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## Review Article

# Review On Formulation and Evaluation of Polyherbal Hair Serum

Gaurav Khairnar<sup>1\*</sup>, Yogesh Chaudhari<sup>2</sup>, Swapnil Phalak<sup>3</sup>

<sup>1</sup> Department of Pharmaceutics, Konkan Gyanpeeth Rahul Dharkar College of Pharmacy and Research Institute, Karjat, Maharashtra

<sup>2</sup> Department of Pharmaceutics, Dr L H Hiranandani College of Pharmacy, Dr L H Hiranandani College of Pharmacy, Ulhasnagar, Maharashtra

<sup>3</sup> Department of Pharmaceutics, Konkan Gyanpeeth Rahul Dharkar College of Pharmacy and Research Institute, Karjat, Maharashtra

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## ABSTRACT

The increasing demand for plant-based alternatives in hair care is significantly propelled by rising consumer concerns regarding the potentially adverse effects associated with synthetic hair care products [1], [2], [3]. These concerns often include fears of scalp irritation, hair damage, and potential long-term health risks linked to ingredients like sulfates, parabens, and artificial fragrances commonly found in conventional hair products. This shift in consumer preference underscores the need for safer, more biocompatible options that harness the power of nature to promote hair health. To address this growing demand, a polyherbal hair serum integrating a carefully selected blend of botanical extracts—coriander (*Coriandrum sativum*), hibiscus (*Hibiscus rosa-sinensis*), grape seed (*Vitis vinifera*), flaxseed (*Linum usitatissimum*), and walnut (*Juglans regia*)—along with the aromatic and therapeutic benefits of rose oil (*Rosa damascena*), was systematically formulated and evaluated for both its safety and efficacy [4], [5], [6]. This formulation aims to capitalize on the synergistic properties of these herbal ingredients, each chosen for their unique contributions to hair and scalp health, while also adhering to stringent safety standards to ensure a non-toxic and well-tolerated product. This novel formulation seeks to provide a sustainable and non-toxic hair care solution, effectively blending the time-honored principles of Ayurvedic medicine with the cutting-edge advancements of modern cosmeceutical science [7], [8], [9]. By drawing upon the rich tradition of Ayurveda, which emphasizes holistic well-being and the use of natural ingredients, this research aims to develop a hair serum that not only addresses specific hair concerns but also promotes overall scalp health and vitality. Furthermore, by integrating modern cosmeceutical techniques, the formulation is designed to enhance the bioavailability and efficacy of the herbal extracts, ensuring optimal results for consumers seeking a natural and effective hair care solution.

**\*Corresponding Author:** Gaurav Khairnar

**Address:** Department of Pharmaceutics, Konkan Gyanpeeth Rahul Dharkar College of Pharmacy and Research Institute, Karjat, Maharashtra.

**Email** ✉: [gauravbk133@gmail.com](mailto:gauravbk133@gmail.com)

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## INTRODUCTION

### 1.1. The Appeal of Natural Hair Care

Consumers are actively seeking alternatives to synthetic hair care products in response to growing concerns about the potential harm caused by harsh chemicals and the array of side effects that can accompany their use [1], [2], [3]. These concerns often stem from the understanding that synthetic ingredients, such as sulfates, parabens, and artificial fragrances, can disrupt the delicate balance of the scalp, leading to irritation, dryness, and even more severe conditions like allergic reactions and hair loss. This awareness has fueled a significant shift towards natural and organic hair care options, perceived as being gentler, safer, and more in harmony with the body's natural processes. Herbal cosmetics are meticulously formulated with natural ingredients, making them an appealing choice for individuals keen on avoiding synthetic chemicals and embracing products that are perceived as safer and more biocompatible for their hair and scalp [3], [12]. These formulations often incorporate a diverse range of plant-derived extracts, essential oils, and other botanical compounds known for their beneficial properties, offering a holistic approach to hair care that addresses various concerns without the harsh side effects associated with synthetic alternatives. The appeal of herbal cosmetics lies not only in their natural composition but also in their ability to provide nourishment, protection, and rejuvenation, promoting overall hair health and vitality. Plant-based ingredients offer a rich reservoir of biocompatible phytochemicals, including flavonoids, terpenoids, and omega fatty acids, which work synergistically to nourish hair follicles, mitigate oxidative stress, and restore the natural homeostasis of the scalp, promoting a healthy environment for hair growth [13], [8], [9]. These phytochemicals possess a wide range of therapeutic properties, such as antioxidant, anti-inflammatory, and antimicrobial effects, which contribute to their ability to address various hair and scalp concerns

in a natural and holistic manner. By harnessing the power of these plant-derived compounds, herbal hair care products can effectively promote hair health, prevent damage, and restore the scalp's natural balance.

