



iJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** IX **Month of publication:** September 2026

DOI: <https://doi.org/10.22214/ijraset.2026.84705>

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A Comprehensive Review of Rosemary-Based Herbal Hair Growth Serum: Formulation, Evaluation and Therapeutic Potential

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Abstract: Hair loss and hair thinning are common cosmetic concerns associated with androgenetic alopecia, telogen effluvium, oxidative stress, scalp conditions and lifestyle-related factors. Rosemary (*Rosmarinus officinalis* L.) has attracted scientific interest because its phytoconstituents possess antioxidant, anti-inflammatory and other biological activities that may support scalp and hair-follicle health. This review summarizes the available information on rosemary-based herbal hair growth serums, with emphasis on rosemary, fenugreek (*Trigonella foenum-graecum*), curry leaves (*Murraya koenigii*) and Aloe vera. The review discusses botanical and phytochemical characteristics, proposed mechanisms of hair-growth support, extraction and formulation considerations, physicochemical and functional evaluation parameters, safety assessment and current evidence. A randomized comparative study reported that rosemary oil and 2% minoxidil produced comparable improvements in hair parameters over six months in androgenetic alopecia; however, this evidence should not be generalized to every rosemary preparation or polyherbal serum. The available literature supports further investigation of standardized rosemary-based formulations, particularly through controlled studies, stability testing and long-term clinical evaluation. Future work should focus on standardized extracts, optimized concentrations, quality control and well-designed clinical trials.

Keywords: Rosemary; *Rosmarinus officinalis*; herbal hair serum; hair growth; fenugreek; Aloe vera; curry leaves; formulation; evaluation; androgenetic alopecia.

I. INTRODUCTION

A. Background

Hair is an important component of appearance and self-esteem, and hair loss can have substantial cosmetic and psychological effects. The original paper identifies increasing interest in herbal hair-care products and the use of pharmaceutical formulation approaches to develop acceptable topical preparations. Herbal serums can provide a non-oily vehicle for delivery of selected plant-derived constituents to the scalp.

B. Rationale for Rosemary-Based Serum

Rosemary is traditionally associated with hair and scalp care and contains phenolic diterpenes, rosmarinic acid, ursolic acid and volatile constituents such as 1,8-cineole, camphor and alpha-pinene. These constituents have been investigated for antioxidant, anti-inflammatory, antimicrobial and other biological activities. Combining rosemary with complementary botanical ingredients may provide a broader formulation approach, although the contribution of each ingredient requires appropriate experimental validation.

C. Objectives

The objectives of this review are to: (i) summarize the phytochemical characteristics of rosemary and selected complementary herbs; (ii) discuss proposed mechanisms relevant to hair and scalp health; (iii) review formulation and extraction considerations; (iv) describe quality-control and efficacy evaluation methods; (v) summarize available clinical evidence; and (vi) identify research gaps for development of standardized rosemary-based hair serums.

II. REVIEW METHODOLOGY

The supplied paper was reorganized as a narrative review. The literature cited in the source manuscript was retained as the primary evidence base. The revised paper emphasizes distinction between traditional use, mechanistic evidence, experimental evidence and clinical evidence.

For a journal submission, the authors should add the exact databases searched, search dates, keywords, inclusion and exclusion criteria, and article-selection process if a formal systematic search was performed. These details were not provided in the supplied manuscript and therefore are not invented here.

III. HAIR GROWTH AND HAIR LOSS

The hair follicle passes through anagen (active growth), catagen (transition) and telogen (resting) phases. The supplied manuscript describes anagen as lasting approximately 2–7 years, catagen as approximately 2–3 weeks and telogen as approximately 3 months. Androgenetic alopecia involves progressive follicular miniaturization associated with androgen signaling, whereas telogen effluvium can follow hormonal changes, nutritional deficiencies, illness, medication or psychological stress. Oxidative stress and inflammatory processes may also contribute to follicular damage.

IV. ROSEMARY (ROSMARINUS OFFICINALIS L.)

A. Botanical and Phytochemical Profile

Rosemary belongs to the family Lamiaceae and is an aromatic perennial shrub. The source manuscript identifies carnosic acid, carnosol, rosmarinic acid and ursolic acid among important constituents, together with volatile components including 1,8-cineole, camphor and alpha-pinene.

B. Proposed Mechanisms

The source manuscript proposes several mechanisms, including antioxidant protection, anti-inflammatory activity, possible modulation of 5-alpha reductase/DHT-related pathways and effects on scalp microcirculation. These mechanisms should be described as proposed or supported by specific experimental evidence rather than as established clinical mechanisms for every rosemary formulation.

