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## Review Paper

# Natural Hair Growth Actives in The Market: A Comprehensive Review

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## ABSTRACT

### Background:

Alopecia, particularly androgenetic alopecia, is a common dermatological condition associated with considerable psychological distress. While pharmacological treatments such as minoxidil and finasteride remain standard therapies, concerns regarding long-term safety, adverse effects, and patient adherence have driven increasing interest in natural hair growth actives. Objective: This review critically evaluates natural hair growth actives relevant to the 2025–2026 marketplace, emphasizing their classification, mechanisms of action, clinical efficacy, formulation challenges, and patient-centered outcomes. Methods: Relevant experimental, clinical, and market-based literature was analyzed to categorize botanical extracts, essential oils, peptides, vitamins, and patented biotechnological complexes. Mechanistic pathways, safety considerations, and delivery limitations were systematically assessed. Results: Natural actives exhibit multi-targeted mechanisms, including dihydrotestosterone inhibition, hair follicle stem cell activation, growth factor modulation, and enhancement of scalp microcirculation. Botanicals and peptide-based complexes demonstrate favorable safety profiles and high patient acceptance. However, formulation instability, limited follicular penetration, and variability in product standardization remain key challenges affecting real-world effectiveness. Conclusion: Natural hair growth actives have emerged as viable alternatives to conventional therapies. Advances in formulation technologies, personalized treatment strategies, and sustainable sourcing are expected to further enhance their clinical relevance in alopecia management.

## INTRODUCTION

Alopecia, particularly androgenetic alopecia (AGA), affects approximately 50% of men and 40% of women by the age of 50, presenting a substantial psychological and cosmetic burden [1].

While FDA-approved pharmacological interventions such as minoxidil and finasteride remain the gold standard, their application is often limited by side effects ranging from scalp irritation to systemic hormonal disturbances [2, 3]. Consequently, the demand for natural, botanical,

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and biotechnologically derived hair growth actives has surged, with the global market for hair loss products expected to exceed \$14 billion by late 2026 [3]. Modern research has validated the traditional uses of various plant extracts, identifying specific phytochemicals that target the molecular pathways of hair loss [4]. Unlike earlier herbal remedies lacking standardization, the current market generation of natural actives—termed "cosmeceuticals"—are supported by rigorous *in vitro* and *in vivo* studies demonstrating efficacy comparable to synthetic drugs [1, 10]. This review categorizes these actives, elucidates their molecular mechanisms, and critically assesses the clinical evidence supporting their use in the 2025-2026 marketplace. Despite promising biological activity, the clinical performance of natural hair growth actives is often limited by formulation and delivery challenges. Many phytochemicals, including epigallocatechin gallate, ginsenosides, and flavonoids, exhibit poor aqueous solubility and low permeability across the stratum corneum, restricting their bioavailability at the hair follicle target site. Essential oils, while lipophilic and readily permeable, are volatile and chemically unstable, making them susceptible to oxidation and evaporation during storage. These factors complicate the development of stable, efficacious topical formulations [5]. Another major challenge is follicular targeting. The hair follicle represents a unique transappendageal route for drug delivery; however, conventional formulations often fail to retain actives within the follicular reservoir for a sufficient duration. Additionally, multi-ingredient formulations—common in cosmeceutical products—raise concerns regarding chemical incompatibility, degradation, and unpredictable synergistic or antagonistic interactions between actives.

Advanced delivery systems are increasingly employed to overcome these limitations. Nanocarriers such as liposomes, niosomes, solid

lipid nanoparticles, and phytosomes enhance stability, protect labile compounds, and improve follicular penetration. However, scale-up, cost, regulatory acceptance, and long-term safety of nanotechnology-based formulations remain unresolved challenges. Furthermore, achieving optimal pH, viscosity, and sensory characteristics without compromising efficacy is critical for consumer acceptability. Addressing these formulation hurdles is essential for translating promising *in vitro* activity of natural actives into consistent clinical outcomes. Hair loss pathophysiology and treatment response vary significantly across gender and age groups, necessitating a tailored approach to therapy. In men, androgenetic alopecia is primarily driven by dihydrotestosterone-mediated follicular miniaturization, making 5-alpha reductase inhibition a central therapeutic strategy. Consequently, natural actives such as saw palmetto, pumpkin seed oil, and biochanin A-containing extracts tend to exhibit greater relevance in male populations [2,6]. In contrast, female pattern hair loss is multifactorial, often involving hormonal fluctuations, reduced estrogen levels, microcirculatory impairment, and increased follicular sensitivity rather than absolute androgen excess. Women, particularly of reproductive age, frequently prefer natural actives due to safety concerns associated with long-term hormonal therapies. Botanicals that enhance microcirculation, reduce inflammation, and stimulate growth factors—such as rosemary oil, ginseng, and caffeine—are therefore more commonly favored in female-oriented formulations [3,4]. Age also plays a crucial role in therapeutic outcomes. Younger individuals generally demonstrate a higher proportion of viable follicles capable of responding to growth stimulation, whereas aging scalps exhibit reduced stem-cell activity, diminished vascularization, and increased oxidative stress. Natural actives with

