	Amla	Emblica officinalis & Phyllanthaceae	Antioxidant, anti-inflammatory, analgesic.	Phosphorus, iron and calcium	It used for nourishing the scalp
4.	Alkanet root	Alkanna tinctoria & Boraginaceae	Anti-microbial, Anti-bacterial, antiviral.	Naphtoquinones, Fatty acid	Hair growth& strength
5.	Curry leaf	Murraya koenigii & Rutaceae	Antioxidants, amino acids	Linalol, elemol and geranyl acetate	Stimulate hair growth
6.	Castor oil	Ricinus oil & Euphorbiaceae	Increasing blood flow and locking in moisture	Fatty acid and neutral lipids	Nourishing
7.	Almond oil	Prunus Amygdalus Dulcis & Rosaceae	Emollience, antioxidation, lubrication	Oleic acid, linoleic acid, palmitic acid, palmitoleic acid.	Anti-frizz
8.	Onion	Allium cepa & Amaryllidaceae	Boosting Sulphur for keratin, reducing inflammation	Allicin, quercetin, fisetin	Hair growth, reduce hair breakage

9.	Henna	Bay, Lawsonia inermis	Anti-microbial and Anti-fungal, Sebum regulation	P-Coumaric acid, -2-mathoxy-3methy-1,4napthoquinone andapiin	Hair conditioning
10.	Reetha	Sapindus mukorossi & Sapindaceae	Anti-fungal and Antibacterial	Saponins like oleanane, dammarane, triterpenes	Fungicidal and Surfactant
11.	Orange Peel	Citrus sinensis & Rutaceae	Antioxidant, Anti-inflammtory	Limonene, (S)-linalool, pectin, octanal	Orange oil as perfuming agent
12.	Fenugreek	Trigonella foenum-graceum & Leguminosae	Antidiabetic and Antifungal	Vitamin B, alkaloids and flavonoids	Hair growth stimulation, antibacterial
13.	Flaxseeds	Linum usitatissimum & Linaceae	Omega-3 fatty acids and vitamin E	Alpha-linoleic acid, lignans	Anti-inflammatory, antioxidant

2.2. Formulation of Herbal Hair Serum:

2.2.1. Extraction of Crude Drugs:

Maceration: In this process either entire plant or its roughly powdered specimen is kept in a solvent, which has ability of dissolving a number of active ingredients, on a cooled container for a specific period of time with successive stirring. This strategy is best suitable for use if there should be an occurrence of the thermolabile medication. It's a technique for extracting solids from liquids. (14)

Percolation: The process of percolation varies slightly from maceration. In this process, powdered drug is first mixed with the menstruum, and is allowed to stay for 4 hrs, and then it is packed into a percolator. Add sufficient menstruum covering the drug and then leave it for 24 hrs. Drain the liquid very slowly from the percolator bottom. Add more menstruum and continue the process till the volume reaches about 1/3rd of the desired volume. Press the marc, add this to the flask, and add more menstruum to reach the required volume and then the whole amount of liquid is clarified**.** (15)

Infusion: This process is like that of maceration wherein the drug material is pounded and powdered to form a minute powder after which it is placed into a sterile holder. The drug compound is soaked in either hot or cold solvent for a small-time duration. This technique is useful in the extraction of readily soluble bioactive components. Fresh extract for immediate use can be prepared using this method. Depending on the planned purpose, the ratio of solvent to sample can either be 4:1 or 16:1. (16)

Decoction: This method involves boiling the crude medication for a predetermined amount of time in a given volume of water; it is then cooled and filtered or strained. This method works well for extracting components that are heat- and water-soluble. (17)

Digestion: This is a form of maceration in which gentle heat is used during the process of extraction. It is used when the moderately elevated temperature is not objectionable, and the solvent efficiency of the menstruum is increased thereby. (18)

Solvation: It has been most frequently used for isolation of organic pollutants from environmental samples for the last 20 years. In this procedure, the water lines are hooked up to the condenser, and the lines are secured with copper wire/plastic straps to avoid water spillage. The solvent flask should be filled with 60-70% of solvent and placed into the heating source.

