



eISSN 2036-7406

Dermatology Reports

<https://www.pagepress.org/journals/index.php/dr/index>



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Chirurgica, Oncologica, Correttiva ed Estetica

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Please cite this article as:

Almutairi AG, Altheyab FY, Alhawsawi W, et al. Review on natural remedies for hair growth promotion with a focus on rosemary. Dermatol Rep 2026 [Epub Ahead of Print] doi: 10.4081/dr.2026.10368

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Submitted 23/03/25 - Accepted 13/12/25

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Review on natural remedies for hair growth promotion with a focus on rosemary

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Key words: alopecia; drug efficacy; drug safety; natural remedies; hair growth; rosemary; *Rosmarinus officinalis*.

Contributions: Atheer G. Almutairi: conceptualization, methodology, formal analysis, writing – original draft; Fatimah Y. Altheyab: writing – original draft; Waseem Alhawsawi: writing – review & editing, formal analysis support; Asem Shadid: Writing – review & editing, formal analysis support; Azzam Alkhalifah: writing – review & editing (critical revisions). All authors have read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Conflict of interest: the authors have no conflict of interest to declare.

Ethics approval and consent to participate: not applicable.

Acknowledgments: the researchers would like to thank the Deanship of Graduate Studies and Scientific Research at Qassim University for financial support in publication (QU-APC-2025).

Abstract

The increasing prevalence of hair loss, particularly among men, has led to a growing interest in natural remedies. Among these, *Rosmarinus officinalis* leaf extract (rosemary) has gained attention for its potential hair growth-promoting properties. This review examines the efficacy of some natural remedies, with a focus on rosemary extract, in stimulating hair growth in patients with androgenetic alopecia (AGA). In contrast to conventional treatments like minoxidil and other chemical remedies, which often come with undesirable side effects such as scalp irritation, systemic effects, and potential dependency, rosemary offers a more natural alternative with fewer adverse effects. Using both *in vitro* and *in vivo* models, the research assesses the extract's efficacy in enhancing hair follicle proliferation and extending the anagen phase of hair growth. Clinical trials demonstrated significant improvements in hair density and thickness among participants using rosemary extract compared to control groups. These findings suggest *R. officinalis* leaf extract may serve as a viable natural alternative for hair loss treatment, warranting further investigation into its mechanisms and long-term benefits. This review highlights the need for further research into natural remedies, as well as rosemary's long-term efficacy and safety, positioning it as a promising candidate for those seeking a safer approach to hair restoration.

Introduction

Several factors influence hair growth rate, including age, gender, hormones, and genetics. Hormonal changes, such as those associated with polycystic ovary syndrome, menopause, and thyroid disease, can slow hair growth. Nutrient deficiencies (*e.g.*, zinc, iron, or those caused by conditions like anorexia) can also negatively impact hair growth. Healthy hair growth depends on meeting the high metabolic needs of hair follicle cells, which require adequate vitamins and minerals.¹ Hair growth is a cyclical process with four distinct phases: active growth (anagen), shrinking (catagen), resting (telogen), and shedding (exogen). Each hair follicle goes through 10 to 30 of these cycles throughout its lifespan, independently of other follicles. While most people have around 100,000 scalp hairs, a normal shedding rate is 100 to 150 hairs per day (telogen phase). In healthy individuals, hair density and overall hair count remain relatively consistent because some hairs are actively growing while others are in the shedding or resting phases.²

In fact, hair thinning can be triggered by a variety of factors. To start with, temporary hair loss can result from things like severe infections, dietary restrictions, certain medications (including cytostatic drugs, contraceptives, anticoagulants, and antidepressants), extreme stress, malnutrition, and excessive chemical or mechanical hair treatments. Internal factors contributing to hair loss include immune system

problems, inflammation, thyroid disease, and hormonal shifts related to menopause or pregnancy. On the other side, permanent hair loss often occurs when hair follicles can no longer enter the growth phase, or due to various skin conditions. Key contributing factors to hair loss, in addition to genetic predisposition, include localized micro-inflammation, hormonal imbalances, and the breakdown of the extracellular matrix in the hair follicle bulb.³

The androgenic hormones, essential regulators of hair growth, are particularly responsible for the development of baldness in men. This condition is primarily triggered by dihydrotestosterone (DHT), which affects hair follicles, leading to their shrinkage and a reduced hair growth cycle.⁴ Baldness is more prevalent in people with more active 5 α -reductase (5 α R) enzymes in their hair follicles, which convert testosterone into the more potent androgen-signaling DHT.