### 1.2. Ayurveda and Traditional Medicine

Ayurveda, the ancient Indian system of medicine, employs complex mixtures of plant products in its medicinal preparations, reflecting a holistic approach to health and well-being that considers the interconnectedness of the body, mind, and spirit [7], [5]. This traditional practice recognizes the synergistic benefits of combining multiple herbs, leveraging their diverse phytochemical profiles to achieve enhanced therapeutic outcomes, addressing the root causes of imbalances rather than simply treating the symptoms. Ayurvedic formulations are carefully crafted to restore harmony and promote natural equilibrium, emphasizing the use of plant-based remedies as a means to support overall health and longevity. Traditional herbal remedies are experiencing a resurgence in popularity and are gaining increasing acceptance in modern healthcare, largely due to the perception that these natural products have fewer side effects compared to their synthetic counterparts, offering a gentler and more well-tolerated approach to treatment [6], [4]. This preference is driven by a growing awareness of the potential risks associated with synthetic drugs, which can often cause a range of adverse reactions, from mild discomfort to severe health complications. Herbal remedies, on the other hand, are generally considered to be gentler and better tolerated by the body, making them an attractive option for individuals seeking natural and holistic approaches to healthcare. Polyherbal formulations have been traditionally used to treat numerous diseases, offering several advantages over single-herb formulations, including enhanced efficacy through synergistic interactions and reduced toxicity by balancing the effects of individual herbs [5], [4]. By combining multiple herbs with



complementary properties, these formulations can target multiple pathways simultaneously, leading to a more comprehensive and synergistic therapeutic effect. The concept of polyherbalism recognizes that the whole is often greater than the sum of its parts, harnessing the power of nature to create complex and effective remedies that address the underlying causes of disease.

### 1.3. Addressing Lacunae in Herbal Product Standardization

Standardization is essential to ensure consistent quality and efficacy in herbal products, addressing a major challenge in the herbal industry where variations in plant material and processing methods can lead to inconsistencies in the final product [14], [4]. By establishing standardized protocols for cultivation, harvesting, extraction, and formulation, manufacturers can ensure that each batch of herbal product contains a consistent level of active constituents, providing consumers with a reliable and predictable therapeutic experience. Scientific validation is critically needed to bridge the existing gap between empirical herbal knowledge, often based on traditional practices and anecdotal evidence, and the rigorous pharmaceutical standards required for modern medicine, providing a solid foundation of scientific evidence to support the use of herbal products in healthcare [12], [14]. This validation process involves conducting thorough research to identify the active constituents in herbal extracts, elucidate their mechanisms of action, and demonstrate their efficacy and safety through preclinical and clinical studies. This research is specifically designed to bridge the gap between empirical knowledge, derived from traditional herbal practices, and the rigorous standards of pharmaceutical validation, ultimately offering a paradigm shift towards integrative dermatology that combines the best of both worlds [13], [15]. By applying modern scientific methods to the study of herbal remedies, this research aims to provide a solid foundation of evidence to support their use in dermatological applications,

promoting a more holistic and integrated approach to skin and hair care.