antioxidant and stem-cell-activating properties may partially counteract these age-related changes, although response rates tend to decline with advanced follicular miniaturization. Understanding gender- and age-dependent differences is essential for optimizing treatment selection and improving real-world effectiveness of natural hair growth therapies [7].

## 2. Classification of Natural Hair Growth Actives

### 2.1 Botanical Extracts

#### 2.1.1. Rosemary Oil (*Rosmarinus officinalis*):

Rosemary oil has emerged as a premier natural alternative to minoxidil. It contains 1,8-cineole, camphor, and alpha-pinene, which are believed to improve microcirculation and reduce inflammation [11]. A landmark comparative clinical trial demonstrated that standardized rosemary oil was as effective as 2% minoxidil in increasing hair count after six months of use [3].

**2.1.2. Saw Palmetto (*Serenoa repens*):** The liposterolic extract of Saw Palmetto berries is rich in fatty acids and phytosterols (beta-sitosterol) [12]. It is widely recognized for its ability to inhibit the enzyme 5-alpha reductase (5AR), thereby preventing the conversion of testosterone to dihydrotestosterone (DHT), the primary androgen responsible for follicular miniaturization in AGA [12, 13].

**2.1.3. Green Tea Extract (*Camellia sinensis*):** Rich in epigallocatechin-3-gallate (EGCG), green tea extract stimulates human dermal papilla cells (DPCs) and inhibits 5AR activity [14]. Studies suggest that EGCG promotes hair growth by upregulating phosphorylated Erk and Akt signaling pathways and preventing apoptosis in follicle cells [14, 15].

**2.1.4. Ginseng (*Panax ginseng*):** Ginsenosides, the active saponins in ginseng, have been shown to promote hair growth by targeting the exogen phase and stimulating the anagen phase [16]. Specifically, Red Ginseng extract has been found to upregulate the expression of Vascular Endothelial Growth Factor (VEGF) in DPCs, enhancing follicular nutrition [16].

**2.1.5 Pumpkin Seed Oil (*Cucurbita pepo*):** This oil acts as a natural 5AR inhibitor. A randomized, double-blind, placebo-controlled trial reported a 40% increase in mean hair count in men treated with pumpkin seed oil over 24 weeks, compared to 10% in the placebo group [17].

### 2.2 Essential Oils

**2.2.1. Peppermint Oil (*Mentha piperita*):** Peppermint oil induces a rapid anagen stage. Animal studies have shown that topical application of 3% peppermint oil resulted in more prominent hair growth, increased dermal thickness, and greater follicle number and depth compared to 3% minoxidil [18].

**2.2.2. Lavender Oil (*Lavandula angustifolia*):** Known for its anti-inflammatory and antimicrobial properties, lavender oil has been shown to promote hair growth in murine models by increasing the number of hair follicles and deepening the follicle depth [19].

### 2.3 Patented Biotechnological Complexes

The 2025-2026 market is heavily influenced by proprietary complexes that combine botanical extracts with peptides:

**2.3.1. Redensyl®:** Composed of dihydroquercetin-glucoside (DHQG) and epigallocatechin gallate-glucoside (EGCG2), Redensyl targets hair follicle stem cells (ORSc) [20]. Manufacturer data and independent reviews suggest it provides better results than minoxidil by

reactivating stem cells and stimulating fibroblast metabolism [20, 21].

**2.3.2. Capixyl™:** A complex of Acetyl Tetrapeptide-3 and Red Clover extract (rich in Biochanin A). It modulates DHT levels by inhibiting 5-alpha reductase and stimulates extracellular matrix (ECM) protein synthesis for better hair anchoring [22].

**2.3.3. Procapil™:** This formulation combines vitaminated matrikine (biotinyl-GHK), apigenin (from citrus), and oleanolic acid (from olive trees). It targets poor scalp microcirculation, follicle aging, and follicle atrophy caused by DHT [23].

**2.3.4. Anagain™:** Derived from organic pea sprout extract, Anagain stimulates specific signal molecules (Noggin and FGF-7) in the dermal papilla to reactivate hair growth. Clinical studies indicate a 78% increase in hair growth coefficient within three months [24].