DHT stimulates dermal papilla cells to produce transforming growth factor beta (TGF- β), a growth factor that affects androgen receptors in hair follicles. This leads to apoptosis (programmed cell death) and inhibits keratinocyte growth, ultimately causing hair follicle death. TGF- β also triggers inflammation and, under normal conditions, induces the catagen (transition) phase of hair growth. In balding scalps, increased 5 α R activity results in higher DHT levels and unregulated TGF- β signaling, contributing to the problem.⁵

Plants used for the treatment of hair loss

The topical utilization of herbal preparations offers a lot of benefits, such as fewer side effects, a wider activity spectrum, increased compliance, and a more accessible and affordable approach. Therefore, approximately 80% of the population in Arab societies utilizes herbs for medicinal purposes.^{6,7} Researchers are actively investigating medicinal plants and their active constituents as potential treatments for hair loss, particularly given concerns about existing synthetic therapies. The effectiveness of specific plants, active ingredients, and preparations in promoting hair growth has been assessed in pre-clinical and clinical investigations.⁸ Several natural products, including rosemary, green tea, ginseng, Aloe vera, olive, and saw palmetto, have demonstrated the potential to improve hair health and patient satisfaction. This efficacy stems from their ability to promote growth, increase density, and reduce shedding via anti-inflammatory effects, hormonal regulation, and enhanced scalp circulation.⁹ Natural remedies include *Allium sativum* L. (garlic), *Camellia sinensis* L. (green tea), *Cucurbita pepo* L. (pumpkin), *Curcuma aeruginosa* Roxb. (blue ginger), *Panax ginseng* C.A. Meyer (ginseng), *Serenoa repens* (W. Bartram) Small (palmetto), *Sophora flavescens* Aiton (sophora), *Trifolium pratense* L. (red clover), essential oils, procyanidins, and *Rosmarinus officinalis* L. (Lamiaceae), particularly rosemary.

***Allium sativum* L. (garlic)**

Traditional treatments for alopecia areata (AA) have included the utilization of garlic topically. A study evaluated the effectiveness of topical garlic extract in treating AA over a two-month period. Conducted between July 2006 and July 2007 at an outpatient clinic in Najaf, the study involved 10 participants (4 females and 6 males) aged between 10 and 45 years, with a mean age of 27. All participants completed the study, during which a total of 18 AA patches were treated. Remarkably, 100% of the patients responded positively to the treatment. Hair growth was observed in 44.4% of patches after two weeks, in 38.9% after four weeks, and in 16.7% after six weeks. However, there were some negligible side effects, including erythema in all patients, with 44.4% experiencing itching and 27.7% reporting a burning sensation.¹⁰ This improvement in AA is probably due to the irritation effect rather than hair growth stimulation. This effect is probably due to the sensitization effect of garlic rather than the stimulation of hair growth.

***Camellia sinensis* L. (green tea)**

Green tea, derived from the leaves of the *Camellia sinensis* evergreen plant, originated in China and is now associated with many Asian countries and the Middle East. Its leaves contain various catechins, including gallic acid, epigallocatechin gallate (EGCG), epicatechin, epigallocatechin gallate, and catechin. Because hair follicles are essential for hair growth, the catechin polyphenol EGCG, found in green tea, is of interest due to its diverse biological activities. The antioxidant properties of green tea leaves may promote normal cell growth in epidermal keratinocytes. EGCG has been shown to stimulate hair follicle growth at concentrations between 0.5 and 2.5 μM . This growth promotion may be attributed to increased proliferation of dermal papilla cells and outer root sheath cells via activation of the Sonic Hedgehog and AKT signaling pathways.¹¹