## 2. MATERIALS AND METHODS

### 2.1. Herbal Ingredients and Their Roles

Coriander powder, a key ingredient in this formulation, provides potent antimicrobial properties, primarily attributed to its high concentration of linalool, a monoterpene alcohol known for its ability to inhibit the growth of various microorganisms, promoting a healthy scalp environment [4], [16]. This antimicrobial action helps to prevent scalp infections and maintain a balanced microbiome, contributing to overall hair and scalp health. Hibiscus powder plays a crucial role in stimulating hair growth, largely due to its rich content of anthocyanins and citric acid, which work synergistically to nourish hair follicles, improve blood circulation to the scalp, and promote thicker, stronger, and healthier hair growth [17], [13], [10]. Anthocyanins act as powerful antioxidants, protecting hair follicles from oxidative stress, while citric acid helps to exfoliate the scalp, removing dead skin cells and promoting better nutrient absorption. Flaxseed and walnut oils are essential components of the formulation, providing moisturizing and strengthening benefits to hair follicles, thanks to their high concentrations of essential fatty acids, particularly omega-3 ( $\alpha$ -linolenic acid) and omega-6 (linoleic acid), which nourish the hair roots, prevent dryness, and promote overall hair health and resilience [18], [19]. These essential fatty acids help to maintain the integrity of the hair shaft, improve hair elasticity, and reduce the risk of breakage and split ends.

### 2.2. Preformulation Studies

Organoleptic evaluation is a crucial first step in assessing the quality and purity of herbal ingredients, involving a thorough examination of their physical characteristics, such as color and aroma, to ensure they meet the required standards for use in cosmetic formulations [4], [16]. The



color of an herbal extract can indicate the presence of specific phytochemicals, while the aroma can reveal the presence of volatile oils and other aromatic compounds, providing valuable insights into the overall quality and therapeutic potential of the plant material. Solubility profiling is a critical step in determining the optimal solvent for extraction, maximizing the yield of desired compounds from the herbal ingredients and ensuring their efficient incorporation into the final formulation [20], [12]. By identifying the solvent that best dissolves the target phytochemicals, formulators can optimize the extraction process and ensure that the resulting extract is rich in the active constituents responsible for the therapeutic benefits of the herbal ingredients. pH determination is essential to ensure compatibility with the scalp's natural pH, maintaining the delicate microbiome balance and preventing irritation or disruption of the scalp's natural flora, which can lead to various scalp conditions such as dandruff and inflammation [3], [21]. The scalp's natural pH is slightly acidic, typically ranging from 4.5 to 5.5, which helps to maintain a healthy balance of microorganisms and protect against infection.

### 2.3. Formulation Protocol

Extraction involved maceration for coriander and hibiscus, a process where the herbal material is soaked in a solvent (ethanol-water mixture) to draw out the desired compounds, and Soxhlet extraction for grape seed, a continuous extraction method using refluxing solvent to efficiently isolate proanthocyanidins [20], [12]. Maceration is a simple and cost-effective technique suitable for extracting a wide range of phytochemicals, while Soxhlet extraction is particularly effective for extracting compounds that are not readily soluble in the solvent. Emulsification combined the oil and aqueous phases, utilizing beeswax as a natural emulsifier to create a stable emulsion, ensuring that the oil and water components remain uniformly mixed and preventing phase separation, which can compromise the product's efficacy and

aesthetic appeal [20], [11]. Beeswax is a biocompatible emulsifier that helps to create a smooth and creamy texture, enhancing the overall user experience. Homogenization at high speeds was performed to ensure uniform distribution of ingredients throughout the formulation, preventing phase separation and creating a stable and consistent product that delivers its therapeutic benefits effectively [20], [1]. This process reduces the size of the oil droplets in the emulsion, making them more stable and less likely to coalesce, resulting in a smooth and creamy texture.

## 3. RESULTS

### 3.1. Physicochemical Characterization

The pH of the serum was carefully controlled to be ideal for maintaining the scalp's microbiome equilibrium, supporting the growth of beneficial microorganisms and inhibiting the proliferation of harmful bacteria and fungi that can cause scalp infections [3], [21]. A slightly acidic pH, within the range of 4.5 to 5.5, helps to maintain a healthy balance of microorganisms on the scalp, preventing the overgrowth of harmful species and promoting overall scalp health. The viscosity of the serum was optimized to ensure non-greasy application, allowing for easy and even distribution throughout the hair and scalp without leaving a heavy or oily residue [20], [11]. A suitable viscosity is essential for a positive user experience, ensuring that the product is both effective and pleasant to use. The spreadability of the serum surpassed that of commercial analogs, improving consumer satisfaction by allowing for easier and more even coverage of the scalp, maximizing the contact between the active ingredients and the targeted areas [20], [8]. A serum with good spreadability will be easy to apply and will provide uniform coverage, ensuring that all areas of the hair and scalp receive the intended dose of active ingredients.

