

Phytochemical Analysis, and in Vitro Evaluation of a Hair Serum Based on Rosmarinus Officinalis Leaves and Coconut Oil

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Annotation: The study aimed to formulate and evaluate a natural hair serum using rosemary (*Rosmarinus officinalis*) leaves and coconut oil (*Cocos nucifera*) as a base, with the goal of providing a safe, effective, and natural solution for hair loss and damage, thus serving as an alternative to products with potential chemical side effects.

Various formulations with different ingredient concentrations were developed and subjected to a range of evaluations, including organoleptic (appearance, odor, texture), physicochemical (pH, viscosity, homogeneity, stability), and in vitro/in vivo biological assessments. Efficacy was measured using parameters like hair growth rate, thickness, density, hair length, and reduction in hair fall, often compared against a control group using plain coconut oil or standard minoxidil 2% solution.

Keywords: Rosemary (*Rosmarinus officinalis*), Coconut Oil (*Cocos nucifera*), Hair Growth, Formulation, Phytochemicals.

Introduction:- Hair loss is a widespread concern with significant psychological impact, prompting extensive research into safe, effective, and natural remedies as alternatives to conventional treatments which may have side effects. Rosemary (*Rosmarinus officinalis*) oil has shown promise in numerous studies for its ability to stimulate hair growth, potentially by

inhibiting DHT, a hormone linked to androgenetic alopecia, and improving blood circulation to the scalp. When combined with coconut oil (*Cocos nucifera*), a carrier oil rich in lauric acid that penetrates the hair shaft to reduce protein loss and provide deep nourishment, the resulting serum offers a potent, plant-based solution aimed at promoting hair follicle health, enhancing hair strength, and improving overall scalp condition.

Modern formulations refine traditional methods by ensuring optimal concentrations and the inclusion of synergistic ingredients for enhanced results and stability.

- **Optimal Ratios:** The most effective over-the-counter and research formulations typically use a 1% concentration of rosemary essential oil blended into a 99% carrier oil base, such as cold-pressed virgin coconut oil.
- **Added Actives:** For a multi-pronged approach, ingredients like biotin, caffeine, vitamin E (as a natural preservative and antioxidant), and other botanicals like amla or fenugreek are frequently included to further nourish the scalp and hair.
- **Lightweight Formulas:** Formulations focus on a non-greasy, lightweight texture that absorbs quickly into the scalp, making the serum suitable for regular and even overnight use without weighing hair down.



Rosemary - Herb Seeds

1. Anagen (Growth Phase)

- **Duration:** 2 to 7 years.
- **Serum Impact:** Rosemary oil stimulates the dermal papilla cells, extending the duration of the anagen phase. By increasing blood circulation to the follicle, the serum ensures a continuous supply of nutrients, allowing hair to grow longer and thicker [1].

2. Catagen (Transition Phase)

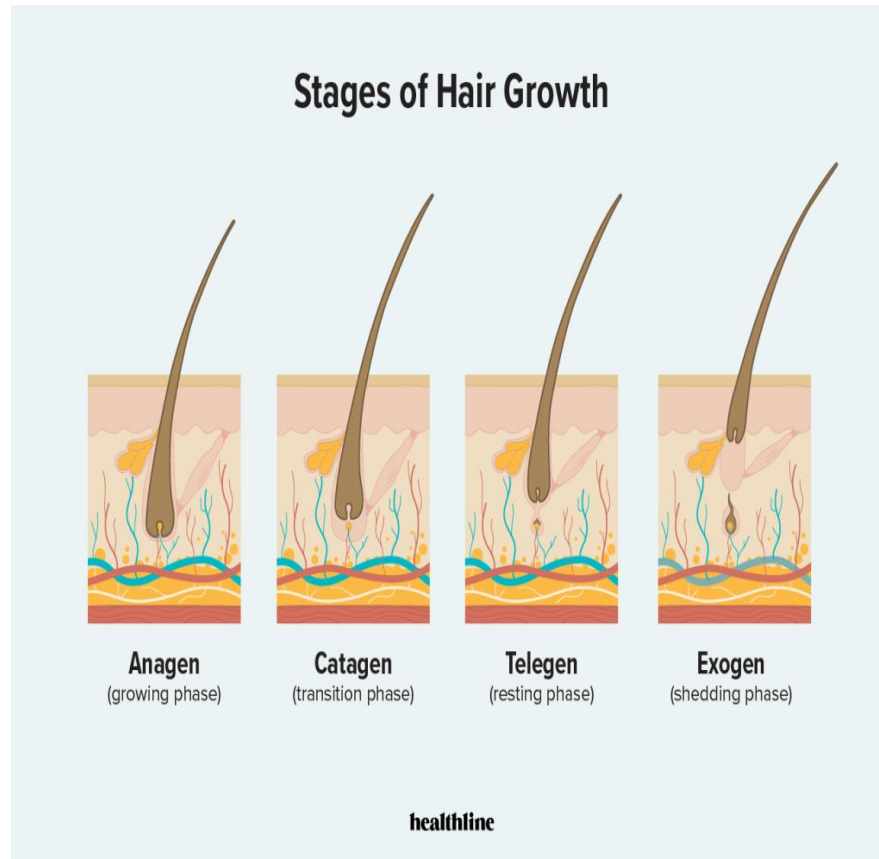
- **Duration:** 2 to 3 weeks.
- **Serum Impact:** During this phase, the hair follicle shrinks and detaches from the dermal papilla. The anti-inflammatory properties of the serum help maintain follicle health during this sensitive transition, preventing oxidative stress that can lead to early detachment [1].