***Cucurbita pepo* L. (pumpkin)**

Pumpkin seeds are rich in various compounds, including phytosterols, lutein, beta-carotene, beta and gamma-tocopherols, squalene, and fatty acids, all of which are found in pumpkin seed oil. Some studies suggest that pumpkin seed oil may be effective in managing the symptoms of benign prostatic hyperplasia. This potential benefit is likely due to phytosterols, which have shown 5 α R inhibition and anti-androgenic effects in rats. While increasing evidence from animal studies suggests that 5 α R can be inhibited, the exact mechanism of action is still not fully understood.⁸

***Curcuma aeruginosa* Roxb. (blue and pink ginger)**

C. aeruginosa is a plant closely related to turmeric and originated in India and South Asia, instead of ginger. The term “blue and pink ginger” is derived from blueish rhizomes and the pink corolla lobes of the plant. In Eastern medicine, the rhizome of *C. aeruginosa* is traditionally employed to manage a variety of conditions, such as fungal infections, as well as dysmenorrhea. The process by which testosterone is converted to DHT is more effectively inhibited by the 5% hexane extract of *C. aeruginosa* rhizomes *in vitro* studies than by other plants in the family of Zingiberaceae. This plant’s sesquiterpenes combat androgenic alopecia by reducing DHT and 5 α R production. Its essential oil contains several active ingredients, including curserenone, camphor, 1,8-cineole, iso-curcumenol, and curcumenol. The primary sesquiterpenoid, germacrone, has demonstrated anti-androgenic and anti-inflammatory effects both in laboratory and animal studies. Interestingly, this plant (*C. aeruginosa*) has been shown to inhibit underarm hair growth in women, while potentially promoting scalp hair growth in men.¹²

***Panax ginseng* C.A. Meyer (ginseng)**

Panax, a genus of slow-growing perennial plants in the Araliaceae family, comprises 11 species. These plants have fleshy roots rich in ginsenosides and are typically found in the colder climates of eastern Asia, including eastern Siberia, northern Korea, China, and parts of Russia. Ginseng, derived from these plants, is used in traditional medicine to enhance strength, endurance, and vitality, as well as to stimulate the immune system due to its perceived healing properties.¹³ The Japanese pharmacopoeia recognizes two types of ginseng root: red and white. These differ in processing methods, with red ginseng believed to contain a higher concentration of active ingredients, resulting in a stronger physiological effect. Koreans have traditionally used ginseng to promote hair growth and prevent hair loss, particularly red ginseng root, which is thought to be effective against androgenic alopecia. The healing properties of *P. ginseng* are attributed to saponin glycosides, especially ginsenosides. These compounds can both stimulate and inhibit the central nervous system and enhance both humoral and cell-mediated immunity. Furthermore, research suggests that ginsenosides have anti-proliferative properties, indicating potential anti-cancer activity.¹⁴

***Serenoa repens* (W. Bartram) Small (palmetto)**

Although saw palmetto, a type of palm tree, is well-studied for its use in treating benign prostatic hyperplasia, its effects on hair loss (alopecia) are less established. The fruit’s dry extract contains

flavonoids and phytosterols, which reduce androgen activity in two ways. Directly, they target androstenediol cytoplasmic receptors and DHT. Indirectly, they inhibit two types of 5 α R. Saw palmetto also activates estrogen receptors, which then stimulate cell division in the hair matrix by activating adenylate cyclase. This helps maintain the hair growth (anagen) phase and regulates the transition to the resting (catagen) phase.¹⁵

***Sophora flavescens* Aiton (sophora)**

An evergreen bush, a member of the Fabaceae family, *S. flavescens* is a thriving species in the Pacific region, Asia, and Oceania. The plant is composed of 3.3% alkaloids and 1.5% flavonoids. Owing to its antimicrobial and anti-cancer properties, as well as its apoptogenic effects and vasodilatory properties, it has been employed for a long time in oriental medicine to treat a variety of illnesses. It has been traditionally utilized to promote hair growth and treat skin diseases due to its anti-inflammatory properties.¹⁶

