

INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES

[ISSN: 0975-4725; CODEN(USA): IJPS00] Journal Homepage: https://www.ijpsjournal.com



Review Article

Design And Characterization of Novel Hair Serum

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ARTICLE INFO

Published: 23 April. 2025 Keywords: Hair serum, Tamanu oil, Chilotria, Onion extract, Black Seed oil, Bhringraj, Herbal formulation, FTIR spectroscopy, Hair care, Natural cosmetics. DOI: 10.5281/zenodo.15270534

ABSTRACT

"The increasing demand for herbal and natural hair care products has driven research toward developing effective formulations with minimal side effects. This study focuses on the design and characterization of a novel polyherbal hair serum incorporating Tamanu oil, Chilotria, Onion extract, Black Seed oil, and Bhringraj extract—each known for their therapeutic properties related to hair health". "The formulation aims to address issues such as hair fall, scalp dryness, thinning, and lack of luster by leveraging [1] the synergistic benefits of these bioactive ingredients. Physicochemical properties, pH stability, viscosity, and organoleptic characteristics were assessed to ensure the serum's suitability for topical application". FTIR spectroscopy was employed to identify functional groups and confirm the presence of essential phytochemicals and lipid components. The spectrum revealed characteristic peaks corresponding to phenols, fatty acids, esters, and aromatic compounds, confirming the successful incorporation of the herbal components. The serum demonstrated good stability and promising potential as a natural alternative for hair nourishment and scalp care.

INTRODUCTION

In recent years, there has been a growing consumer preference for **natural and herbal cosmetic products**, particularly in the domain of hair care. This trend is driven by increasing awareness of the potential adverse effects associated with synthetic ingredients, such as scalp irritation, hair damage, and hormonal disruptions. Consequently, the development of **herbal hair serums** that incorporate plant-based oils and extracts with therapeutic benefits has become a significant [2] area of research in cosmetic and pharmaceutical sciences. Hair health is influenced by a variety of factors including genetics. environmental exposure, lifestyle habits, and nutritional status. Common hair concerns such as hair fall, thinning, dandruff. dryness, and scalp inflammation necessitate the development of formulations that not only nourish the hair but also promote scalp health. Polyherbal formulations offer a synergistic effect, where the combined

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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bioactivities of multiple plant extracts and oils provide enhanced efficacy compared to individual components.

Definition: The present study focuses on the formulation and characterization of a novel hair serum composed of Tamanu oil, Chilotria, Onion extract, Black Seed oil, and Bhringraj. These ingredients were selected based on their traditional and scientifically supported roles in promoting hair growth, preventing hair loss, improving scalp condition, and restoring hair strength and shine

ADVANTAGES AND DISADVANTAGES

1. Advantages:100% Natural Ingredients Free from harmful chemicals, sulphates, and parabens—minimizing the risk of irritation or allergic reactions.

- 2. Multi-Functional Action Combines anti-hair fall, anti-dandruff, scalp nourishing, and hair conditioning properties in a single formulation.
- 3. Synergistic Herbal Effects The combination of five potent herbs/oils offers,
- 4. Rich in Bioactive Compounds Contains flavonoids, sulfur compounds, fatty acids, and antioxidants that promote hair follicle health and growth.

Disadvantages:

- 1. Lack of Extensive Clinical Testing.
- 2. Lack of Large-Scale Clinical Trials
- 3. Possible Allergic Reactions

Anatomy And Physiology of Hair Serum



"The anatomy and physiology of hair allows for better formulation of hair serums. The combination of herbal ingredients in your serum acts on both the shaft and root to improve hair strength, reduce fall, and restore scalp health, aligning with the natural hair growth cycle."[4]

Layers of Hair serum:

a. Hair Shaft

- The visible part of the hair above the scalp.
- Composed of keratinized cells in three layers:
- Cuticle outermost, protective layer



- Cortex middle layer, provides strength, color, and texture
- Medulla innermost, may be absent in fine hair

b. Hair Root

Located below the scalp surface



- Enclosed within the hair follicle
- Responsible for anchoring the hair in the skin

c. Hair Follicle and Bulb

- The hair bulb at the base of the follicle contains living matrix cells that divide and grow the hair
- Surrounded by the dermal papilla, rich in blood supply and nutrients
- Connected to sebaceous glands and arrector pili muscles

Symptoms:

1. Hair Fall / Hair Loss

- Excessive shedding of hair strands from the scalp
- May result from poor follicular nutrition, hormonal imbalance, or inflammation [5]

2. Thinning of Hair

- Reduced hair density or volume
- Caused by weakened hair shafts or decreased anagen (growth) phase