### 3.2. Stability Profile



No phase separation, color change, or odor alteration was observed during accelerated stability testing, indicating that the formulation is stable and that its key ingredients are not degrading or interacting in undesirable ways over time [1]. These parameters are key indicators of product stability and are carefully monitored to ensure that the serum maintains its quality and efficacy throughout its shelf life. pH drift was minimal during stability testing, affirming the formulation's robustness and long-term stability, demonstrating that the product is resistant to changes in acidity or alkalinity over time, which can affect its efficacy and safety [20], [1]. A stable pH is essential for maintaining the integrity of the formulation and ensuring that the active ingredients remain effective. These results collectively indicate that the formulation is stable under accelerated conditions, suggesting that it will maintain its quality and efficacy throughout its intended shelf life, providing consumers with a reliable and consistent hair care solution [1]. Accelerated stability testing is a valuable tool for predicting the long-term stability of cosmetic products, allowing manufacturers to identify potential problems and make necessary adjustments to the formulation.

### 3.3. Bioactivity Assessment

Antioxidant efficacy was demonstrated by the DPPH radical scavenging assay, confirming the serum's ability to neutralize free radicals and protect the scalp and hair follicles from oxidative stress, a major contributor to hair damage and premature aging [9], [22]. The DPPH assay is a widely used method for measuring the antioxidant activity of various substances, providing a quantitative assessment of their ability to scavenge free radicals. Antimicrobial potency was shown against *S. aureus*, a common bacterium that can cause scalp infections, demonstrating the serum's ability to inhibit the growth of harmful microorganisms and maintain a healthy scalp environment [4], [16]. This antimicrobial activity is particularly important for preventing and

treating scalp conditions such as dandruff and folliculitis. The serum's bioactivity is likely due to the synergistic effects of the herbal constituents, where the combination of multiple herbs enhances their individual therapeutic properties, resulting in a more potent and comprehensive effect on hair and scalp health [5], [4]. This synergistic effect is a key principle of polyherbalism, recognizing that the whole is often greater than the sum of its parts.

## 4. DISCUSSION

### 4.1. Formulation Rationale

The selection of herbal ingredients for this formulation was carefully based on their well-established benefits for hair health and scalp condition, drawing upon both traditional knowledge and scientific research to identify herbs with specific therapeutic properties [13], [19], [18]. Each herb was chosen for its unique contribution to the overall formulation, targeting different aspects of hair and scalp health, such as hair growth, strength, moisture, and protection. The combination of multiple herbs in this formulation aims to provide a synergistic effect, where the individual therapeutic properties of each herb are enhanced by the presence of the others, resulting in a more potent and comprehensive treatment for hair and scalp concerns [5], [22], [4]. This synergistic approach recognizes that the complex nature of hair and scalp conditions often requires a multi-faceted treatment strategy, where different herbs work together to address multiple underlying factors. The formulation was specifically designed to address multiple factors that contribute to hair loss and damage, including oxidative stress, inflammation, microbial imbalances, and nutrient deficiencies, providing a holistic approach to hair care that targets the root causes of these problems [8], [10], [23]. By addressing these multiple factors simultaneously, the formulation aims to promote healthy hair growth, prevent damage, and restore the scalp's natural balance.

### 4.2. Comparison to Existing Products



The polyherbal serum demonstrates comparable or superior efficacy to commercial products in promoting hair health and improving scalp condition, while offering a safer and more natural alternative to synthetic formulations that may contain harsh chemicals [3], [23]. This comparison is essential to demonstrate the value of the polyherbal serum as a viable alternative to conventional hair care products, providing consumers with a natural and effective option that aligns with their values. The serum's cost-effectiveness, achieved through the use of readily available and affordable herbal ingredients, makes it more accessible to a wider range of consumers, particularly those seeking natural and effective hair care solutions without the high price tag often associated with synthetic products [4], [12]. This affordability makes the polyherbal serum a more equitable option for consumers from diverse socioeconomic backgrounds, promoting access to quality hair care for all. The absence of harsh chemicals in the polyherbal serum reduces the risk of side effects, enhancing consumer appeal and making it a more suitable option for individuals with sensitive skin or scalps who may be prone to irritation or allergic reactions from synthetic ingredients [3], [10]. This safety profile is a key advantage of using natural ingredients, providing consumers with peace of mind and confidence in the product's ability to promote hair health without causing harm.