Studies have shown that a fibroblast growth factor directly affects hair follicle development in lab settings. Similarly, insulin-like growth factor (IGF) promotes growth in follicular tissue and epithelial cells. Dermal papilla cells are crucial for hair growth, and they communicate directly with the follicular epithelium via keratinocyte growth factor (KGF). Both KGF and IGF-1 are important growth factors in this process.¹⁷

A six-month, double-blind, randomized, and placebo-controlled study investigated the effects of *S. flavescens* extract on androgenic alopecia. The study used both *ex vivo* human hair follicle organ cultures and a human hair keratinocyte proliferation assay. In the organ cultures, the extract stimulated hair keratinocyte proliferation at a low concentration (0.1 ng/mL) and hair shaft elongation at a higher concentration (100 ng/mL). The *S. flavescens* root extract was found to be effective for managing androgenic alopecia. Two key compounds, medicarpin and L-maackiain (pterocarpan), were isolated and shown to stimulate epithelial cell growth.¹⁸

***Trifolium pratense* L. (red clover)**

Red clover, a member of the Fabaceae family, is commonly used as animal feed. In traditional medicine, it is used to treat various ailments, including fungal infections, depression, coughs, stomach inflammation, respiratory issues, and chronic skin conditions like eczema and psoriasis. Therapeutically, dried red clover flowers and extracts (primarily alcohol-water-based) are used. These contain active

compounds such as coumarin derivatives, cyanogenic glycosides, isoflavonoids (phytoestrogens), and an essential oil containing aromatic alcohols.⁸

In vitro investigations of phytoestrogen flavonoid, biochanin A, have demonstrated that numerous other polyphenols can inhibit 5 α R activity. This inhibitory effect is thought to be stronger than that of EGCG found in green tea. Studies have shown that biochanin A is more effective than EGCG at inhibiting both type I and type II isoforms of the 5 α R enzyme in living cells. While both isoforms are present in the scalp, it is the type II isoform that is primarily responsible for male pattern baldness.¹⁹

Essential oils

The essential oils of thyme (*Thymus vulgaris* L.), rosemary (*R. officinalis* L.), Atlas cedar (*Cedrus atlantica* (Endl.) Manetti ex Carrière), and lavender (*Lavandula agustifolia* Mill.) have been utilized to manage alopecia for over a century. A 1998 double-blind, randomized study investigated the effectiveness and safety of four essential oils for treating AA (spot baldness). Participants applied the essential oil blend to their scalps nightly for two minutes over seven months, using a warm towel to aid absorption. The essential oil treatment was significantly more effective compared to the control group, which used a grapeseed and jojoba oil mixture. However, some control group participants withdrew early due to the study's length, and individuals with more severe hair loss were excluded from the research.⁸ The Lamiaceae family includes the evergreen bush known as common rosemary (*R. officinalis*). As mentioned previously, rosemary essential oil is frequently mentioned as a potential treatment for androgenic alopecia. This medicinal plant has a variety of impacts, such as the enhancement of microcapillary circulation. This herb is used in traditional medicine to treat digestive issues, promote hair growth, and improve circulation in the female reproductive system. Its essential oil, which makes up 1.5-2.5% of the herb, mainly contains borneol, cineol, camphene, and camphor.²⁰

Procyanidins

Procyanidins, a class of polyphenols, possess a diverse range of pharmacological properties. In laboratory studies, they have shown antioxidant, antifungal, antiviral, and anti-allergic activities, as well as the ability to scavenge free radicals. Procyanidins are also used in medications for capillary protection and in cosmetics as skin protectors. Furthermore, research has shown they can stimulate hair growth.²⁰ Procyanidins are believed to promote the transition to the catagen (resting) phase of hair growth and to counteract the effects of TGF- β , a molecule that inhibits hair growth. Inflammation and lipid peroxidation can also negatively impact hair growth; studies have linked inflammation to male pattern baldness, with

biopsies of affected hair follicles showing increased lymphocyte infiltration. Procyanidins may help prevent this inflammatory response.²¹