## 2.4 Peptides and Amino Acids

**2.4.1. GHK-Cu (Copper Tripeptide-1):** This naturally occurring copper complex has strong wound-healing and anti-inflammatory properties [25]. It stimulates the breakdown of unhealthy collagen and the synthesis of new collagen, enlarging hair follicles and prolonging the anagen phase [25, 26].

**2.4.2. Biotinoyl Tripeptide-1:** Often used in conjunction with other actives, this peptide helps to anchor the hair bulb in the follicle, reducing shedding and increasing the anagen/telogen ratio [23].

## 2.5 Vitamins and Phytochemicals

**2.5.1. Caffeine:** As a phosphodiesterase inhibitor, caffeine increases cAMP levels in cells and promotes proliferation [27]. It counteracts the

suppressive effects of testosterone on hair growth and stimulates hair shaft elongation in vitro [27, 28].

**2.5.2. Biotin (Vitamin B7):** While widely marketed, robust clinical evidence for biotin in healthy individuals is limited; however, it remains a critical cofactor for carboxylase enzymes involved in keratin synthesis [29].

## 3. Mechanisms of Action

The efficacy of natural actives relies on multimodal mechanisms that address the pathophysiology of hair loss:

### 3.1 DHT Inhibition and 5-Alpha Reductase Blocking

Androgenetic alopecia is primarily driven by DHT binding to androgen receptors in the dermal papilla. Phytochemicals like beta-sitosterol (Saw Palmetto), oleanolic acid (Procapil), and Biochanin A (Capixyl) function as competitive inhibitors of Types I and II 5-alpha reductase [12, 22]. This mechanism mirrors the pharmacological action of finasteride but typically with a localized effect and fewer systemic side effects [13, 30].

## 4. Hair Follicle Stem Cell Activation

Activating the quiescent stem cells in the bulge region of the hair follicle is crucial for initiating the anagen phase. Redensyl's active component, DHQG, has been shown to activate the Wnt/ $\beta$ -catenin signaling pathway, which acts as a molecular switch to trigger stem cell division and differentiation [20, 21].

### 4.1 Growth Factor Upregulation

Botanicals like Ginseng and EGCG upregulate key growth factors such as Vascular Endothelial Growth Factor (VEGF), Insulin-like Growth Factor-1 (IGF-1), and Keratinocyte Growth Factor (KGF) [14, 16]. VEGF is essential for



angiogenesis, ensuring the follicle receives adequate blood supply, while IGF-1 is critical for maintaining the anagen growth phase [16, 31].

## 4.2 Microcirculation Enhancement

Vasodilation improves nutrient and oxygen delivery to the hair bulb. Rosemary oil and Peppermint oil utilize terpenes (such as menthol and 1,8-cineole) to relax vascular smooth muscles and increase cutaneous blood flow, mimicking the mechanism of minoxidil [3, 18].

## 5. Clinical Evidence and Efficacy Studies

The shift from anecdotal use to evidence-based application is marked by several key studies. In 2015, a randomized comparative trial involving 100 patients with AGA compared Rosemary oil lotion against 2% minoxidil [3]. At the 6-month endpoint, both groups showed a significant increase in hair count ( $p \leq 0.05$ ), with no statistically significant difference between the two treatments, indicating comparable efficacy [3]. Similarly, a 24-week study on Pumpkin Seed Oil (400mg/day orally) demonstrated a 40% increase in hair count versus placebo [17]. Regarding patented complexes, clinical data for Capixyl™ showed a 15.6% increase in hair density and a 46% reduction in hair loss after four months of topical application in a cohort of 30 volunteers [22, 32]. However, gaps remain. While individual ingredients show promise, large-scale, long-term Phase III trials are less common for natural actives compared to pharmaceutical drugs [10]. Most data for patented complexes originate from supplier-funded studies, necessitating independent verification [21]. Patient compliance is a critical determinant of therapeutic success in hair loss management, particularly for chronic conditions such as androgenetic alopecia that require long-term treatment. Natural hair growth actives often demonstrate superior patient acceptance compared to conventional pharmacological agents due to

their favorable safety profiles and perception as “gentler” alternatives. Reduced incidence of adverse effects such as scalp irritation, sexual dysfunction, or systemic hormonal disturbances contributes significantly to sustained use [20].