#### 4.3. Implications for Cosmeceutical Science

This study highlights the significant potential of ethnopharmacology, the study of traditional medicines used by different cultures, to inform the development of innovative cosmeceutical products that combine the wisdom of ancient healing practices with the rigor of modern scientific research [7], [4]. By exploring the traditional uses of various herbs and their documented therapeutic properties, researchers can identify promising candidates for use in cosmetic formulations, creating products that are both effective and culturally relevant.

The findings of this research support the integration of traditional herbal knowledge with modern formulation techniques, demonstrating the value of combining time-tested remedies with cutting-edge scientific methods to create innovative and effective cosmeceutical products [14], [15]. This integrated approach allows for the development of products that are not only based on empirical evidence but also optimized for bioavailability, stability, and efficacy, ensuring that consumers receive the maximum benefits from the herbal ingredients. The eco-friendly profile of the polyherbal serum aligns with sustainable development goals, promoting responsible consumption and production practices that minimize the environmental impact of the cosmetic industry, reducing waste, conserving resources, and promoting ethical sourcing of raw materials [11], [12]. This commitment to sustainability reflects a growing awareness of the need to protect the planet and promote responsible business practices that benefit both consumers and the environment.

## 5. CONCLUSION

### 5.1. Summary of Key Achievements

A stable and effective polyherbal hair serum was successfully formulated and evaluated, demonstrating its potential as a natural and safe alternative to synthetic hair care products [20], [3]. Through careful selection of herbal ingredients and optimization of the formulation process, this research has created a product that is both effective and well-tolerated, providing consumers with a reliable and consistent hair care solution. The serum demonstrates promising antioxidant and antimicrobial properties, highlighting its ability to promote scalp health and hair growth by protecting against oxidative stress and inhibiting the growth of harmful microorganisms [22], [24]. These bioactivities contribute to the overall efficacy of the serum, addressing multiple factors that can contribute to hair loss and damage.



The eco-friendly formulation provides a sustainable alternative to synthetic hair care products, aligning with the growing consumer demand for environmentally responsible products and promoting a more sustainable approach to personal care [11], [12]. This commitment to sustainability encompasses various aspects of the product lifecycle, from the sourcing of raw materials to the packaging and disposal of the final product.

## 5.2. Future Research Directions

Future research should explore the potential of nanoemulsion-based delivery systems to further enhance the bioavailability and follicular penetration of the serum's active ingredients, potentially leading to even greater efficacy and improved results [15], [25]. Nanoemulsions are emulsions with extremely small droplet sizes, which can improve the absorption and delivery of active ingredients to the targeted areas of the hair and scalp. Further studies should be conducted to explore the serum's long-term effects on hair density and overall scalp health, providing a more comprehensive understanding of its benefits and potential for sustained improvement in hair condition [23], [9]. These studies should involve larger sample sizes and longer observation periods to assess the long-term effects of the serum on hair growth, thickness, and overall scalp health. Clinical trials are needed to validate the serum's therapeutic efficacy and safety in diverse populations, ensuring that the product is effective and well-tolerated across a wide range of individuals with different hair types and scalp conditions [23], [26]. These trials should be conducted in accordance with rigorous scientific standards, using appropriate controls and outcome measures to assess the serum's impact on hair growth, hair loss, and scalp health.

## 5.3. Concluding Statement

This study provides a solid foundation for the development of novel herbal cosmeceuticals, offering a natural and sustainable approach to hair

care that combines the wisdom of traditional medicine with the advancements of modern science [13], [8]. By harnessing the power of plant-based ingredients and employing innovative formulation techniques, this research paves the way for the creation of effective and eco-friendly hair care solutions that promote both hair health and environmental responsibility.

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