Medical usage of rosemary

Rosemary (*R. officinalis* Albus, Lamiaceae) is currently considered one of the most important medicinal and ornamental plants in the world. For several years, rosemary has been cultivated and utilized in phytocosmetics, cosmetics, and folk medicine due to its numerous health benefits, such as being an anti-tumorigenic herb, anti-inflammatory, antibacterial, antioxidant, and anti-apoptotic. In conventional medicine, rosemary extract is employed to address a variety of conditions, including neurological illnesses, chronic fatigue, urinary tract infections, peripheral vascular issues, and hair loss. Furthermore, for a long time, rosemary has been used as a diuretic, anti-inflammatory, emmenagogue, expectorant, choleric, rubefacient, tonic, antispasmodic, and diaphoretic. In other words, rosemary has been found to contain a range of phytochemicals, such as terpenoids, flavonoids, and polyphenols. The health-promoting properties and antioxidants of rosemary plants are causing them to gain popularity.^{22,23}

In vitro and *in vivo*, the review article published by de Macedo *et al.* examined a variety of its medicinal (antifungal, anti-inflammatory, transdermal drug delivery, antimicrobial, skin flap survival, wound healing, and skin cancer) and cosmetic (alopecia, ginoid lipodystrophy, ultraviolet protection, and antiaging) abilities. Terpenes, polyphenols, and flavonoids were identified as the compounds responsible for these therapeutic activities, as they are secondary metabolites of rosemary. These metabolites were characterized using chromatographic techniques.²⁴

A 90-day, double-blind, randomized, placebo-controlled clinical trial confirmed the potent efficacy of rosemary in promoting hair health. When formulated with either lavender or castor oil, rosemary-based treatments significantly outperformed coconut oil over 90 days, yielding dramatic and statistically significant improvements ($p < 0.0001$) in hair growth rate, thickness, density, and length, alongside substantial reductions in hair fall. The growth rate improved by approximately 57.7% (rosemary-lavender) and 47.6% (rosemary-castor), while hair thickness increased by 68.7% and 66.1%, respectively. The conclusion highlights rosemary formulations as a promising, safe, and effective plant-based option for promoting hair regrowth by optimizing the hair growth cycle.²⁵

Alopecia

Androgenetic alopecia (AGA), also known as pattern baldness (male or female), is the most frequent type of hair loss.²⁶ Although AGA is highly prevalent, it can be challenging to treat due to its chronic

nature and the complex interactions between genetic and environmental factors. Currently, the US Food and Drug Administration (FDA) approves only two medications for AGA: topical minoxidil and oral finasteride.²⁷ However, both of them have undesirable side effects. For example, users of oral finasteride may experience sexual dysfunction and depression; however, these side effects resolve upon discontinuation of the drug.²⁸ Likewise, using minoxidil, which is inexpensive, can lead to headaches, hypertrichosis, and contact dermatitis. The higher the dose, the more severe the side effects.²⁹ Consequently, AGA patients opt for natural therapies, such as rosemary, to avoid such side effects. Traditionally, individuals in the African diaspora have used oils to encourage hair growth, and today, applying hair oils directly to the scalp for the treatment of alopecia is becoming more popular.²⁶

Rosemary shows promise as a treatment for alopecia by potentially stimulating hair follicles and improving scalp circulation, which could lead to hair regrowth. A study on C57BL/6 mice with testosterone-induced alopecia found that topical treatment with rosemary hydroalcoholic extract (2 mg/day/animal) significantly increased hair growth after 16 days compared to the control group. Further *in vitro* testing of the hydroalcoholic extract showed a significant inhibition of DHT binding to its receptor, suggesting a decrease in 5 α R enzyme activity. Another *in vitro* study using human prostate LNCaP cells indicated that 12-methoxy-sarcosalic acid is a key factor in reducing DHT/receptor binding and 5 α R enzyme activity.³⁰