3. Telogen (Resting Phase)

- **Duration:** Approximately 3 months.
- **Serum Impact:** About 10–15% of hairs are in this phase at any time. Formulations containing rosemary and coconut oil aim to reduce the percentage of hairs entering this phase prematurely (often caused by DHT or stress), thereby maintaining higher hair density [1].

4. Exogen (Shedding Phase)

- Duration: 2 to 5 months.
- Serum Impact: This is the final stage where old hair is shed and new hair begins to grow. The lauric acid in coconut oil strengthens the hair shaft at the base, reducing "mechanical shedding" caused by breakage during this phase, while rosemary activates signal the follicle to re-enter the Anagen phase quickly [1].



Stages of Hair Growth

Types by Formulation Base

- **Water-Based Serums:** These are lightweight, non-greasy, and absorb quickly into the scalp or hair. They are ideal for fine, oily, or straight hair and are often used as **scalp treatments** for hair growth because they leave no residue.
- **Oil-Based Serums:** Rich and moisturizing, these use natural oils like argan, jojoba, or coconut. They are best for thick, curly, or extremely dry hair as they seal the cuticle and lock out humidity.
- **Silicone-Based Serums:** These primarily coat the hair surface to provide an instant glossy finish and a protective barrier against environmental stressors like pollution or forceful brushing.

Types by Targeted Concern

- **Hair Growth & Scalp Serums:** Formulated with actives like **Redensyl**, **Anagain**, **Biotin**, and **Rosemary oil**. Unlike styling serums, these are applied directly to the scalp to stimulate follicles and improve density.
- **Frizz Control & Smoothing Serums:** Designed to tame flyaways and manage unruly hair, often using ingredients like **Glycolic acid** or **Argan oil** to create a sleek appearance.

- **Heat Protection Serums:** Specifically used before styling with hot tools. They contain ingredients like **Keratin** or **Dimethicone** to form a shield that prevents breakage and split ends from temperatures up to 250°C.
- **Damage Repair & Strengthening Serums:** Enriched with proteins (e.g., plant-based keratin) and vitamins to rebuild the internal structure of chemically treated or fragile hair.
- **Color-Protect Serums:** Feature UV filters and antioxidants to maintain the vibrancy of dyed hair and prevent fading from sun exposure.

BENEFITS OF HERBAL HAIR SERUM: -

- **Stimulates Hair Growth:** Rosemary contains **carnosic acid** and **ursolic acid**, which improve blood circulation in the scalp and reawaken dormant hair follicles. Research suggests these natural extracts can be as effective as **2% minoxidil** in increasing hair count without the common side effect of scalp itching.
- **Reduces Hair Fall and Breakage:** By strengthening the hair shaft and root interface, herbal serums significantly reduce shedding. Rosemary specifically helps block **DHT**, a hormone linked to follicle miniaturization and pattern baldness.
- **Improves Scalp Health:** These serums possess potent **antifungal and antibacterial properties** that combat dandruff and soothe scalp irritation. Coconut oil's lauric acid helps maintain a balanced scalp pH (ideal range: 4.5–5.5), which keeps the hair cuticle closed and minimizes damage.
- **Deep Nourishment and Shine:** Unlike synthetic serums that merely coat the hair for temporary gloss, herbal versions penetrate deep into the scalp and roots. Ingredients like coconut oil and aloe vera provide lasting hydration, making hair softer, smoother, and more manageable.