Microwave Assisted Extraction: Microwave-Assisted Extraction uses microwave energy (typically 300 MHz to 300 GHz) to rapidly heat the solvent and plant matrix, causing cell rupture and improved diffusion of intracellular compounds. The technique relies on the dipolar rotation and ionic conduction of polar solvents and solutes, leading to selective heating. MAE significantly reduces extraction time and solvent use, making it suitable for thermolabile and moderately polar compounds such as alkaloids, saponins, and phenolics. It has been successfully applied to extract active ingredients from plants like turmeric, green tea, and Eucalyptus. The main advantages include uniform heating, enhanced yield, and ease of scaling up. However, it may not be ideal for non-polar solvents or compounds and requires specialized microwave reactors to avoid overheating and degradation. (19)

Ultrasound Assisted Extraction (Sonication): Ultrasound-assisted extraction utilizes high-frequency ultrasound waves to enhance the extraction process. The sound waves disrupt cell walls, increasing the release of bioactive compounds, thus reducing extraction time and increasing efficiency. (20)

Supercritical Fluid Extraction: Carbon Dioxide Extraction (SFE) Systems extract chemical compounds without the need of an organic solvent. A fluid enters the supercritical fluid state when it is between the normal gas and liquid states and is above its critical temperature (Tc) and critical pressure (Pc). The item of interest can be solubilized and extracted selectively by adjusting the fluid's temperature and pressure. The sample is put in an extraction vessel and put under CO2 pressure to dissolve it. After being transferred to a fraction collector, the contents are depressurized, the CO2 loses its ability to serve as a solvent, and the targeted substance precipitates. You can recycle the condensed CO2. (21)

Solvent Selection: The Type of solvents used in extraction procedures determines the success rate of determination of biological active compounds from the plant materials. There are many factors that determine the efficiency of extraction; one of the important factors is selection of solvents. There are also other factors like solubility of metabolites in selected solvents and extraction temperature, which also affects the efficiency of extraction. Depending upon the molecular structure, a molecule may be water soluble or water insoluble. Water-insoluble compounds are mainly extracted using organic solvents like chloroform, ethanol, methanol, acetone.(22)

2.3. Preparation of Herbal Hair Serum:

- The herbal hair serum was formulated via a straightforward dispersion-emulsification technique.
- Natural active ingredients were prepared according to the formulation.
- The required quantities of liquid extracts (amla, hibiscus, aloe vera and fenugreek) were transferred into one beaker.
- In a separate beaker, the required quantity of essential oils was taken according to the formulation.
- The oil phase was maintained at 40□C using a magnetic stirrer with a stirring speed of 500-600 rpm.

- The liquid extracts were added slowly to the oil phase with continuous stirring until a homogeneous emulsion was obtained.
- The emulsifying agent, preservative, and other flavoring agents were then added and mixed thoroughly.
- We can also use other mixing apparatuses (overhead stirrers, rotary evaporators, laboratory shakers, ultrasonic mixers, planetary mixers, high-speed homogenizers.)
- Finally, distilled water was added to make up the required final volume, and the serum was stirred until a smooth, uniform formulation was obtained.

2.4. Phytochemical Analysis:

To identify the presence of phytochemical like Alkaloids, Flavonoids, Terpenoids, Tannins, Phenolic acid, and Anthocyanins. (23)

Table. 2. Phytochemical Analysis

Phytochemical Constituents	Phytochemical Analysis
Alkaloids	Dragendroffs test
Terpenoids	Salkowski test
Flavonoids	Shinoda test
Tannins	Lead acetate test
Phenolic acid	Ferric chloride test
Anthocyanins	Sulphuric acid test

2.5. Evaluation Test for Herbal Hair Serum:

The following parameters are used to evaluate the prepared herbal hair serum.

1. Physical Appearance:

Physical appearance was evaluated by observation on the texture, color, and smell of the formulated cosmetic serum. (24)

2. PH:

The pH meter was calibrated using pH 4 and pH 7 buffer solutions. Then, the electrode was soaked in the hair serum and left until the pH normalized after a few minutes. (25)

3. Viscosity:

Viscosity of the formulation is determined by Brookfield viscometer at 100rpm, using spindle type model S6, 4.5 mL of the serum. The serum will be placed in a big-mouth container with the spindle dipped in it for about 5 minutes before the measurement.

4. Spreadability:

Spreadability was measured by a parallel plate process typically used to assess and measure the Spreadability of semisolid preparations. One gram hair serum was pressed between two horizontal plates of dimension 20×20 cm, the upper of which weighed 125 g. The spread diameter was measured after 1 min. (26)

Spreadability was calculated using the following formula:

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

Where,

S = Spreadability, M = Weight in the pan (Tied to the upper slide) L= Length moved by the glass slide, T= Time

5. Stability:

The herbal hair serum was kept for three months at two separate temperatures of 4± 2□C, with 65% RH. Compared with the original PH and viscosity, the PH and viscosity of the herbal hair serum were determined after three months.

CONCLUSION

The use of plant-based ingredients with antioxidant, nourishing, moisturizing, and hair-growthsupporting properties increases the effectiveness and potential benefits of herbal hair serum. The herbal hair serum market is experiencing significant growth due to increasing consumer preference for natural, plant-based, and chemical-free hair care products.

With continuous innovation, advanced formulations, and the rising popularity of herbal hair serums hold strong potential for future growth in the global hair care market.

The presence of bioactive phytoconstituents with antioxidants and antimicrobial properties may contribute to improved scalp health and overall hair quality.

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