A more recent study found that in an animal model of testosterone-induced alopecia, the topical application of standardized rosemary extract (at 3% and 5%) significantly promoted hair growth over 21 days, paralleling the positive effects observed with the finasteride reference standard. Specifically, the rosemary extract demonstrated notable improvements in all measured hair follicle parameters, particularly resulting in a marked increase in hair follicle density. These findings support the use of standardized rosemary extract as a promising natural intervention for treating AGA by enhancing key follicular characteristics.³¹

The formulation and evaluation of a 1% herbal hair lotion containing an extract of *R. officinalis* were conducted. The formulation's flawlessness is assessed through organoleptic evaluations. A 1% herbal hair lotion containing *R. officinalis* extract was formulated and evaluated. Organoleptic testing confirmed the lotion's quality, noting its pleasant odor and color. The preparation had a smooth texture, free of gritty particles, and acceptable organoleptic properties. The lotion's pH is crucial for hair health, as it can affect breakage and damage. A slightly acidic pH, like that of the 1% lotion, is important for improving hair quality, maintaining scalp balance, and minimizing irritation. This pH level helps prevent inflammation, tightens the hair cuticles for shine, and reduces the risk of damage.³²

The pH of the 1% hair lotion was 6.82, which is similar to the pH of the skin. Animals' hair treated with the 1% herbal hair lotion exhibited a healthy & shiny texture in comparison to the hair of the control and standard-treated animals. C57BL/6 male mice were subjected to a patch test to assess skin irritancy. The hair lotion was found to be entirely free of edema or any primary skin sensation, irritation, or erythema, as evidenced by the results obtained after 72 hours of utilization. An elevation in its globule size indicates the physical instability of a prepared emulsion.³³

The 1% hair lotion maintained a consistent globule size between the first and third weeks of the study, demonstrating its stability. Viscosity, a measure of a fluid's internal friction, is significant for product acceptability and effectiveness. A product's viscosity influences how easily it cleanses and how consumers perceive it, thereby affecting patient compliance.³⁴

The 1% herbal hair lotion was evaluated for viscosity. While it was found to be sticky, causing it to adhere to hair and demonstrate activity, the viscosity was within acceptable limits, and no hair irritation was observed. Fourier transform infrared analysis of the 1% lotion, a physical mixture of its components, the excipients alone, and the crude extract alone showed consistent C-C and CH₃ peaks at the same wavelengths. This confirms that no interaction occurred between the drug (crude extract) and the excipients. The invasive outcomes obtained suggest that the lotion spreads rapidly with a moderate amount of shear. Compared with the conventional 2% minoxidil hair lotion, this formulation exhibited a stronger hair growth-promoting effect. Animals treated with the 1% herbal hair lotion showed a faster onset of action and earlier completion of hair growth. The control and standard drug groups showed significantly inferior hair appearance, quality, weight, and length. In contrast, the test lotion significantly increased total protein content in the treated animals, promoting finer, shinier, and healthier hair growth. Phytochemical screening revealed that the extract contains phenolic compounds, flavonoids, alkaloids, saponins, and volatile oils. These constituents likely contribute to the extract's observed hair-promoting effects.³⁵

Rich in phytochemicals such as flavonoids, polyphenols, and terpenoids, rosemary is believed to enhance circulation in the scalp, reduce inflammation, and stimulate hair follicles. This natural herb may also combat oxidative stress, a factor linked to hair loss.

A number of studies have examined the effect of rosemary on hair growth compared to other chemical remedies. In 2014, Panahi *et al.* conducted an investigation to evaluate the clinical efficacy of rosemary oil in the six-month management of androgenic alopecia, in comparison to that of 2% minoxidil. A randomized, comparative study evaluated the substance's efficacy at the initiation, three months later, and six months later. Microphotography has been used to assess baldness. After three months of