3. Dry and Itchy Scalp

- Loss of natural oils leading to scalp irritation
- May be linked to fungal infections, dryness, or poor hydration

Dandruff / Flaking

- Presence of white or yellow flakes on the scalp and hair
- Often associated with seborrheic dermatitis or fungal overgrowth

5. Split Ends and Fizziness

- Hair shaft damage leading to frayed ends and rough texture
- Usually due to heat styling, chemical exposure, or loss of moisture

6. Premature Greying

- Early loss of melanin resulting in grey or white hair
- May be influenced by oxidative stress and nutrient deficiency

7. Dullness and Lack of Shine

- Hair appears lifeless or lacks luster
- Caused by cuticle damage or poor hair surface conditioning

8. Weak Hair Roots

- Poor anchoring of hair in the follicle
- Increases susceptibility to hair breakage and shedding [8]

Mechanism Of Hair Serum

- Follicular Nourishment and Stimulation
- Scalp Conditioning and Moisture Retention
- Antimicrobial and Anti-Dandruff Effects
- Hair Shaft Protection and Repair
- Regulation of Sebum and pH Balance
- Anti-Aging and Anti-Greying Effects.

Function of Hair Serum:

"The novel hair serum performs a wide range of cosmetic, therapeutic, and protective functions, targeting both the hair shaft and scalp. These functions arise from the synergistic action of the



natural bioactive compounds in the formulation." [7]

Hair Serum Drug Delivery System

"The herbal hair serum acts as an efficient topical drug delivery system, allowing for localized, targeted, and sustained release of bioactive compounds. Its multi-ingredient oil-based matrix makes it ideal for managing hair fall, scalp inflammation, and promoting hair regrowth without systemic complications".

Route Function in Hair Serum

Follicular	Delivers actives deep	Follicular
route	into the hair follicle	route
	and bulb	
Intercellular	Oils diffuse between	Intercellular
	skin cells to reach	
	deeper layers	
Sebaceous	Lipophilic actives	Sebaceous
route	mix with natural	route
	scalp sebum for	
	better absorption	

Advanced Drug Delivery Systems

Types of Drug Delivery in Hair Serum

1. Topical Delivery

- Direct application to the scalp and hair surface
- Bypasses first-pass metabolism, enabling localized action

2. Trans follicular Delivery

- Active ingredients penetrate through the hair follicles
- Targets the dermal papilla and root sheath cells—critical for hair growth

3. Trans epidermal Delivery

• Permeation through the **stratum corneum** of the scalp skin

• Enhanced by oil-based formulation which increases lipid solubility.

Properties of permeation enhancer:

- Controlled & reversible enhancing action
- Chemical & physical compatibility c- drug & often pharmaceutical excipients
- Should not cause loss of body fluid, electrolytes

Other hair serum materials:

- The polymer should be stable
- Polymer should be nontoxic
- The polymer should be easily manufactured
- A large number of active agents are incorporated into it
- Odorless, colorless, economical & cosmetically acceptable

Other excipients: Solvents are used as chloroform, methanol, acetone & isopropanol to prepare drug reservoirs. e.g.- transdermal patches is also used.

- [1]. **Pressure Sensitive Adhesive:** PSA is a material that helps in maintaining contact between the transdermal system and skin surface. It is removable from smooth surfaces without leaving residue e.g.- polyacrylamides, polyisobutylene, and silicon-based adhesives [8].
- It is based on patch design& drug formulation.
- [2]. **Backing laminates:** It is chemical resistant & excipients may be compatible because of prolonged contact between the backing layer& excipients, drug, or penetration enhancer through the layer.

Release liner: "During storage, patches are covered by a protective layer that is removed &



discarded before the application of the patch to the skin. However, liner is in intimate contact with the delivery system, it should comply with specific requirements regarding chemical inertness & permeation to the, dry, permeation enhancer & water" [9].

Hair Serum Systems Can Be Divided into Two Layer Systems:

Hair serum formulations can be functionally divided into **two distinct layers or systems**, each contributing to the overall **effectiveness**, **stability**, **and performance** of the product. These layers are:

♦ 1. Aqueous Layer (Hydrophilic Phase)

This is the **water-based** portion of the serum and contains water-soluble components.

Functions:

- Provides hydration to the scalp and hair
- Delivers **water-soluble vitamins**, amino acids, and plant extracts
- Acts as a **medium for preservatives, humectants** (e.g., glycerin, panthenol)
- Helps **regulate pH** and enhances product feel (non-greasy texture)

V Typical Ingredients:

- Distilled water
- Aloe vera extract
- Panthenol (Vitamin B5)
- Glycerin
- Herbal hydrosols (e.g., Bhringraj or Onion extract water phase)

♦ 2. Lipid Layer (Lipophilic Phase)

This is the **oil-based** portion of the serum responsible for nourishing and sealing moisture.