Advantages over Synthetic Serums

Feature	Herbal Hair Serum	Synthetic/Chemical Serum
Active Ingredients	Botanical extracts (Rosemary, Amla, Bhringraj)	Silicones, Parabens, Sulfates
Side Effects	Minimal risk of irritation; hypoallergenic	Potential for scalp buildup, dryness, and rashes
Sustainability	Biodegradable and eco-friendly	May contain non-biodegradable chemicals
Long-term Impact	Improves hair health from within over time	Provides instant but superficial gloss

Specialized Benefits

- **Anti-Greying:** Rosemary and melanogray extracts help boost melanin production, potentially slowing the onset of premature greying.
- **Protection:** Serums act as a thin protective layer against environmental aggressors like **UV radiation, dust, and pollution**, as well as damage from heat styling tools.

These articles discuss the benefits of herbal hair serums, highlighting rosemary's role in promoting hair growth and overall scalp health:

HOW TO APPLY SERUM: -

1. **Preparation:** Shake the bottle well to ensure the rosemary extracts and carrier oils are perfectly blended. If the serum contains virgin coconut oil, it may solidify in temperatures below 24°C; if so, warm the bottle in your hands or under warm water until it liquefies.
2. **Scalp Application:**
 - ✓ Part your hair into sections using a comb.
 - ✓ Apply **3 to 5 drops** of the serum directly to the scalp or onto your fingertips.
 - ✓ Focus on areas with noticeable thinning or hair loss (e.g., temples or the crown).
3. **Massage:** Use your fingertips to massage the serum into your scalp using gentle, circular motions for **5 to 10 minutes**. This stimulates blood circulation, which helps the active compounds like carnosic acid penetrate deeper.
4. **Length Distribution:** Take a small amount of the remaining serum and run it through the lengths of your hair to provide a protective coating and reduce frizz.
5. **Duration:**
 - ✓ **For Deep Treatment:** Leave the serum on for at least **2 to 4 hours** or overnight before washing.
 - ✓ **For Styling:** Apply 1–2 drops to damp or dry hair to manage flyaways and add shine.

Frequency and Consistency

For 2025 clinical standards, consistency is more important than quantity:

- **For Hair Growth:** Use **3 to 4 times per week**.
- **Results Timeline:** Significant improvements in hair density and thickness are typically observed between **90 to 180 days** of consistent use.

Usage Tips

- **Avoid Overuse:** A few drops are sufficient. Over-applying can lead to a greasy scalp and may clog follicles.
- **Patch Test:** Always perform a 24-hour patch test on the inside of your elbow before the first application to check for sensitivity to rosemary essential oil.
- **Post-Wash:** For best absorption, apply to a clean scalp that is free of product buildup.

For more information on the benefits and usage of rosemary oil for hair loss, visit the American Academy of Dermatology (AAD).

Safety and Stability Parameters: -

These evaluations ensure the product maintains its quality over time and is safe for human use.

- **Stability Studies:** The serum is stored under various temperature and humidity conditions (e.g., 4°C, 25°C, 40°C) for an extended period (e.g., 3 months) to monitor changes in physical appearance, pH, and viscosity.
- **Skin Irritation Test/Sensitivity Test:** Often conducted on animal models (e.g., rabbits) or human volunteers to check for erythema (redness) or edema (swelling) after application.
- **Microbial Contamination Test:** Standard culture methods are used to ensure the serum is free from harmful bacteria, yeast, and molds, which is crucial for product safety.

Efficacy (In Vitro and In Vivo) Parameters

These tests quantify the hair serum's performance in promoting hair health and growth.

- **Hair Growth Activity:** In vivo studies on animal models (e.g., C57BL/6 mice) or clinical trials on human volunteers measure:
- ✓ **Hair Length and Weight:** Significant increases compared to control groups (water or plain oil) and sometimes even standard treatments like 2% minoxidil.
- ✓ **Hair Density and Thickness:** Measured using specialized tools like TrichoScan®.
- ✓ **Anagen to Telogen Ratio:** Histological studies of skin sections are used to observe the induction of the anagen (growth) phase in hair follicles.
- **Scalp Health:** Assessed for a reduction in dandruff, itching, and inflammation, and antimicrobial assays are performed to confirm activity against relevant pathogens.
- **User Satisfaction/Sensory Evaluation:** Volunteer studies gather subjective feedback on the serum's scent, texture, effectiveness in controlling frizz, shine, and overall satisfaction

Conclusion: -

Final Synthesis of Findings

- **Benefits of Ingredients:** Rosemary and coconut oil can offer benefits for hair and scalp health. Some studies suggest rosemary oil may support hair growth, and coconut oil is known for its moisturizing properties and ability to protect hair from protein loss [1].
- **Scalp Health:** These ingredients can contribute to a healthy scalp environment. Rosemary oil has some antimicrobial properties which may help with scalp conditions, and coconut oil provides nourishment [1].
- **Potential for Natural Approaches:** Exploring natural ingredients like rosemary and coconut oil can be part of a holistic approach to hair and scalp care.

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