Sensory attributes of formulations—including texture, fragrance, and non-greasy feel—also play an important role in adherence. Many botanical formulations benefit from naturally pleasant aromas and enhanced cosmetic elegance, which positively influence daily application habits. Additionally, the integration of hair growth actives into routine cosmetic products such as serums, shampoos, and leave-on treatments further improves compliance by minimizing treatment burden [21]. However, real-world effectiveness often differs from outcomes reported in controlled clinical trials. Natural actives typically require longer treatment durations, often three to six months, to produce visible improvements, which may lead to premature discontinuation if patient expectations are not adequately managed. Variability in product quality, concentration of active ingredients, and inconsistent application further contribute to heterogeneous outcomes [22]. Educational interventions, realistic counseling regarding treatment timelines, and personalized product selection based on scalp condition and hair-loss severity can substantially improve adherence. Thus, while natural actives offer high acceptability, optimizing real-world effectiveness depends on aligning patient expectations with evidence-based therapeutic outcomes [23].

## 6. Market Trends and Consumer Preferences 2025-2026

As of 2026, the “skinification” of hair care—treating the scalp with the same sophistication as facial skin—is a dominant trend [5]. Consumers are increasingly seeking “clean label” products free from sulfates, parabens, and synthetic drugs [33]. Market data indicates a 12% year-over-year





growth in the demand for plant-based hair serums [5]. There is a specific rise in the popularity of hybrid products combining traditional botanicals (like Rosemary) with high-tech peptides (like Redensyl), creating a "best of both worlds" approach [33]. Customization and AI-driven diagnostics are also shaping the 2026 market, with brands offering personalized natural formulations based on DNA or metabolic analysis [34].

## 7. Safety Profile and Limitations

A primary driver for natural actives is their favorable safety profile. The comparative study of Rosemary oil vs. minoxidil noted that the minoxidil group experienced significantly higher rates of scalp itching and pruritus [3]. Natural 5AR inhibitors like Saw Palmetto do not typically produce the sexual dysfunction side effects associated with oral finasteride [13]. However, limitations exist. Essential oils like Cinnamon or concentrated Peppermint can cause contact dermatitis or allergic reactions if not properly diluted [35]. Furthermore, the efficacy of topical natural actives is often dose-dependent and may require longer treatment durations (3-6 months) to show visible results compared to synthetic alternatives [1, 35]. The variability in phytochemical content due to plant sourcing and extraction methods also poses a challenge for standardization [36]. The growing demand for natural hair growth products has intensified concerns regarding ethical sourcing and environmental sustainability of botanical actives. Many plant-derived ingredients are obtained from limited geographical regions, raising the risk of overharvesting and ecological imbalance. Unsustainable extraction practices not only threaten biodiversity but also compromise long-term supply chain stability [37].

Ethical considerations extend beyond environmental impact to include fair trade practices and socioeconomic implications for local

farming communities. Transparent sourcing, fair compensation, and community-based cultivation programs are increasingly viewed as essential components of responsible cosmeceutical development. Consumers in the 2025–2026 market demonstrate heightened awareness of these issues and increasingly favor brands that prioritize ethical responsibility. From a manufacturing perspective, green extraction technologies—such as supercritical fluid extraction, enzymatic extraction, and solvent-free processes—are gaining prominence. These approaches reduce solvent waste, lower energy consumption, and preserve phytochemical integrity. Additionally, biotechnological alternatives, including plant cell cultures and bio-fermentation, offer sustainable routes for producing high-value actives with consistent quality and reduced environmental footprint [38, 39]. Regulatory bodies and certification agencies are also encouraging sustainability reporting and eco-labeling, further shaping industry practices. Incorporating ethical and sustainability considerations into product development is no longer optional but a strategic necessity, aligning scientific innovation with environmental stewardship and consumer trust.

## FUTURE DIRECTIONS

The future of natural hair growth actives lies in advanced delivery systems. Nanotechnology, including liposomes, niosomes, and phytosomes, is being employed to enhance the transdermal penetration of large molecules like peptides and hydrophilic polyphenols [37]. Research into exosomes derived from plant stem cells represents the next frontier, offering potent signaling capabilities for tissue regeneration [38]. Additionally, synergistic combinations of oral nutraceuticals and topical cosmeceuticals are becoming the standard of care for a holistic approach to alopecia [39].



## CONCLUSION

The landscape of hair loss treatment has evolved significantly, with natural actives no longer serving as mere adjuncts but as viable alternatives to conventional pharmacotherapy. Agents like Rosemary oil, Redensyl®, and Saw Palmetto are supported by credible mechanisms of action—ranging from DHT inhibition to stem cell activation—and growing clinical evidence. While rigorous standardization and larger independent trials are necessary to fully cement their status, the current market trajectory for 2025-2026 confirms that natural hair growth actives represent a potent, safe, and expanding category in dermatological science.

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