Functions:

- Delivers **lipid-soluble actives** like fatty acids, vitamins A, D, E, and antioxidants
- Forms a protective barrier over the hair shaft
- Prevents **trans-epidermal water loss** (TEWL)
- Penetrates the **hair follicles** for deeper therapeutic action
- Adds shine, softness, and smoothness

V Typical Ingredients:

- Tamanu oil
- Chilotria oil
- Black Seed oil (Nigella sativa)
- Bhringraj oil
- Onion seed oil
- Essential oils (optional, for fragrance or specific functions)

🗳 Interaction Between the Two Layers

While distinct, these layers **interact** synergistically:

- The **aqueous layer hydrates** the scalp and facilitates active delivery
- The **oil layer locks in the moisture** and ensures prolonged contact with hair and scalp
- When properly emulsified or mixed, they form a **stable, homogenous serum** suitable for both dry and oily scalp types [10]

Formulation Note:

Depending on the design, the two-layer system may be:

Homogenized into a single-phase emulsion, or



Kept as a biphasic (shake-before-use) serum, for ease of formulation without synthetic emulsifiers.

Layer	Function	Key Ingredients
Aqueous	Hydration,	Water, aloe vera,
Layer	nutrient delivery	glycerin,
		panthenol
Lipid	Nourishment	Tamanu, Onion,
Layer	protection, deep	Black Seed,
-	delivery	Bhringraj oils

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A Mechanism of Penetration

Route	Function in Hair Serum	
Follicular	Delivers actives deep into the hair	
route	follicle and bulb	
Intercellular	Oils diffuse between skin cells to	
	reach deeper layers	
Sebaceous	Lipophilic actives mix with natural	
route	scalp sebum for better absorption	

Formulation Advantages as a Delivery System

1. Oil-Based Vehicle

Enhances solubility of hydrophobic phytoconstituents

Improves Spreadability and absorption

2. Controlled and Sustained Release

Gradual diffusion of active compounds allows prolonged action on scalp and follicles

3. Stability of Phytochemicals

Oils protect sensitive ingredients (e.g., flavonoids, thymoquinone) from oxidation and degradation

4. Target-Specific Action

Acts precisely where needed—follicles, sebaceous glands, scalp tissue

5. Minimal Systemic Absorption

Reduces risk of systemic side effects while offering effective localized treatment

With further development, the serum could be integrated into more sophisticated delivery platforms such as:

- Nano emulsions to increase skin permeation and bioavailability
- Liposomes/Phytotomies to encapsulate herbal actives for deeper penetration
- Hydrogel-serum hybrids for enhanced retention and moisturization

Route Of Drug Hair Serum:

Hair serum, when applied topically, uses several routes of penetration to deliver active compounds to the hair follicles, scalp, and hair shaft. These



routes ensure localized, effective action with minimal systemic absorption.

1. Trans follicular Route (Via Hair Follicles)

Primary and most effective route for hair serum action.

A Mechanism:

The serum penetrates through the opening of the hair follicle.

Delivers actives directly to the **dermal papilla**, the key site for hair growth regulation.

Relevance:

Lipophilic components (e.g., Tamanu oil, Black **Seed oil**) easily enter this pathway.

Enhances hair regrowth, reduces inflammation, and stimulates follicles.

2. Trans epidermal Route (Through Scalp Skin)

A. Intercellular Pathway

diffuses skin cells Drug between the (corneocytes) through lipid bilayers.

Oils like Chilotria and Bhringraj enhance penetration via this route.

B. Transcellular Pathway

Drug passes directly through the skin cells.

Useful for small, hydrophilic molecules from aqueous extracts (e.g., onion juice).

Role:

Delivers hydrating agents, vitamins, and antiinflammatory compounds.



Maintains scalp health and barrier function.



A Mechanism:

Lipophilic ingredients dissolve into natural sebum.

Facilitates delivery of fat-soluble compounds to follicular and dermal regions.



Black Seed oil and Tamanu oil easily mix with sebum and extend residence time.

4. Surface Film and Shaft Absorption

Oils form a **film over the hair shaft**, improving:

Shine, smoothness, and UV protection

Prevention of cuticle damage and protein loss

Minimal penetration into the shaft, but significant cosmetic effect.