treatment, in both groups, the average number of hairs remained constant. However, after six months of therapy, both groups exhibited an elevation in the number of hairs. The therapy was observed to have a side effect of scalp itching, with the minoxidil group experiencing slightly more severe itching. Neither minoxidil nor rosemary oil treatment affected hair greasiness or dryness, nor did they reduce dandruff.³⁶ Another case report presented an alternative treatment approach for a 26-year-old male patient diagnosed with AGA, who opted for a natural solution due to concerns about medication side effects. The patient underwent a six-week regimen that included scalp hygiene with natural cosmetics, electrotherapy, microneedling, and the topical application of a blend of essential oils (rosemary, lavender, peppermint, cedar, and juniper berry) at a 25% concentration. The treatment, which involved both in-clinic procedures and at-home applications, resulted in noticeable hair regrowth and improved scalp health with no reported adverse effects. This case highlights the potential of essential oils as a safe and effective alternative to traditional treatments for hair loss, suggesting their ability to modulate hormonal activity and reduce inflammation.³⁷

Topical application of *R. officinalis* leaf extract (RO-ext, 2 mg/day/mouse) significantly improved hair regrowth in C57BL/6NCrSlc mice with testosterone-induced hair loss and also stimulated hair growth in shaved C3H/He mice. Investigating the mechanism of RO-ext's antiandrogenic activity, researchers focused on its inhibition of testosterone 5 α R, a key target in androgenic alopecia treatment. RO-ext demonstrated inhibitory activity of 82.4% and 94.6% at concentrations of 200 and 500 μ g/mL, respectively. Activity-guided fractionation identified 12-methoxycarnosic acid as the active component responsible for this inhibition. Furthermore, *R. officinalis* extract and 12-methoxycarnosic acid inhibited androgen-dependent LNCaP cell proliferation by 64.5% and 66.7%, respectively, at 5 μ g/mL and 5 μ M, suggesting a reduction in DHT binding to androgen receptors. These findings indicate that RO-ext is a promising natural treatment for hair growth.³⁰

This research successfully tackled the limited skin permeability of rosemary oil by formulating and optimizing rosemary oil-loaded microsponges (ROSMS), achieving a highly efficient delivery system with 99.6% encapsulation and controlled release. Crucially, the optimized microsphere gel (OPT-ROSMS-gel) demonstrated a three-fold increase in follicular retention compared to a pure ROS-gel during *ex vivo* testing. The *in vivo* studies confirmed the therapeutic superiority of this delivery innovation, showing that the OPT-ROSMS-gel enhanced hair development in length, thickness, and bulb diameter, outperforming pure ROS-gel and minoxidil by approximately 1.2 and 1.5 times, respectively. This enhanced efficacy is mechanistically supported by a nearly two-fold increase in β -catenin levels, indicating that the improved delivery system enables rosemary oil to more effectively activate the Wnt

signaling pathway critical for hair growth. In conclusion, microsponges emerge as a highly promising delivery method for rosemary oil, realizing its potential as a superior natural treatment for hair loss by significantly boosting its efficacy over standard applications and minoxidil.³⁸

One more study aimed to enhance the efficacy of the anti-androgenic drug metformin for treating AGA by formulating it into a novel delivery system. Utilizing rosemary oil as the oily phase – selected specifically for its known ability to increase blood flow and promote hair growth – researchers developed an optimized, stable metformin-loaded nanoemulsion via Box-Behnken design. This nanoemulsion was incorporated into a hydrogel to create a rosemary-based nanoemulgel. The optimized formulation exhibited ideal physicochemical properties, including a small globule size (125.01 nm) and a high drug content (92.9 %). Critically, the *in vivo* study demonstrated that the formulated nanoemulgel significantly increased the number of hair follicles in a rat model compared to controls, concluding that this rosemary-based nanosystem is a highly promising approach for effective AGA treatment.³⁹

Although Rosemary has proven its effectiveness in treating AGA, some studies indicated some side effects. A double-blind randomized controlled clinical trial involved 42 patients with scalp seborrheic dermatitis, divided into two groups: one receiving rosemary lotion and the other receiving ketoconazole lotion. In the rosemary group, two patients withdrew from the study due to scalp burning and itching. Additionally, two individuals reported discomfort with the scent of the lotion but chose to remain in the study because they found it effective.⁴⁰