C. Clinical Evidence

The key clinical reference in the original paper is a randomized comparative trial of rosemary oil versus 2% minoxidil in androgenetic alopecia. The revised interpretation is deliberately cautious: the study provides clinical evidence for the tested rosemary preparation, but it does not establish that all rosemary oils, extracts or polyherbal serums are equivalent to minoxidil.

V. COMPLEMENTARY HERBAL INGREDIENTS

Ingredient	Key constituents/characteristics	Proposed role	Evidence note
Rosemary	Carnosic acid, carnosol, rosmarinic acid, ursolic acid, volatile constituents	Primary botanical active; antioxidant and other proposed hair/scalp effects	Clinical evidence exists for a specific rosemary-oil preparation
Fenugreek	Steroidal saponins, trigonelline, flavonoids, proteins, galactomannan	Conditioning and proposed supportive hair/scalp effects	Evidence should be interpreted according to preparation and study design
Curry leaves	Antioxidants, amino acids, carotenoids, proteins, vitamins and minerals	Traditional hair-care and antioxidant support	Clinical evidence is less established than traditional use
Aloe vera	Polysaccharides and other constituents	Soothing, moisturizing and formulation-base support	Useful for scalp feel; hair-growth claims require direct evidence

VI. FORMULATION DEVELOPMENT

A rosemary-based serum should be developed by considering extract standardization, concentration, solubility, compatibility, preservative system, pH, viscosity, sensory characteristics, packaging and stability. The original manuscript suggests a formulation containing rosemary extract, fenugreek extract, Aloe vera gel, glycerin, vitamin E, rose water, curry-leaf extract and preservatives. Exact concentrations should be reported only after experimental optimization and should be supported by formulation trials.

A. Suggested Development Strategy

- 1) Authenticate and standardize the botanical materials.
- 2) Select and validate the extraction process for the intended active constituents.
- 3) Prepare preliminary batches with different concentrations of the principal extracts.
- 4) Evaluate pH, viscosity, homogeneity, spreadability, specific gravity and appearance.
- 5) Assess preservative effectiveness and microbiological quality where applicable.
- 6) Conduct accelerated and long-term stability studies.
- 7) Select the optimized batch based on predefined quality and performance criteria.

VII. EVALUATION PARAMETERS

Parameter	Purpose	Typical approach
Appearance/colour/odour	Consumer acceptability and batch consistency	Visual and sensory assessment
pH	Scalp compatibility	Calibrated pH meter
Viscosity	Flow and application properties	Suitable viscometer
Spreadability	Ease of application	Validated spreadability method
Specific gravity	Physical characterization	Pycnometer or validated method
Homogeneity	Uniformity and absence of phase separation	Visual/microscopic examination
Stability	Physical and chemical stability	Defined temperature/humidity conditions
Microbial quality	Product safety	Pharmacopoeial/validated microbiological method
Skin irritation	Topical tolerability	Appropriate ethical and validated patch-testing procedure
Hair-growth efficacy	Performance assessment	Validated in-vitro/in-vivo/clinical endpoint

VIII. RESEARCH GAPS AND FUTURE DIRECTIONS

- 1) Standardization of rosemary extract and identification/quantification of marker compounds.
- 2) Optimization of concentrations and ratios in polyherbal combinations.
- 3) Direct comparison of standardized rosemary serum with an appropriate comparator in controlled studies.
- 4) Long-term safety and tolerability assessment.
- 5) Well-designed clinical trials using objective endpoints such as hair density, shaft diameter and standardized photographic assessment.
- 6) Evaluation of batch-to-batch consistency and stability throughout the proposed shelf life.
- 7) Investigation of improved topical delivery systems, provided their safety and performance are demonstrated experimentally.

IX. DISCUSSION

The literature summarized in the supplied manuscript indicates that rosemary is a promising botanical for further investigation in hair-care formulations. Nevertheless, the strength of evidence varies substantially among ingredients and outcomes. The strongest clinical statement in the source material relates to a particular rosemary-oil clinical trial; traditional claims for other botanicals should not be presented as equivalent clinical evidence. A scientifically stronger review therefore separates established observations from proposed mechanisms and traditional use. For a future experimental study, formulation optimization, analytical standardization, microbiological quality, stability and objective efficacy measurements should be integrated into the study design.

X. CONCLUSION

Rosemary-based herbal hair growth serum is a promising area of pharmaceutical and cosmetic formulation research. Rosemary provides a scientifically interesting botanical base, while fenugreek, curry leaves and Aloe vera may provide complementary formulation or scalp-care properties. Current evidence supports continued investigation but does not justify broad claims that every rosemary or polyherbal serum is equivalent to conventional pharmacological therapy. Standardized extracts, reproducible formulations, validated evaluation methods, stability testing and controlled clinical studies are required to establish efficacy and safety more conclusively.

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