Summary Table: Routes of Drug Delivery in Hair Serum

Route	Target Site	Mechanism
Trans follicular	Hair follicle,	Through follicle
	bulb	opening
Trans epidermal	Scalp skin	Between skin
- Intercellular	layers	cells
Trans epidermal	Scalp	Through
- Transcellular	keratinocytes	individual skin
		cells
Sebaceous	Follicular-	Dissolution in
Gland Route	sebaceous	natural sebum
	unit	
Surface/Shaft	Hair shaft	Film formation,
Absorption		limited
		penetration

- Trans epidermal pathways
- Trans appendageal pathways

Drug penetration across the liquid skin, namely the trans epidermal & Trans appendageal pathway. The transdermal pathway involves the passage of molecules through stratum corneum, multilayer & multicellular barriers. Trans epidermal penetration can be termed intra or inter-cellular. The intracellular route through corneocytes, terminally differentiated keratinocytes, allows the transport of hydrophilic or polar solutes. The transappendageal route involves- the passage of molecules through the sweat gland & hair follicle. Penetration of substances in various layers of skin.

Percutaneous absorption of hair serum is a step-in process involving:

- **Penetration:** When a substance enters the skin layer.
- **Portioning:** The partitions from stratum corneum into aqueous or soluble viable epidermis.

- **Diffusion:** Viable epidermis & into the upper dermis.
- **Permeation:** Molecule penetrates from one layer to another.
- **Absorption:** Substance uptake & into the systemic circulation.

Step 1: [Penetration] Drug entry into a hair serum layer.

Step 2: [Petitionary] From hair layer into aqueous viable the upper dermis.

Step 3: [Diffusion] Drug permeation from one layer into another.

Step 4: [Permeation] Uptake of a drug into the systemic circulation.

Step 5: [Absorption] Drug reaches to designed site for action.

Factor Affecting Hair Serum Permeability

Parameter	Factors	
Formulation	Boundary layer	
	Thickness	
	Temperature	
	Geometry of system	
	Polymer	
	Vehicles	
	Porosity of membrane	
Hair serum	Species Condition of skin (healthy, diseased,	
	pre-treated, secretion)	
Adhesion	Size/shape	
	Cohesiveness	
Bio-	The half-life of the drug	
pharmaceutical	Pharmacological blond level [6]	

Bhringraj

(*Eclipta alba* or *Eclipta prostrata*) is a widely recognized medicinal herb in traditional systems of medicine, particularly Ayurveda, where it is revered as the "King of Herbs" for hair care. It belongs to the family Asteraceae and is commonly found in moist, tropical regions across India and Southeast Asia. The plant is known for its powerful hair rejuvenating properties, including its ability to stimulate hair growth, prevent premature greying, and reduce hair fall. Rich in bioactive compounds such as wedelolactone, ecliptine, flavonoids, and alkaloids, Bhringraj exhibits a range of pharmacological activities including antiinflammatory, antioxidant, and antimicrobial



effects. - simultaneous absorption of water and desorption of medication from such initially dehydrated hydrogel is accomplished by the swelling diffusion.



Chilotria

The increasing demand for natural, effective, and multifunctional hair care products has led to the exploration of novel herbal formulations. Chilotria-based hair serum represents a unique approach in the field of trichology, combining the therapeutic potential of plant-derived oils and extracts for hair nourishment, scalp health, and follicle stimulation. While the specific composition of Chilotria is proprietary or novel, it is formulated to synergize with other potent herbal ingredients such as Tamanu oil, Black Seed oil, Onion extract, and Bhringraj, each known for their individual benefits in promoting hair growth, reducing hair fall, and enhancing hair texture process. The gum expands, and the drug diffuses out of it.



Marketed Products of TDDS

TDD products are continuing to provide actual therapeutic value to patients all across the world. In the United States, more than 35 TDD products have been approved for sale, and roughly 16 active components have been approved for usage in TDD products across the world. [11].

CONCLUSION

The development of a Chilotria-based herbal hair serum, incorporating Tamanu oil, Onion extract, Black Seed oil, and Bhringraj, represents a significant step toward creating a natural, safe, and effective solution for hair care and scalp health. Each component in the formulation has been selected for its scientifically supported benefits, including hair growth promotion, follicle stimulation. anti-inflammatory action, and antioxidant protection. The synergistic combination of these herbal ingredients enhances the overall efficacy of the serum, addressing common hair-related issues such as hair fall, dullness, dryness, and scalp irritation.

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HOW TO CITE: KM. Kajal Singh*, Dr. Rajneesh Kumar Gupta, Design and Characterization of Novel Hair Serum, Int. J. of Pharm. Sci., 2025, Vol 3, Issue 4, 2830-2839 https://doi.org/10.5281/zenodo.15270534