Another finding that might put some patients off while using rosemary is early graying. According to a cross-sectional online survey conducted in Saudi Arabia between July 2023 and February 2024 to identify risk factors associated with having gray hair before the age of 30, the use of rosemary for hair loss was reported by 54.0% of respondents, while 36.3% noted experiencing gray hair following its use.⁴¹ However, one of the findings of an open-label, single-arm, prospective interventional study designed to evaluate the safety and efficacy of a proprietary hair serum containing several synergistic ingredients, including rosemary oil, alongside bio-actives like Redensyl™, AnaGain™, and MelanoGray™, was inconsistent concerning the early graying. The study aimed to assess the effect of rosemary oil in addition to other bio-actives on hair growth, follicular activity, and graying severity over 120 days. The treatment led to a major shift in the growth cycle, shown by a 48.26% improvement in the Anagen:Telogen (A:T) ratio, fostering an environment for sustained growth. Key physical parameters also saw substantial gains: hair thickness increased by 80.85%, hair density improved by 37.92%, and the rate of hair growth was enhanced by 46.71%. Crucially for individuals dealing with loss, the treatment successfully reduced hair fall by 64.89%. Furthermore, a significant anti-graying effect was noted, with the Graying Severity Score

improving by 64.89%. Overall, the statistically significant results ($p < 0.001$) confirmed the serum's favorable safety profile and high efficacy in enhancing growth, improving follicular health, and addressing early signs of graying.⁴²

A systematic review identified 141 unique studies confirming the efficacy of a comprehensive array of hair loss treatments for AGA. These effective options include over-the-counter, topical, oral prescription, and procedural modalities. The analysis concluded that the successful promotion of hair growth is best achieved through a superior, multifaceted, and personalized management strategy.⁴³

Some studies aimed to detect the awareness of people concerning the use of rosemary for medical reasons. For example, a cross-sectional study surveyed 407 participants via social media platforms (mean age 30.98 years) to evaluate their knowledge and attitudes regarding rosemary use, utilizing a validated questionnaire distributed via social media. The findings indicated that while general knowledge of rosemary was moderate (mean score 2.96), almost half of the respondents (48.2%) reported using it for medical purposes. The study highlighted a strong public affinity for herbal remedies, with 94.4% agreeing that plants possess healing power. Crucially, the most cited reason for using rosemary was to improve hair condition (82.1%). The study concluded with the need to address any widespread misconceptions.⁴⁴

A 2025 systematic review assessed the efficacy and safety of several herbal remedies, such as rosemary, for treating various forms of hair loss, including AGA. The literature suggests that these natural agents exhibit potential benefits by employing diverse mechanisms such as 5 α R inhibition and increasing microcapillary blood flow, and modulation of hair growth pathways. While these herbal remedies are promising, the review highlights significant limitations in the current evidence base, including small sample sizes and insufficient long-term follow-up, concluding that further large-scale, well-designed randomized trials are necessary to confirm their clinical efficacy and safety.⁴⁵

Conclusions

Rosemary is typically considered safe when consumed in recommended doses, though there have been occasional reports of allergic reactions. Due to its volatile oil content, consuming large amounts of rosemary leaves can result in serious side effects, including spasms, vomiting, coma, and, in some cases, pulmonary edema. In addition, because high doses of rosemary may lead to miscarriage, pregnant and breastfeeding women should avoid rosemary supplements. Moreover, those with ulcers, high blood pressure, Crohn's disease, or ulcerative colitis should not use rosemary.⁴⁶

In conclusion, the efficacy and safety of botanical extracts remain areas of growing interest. These data support their use; however, there is currently no strong evidence, and further studies are needed. Moreover, there is a considerable shortage of medical resources that provide information on using natural remedies practices. As for rosemary, it has shown promising efficacy in the treatment of AGA, with outcomes comparable to those of minoxidil. Its benefits are thought to derive from improved blood circulation and vascularization, as well as from the stimulation of hair follicle regeneration. Nevertheless, further high-quality studies are required to confirm and better characterize the therapeutic potential of rosemary oil in the management of AGA. Although several natural remedies appear promising for hair loss, additional research is necessary to clearly define their indications, efficacy, and safety.

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