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An Overview of Commonly Used Natural Alternatives for the Treatment of Androgenetic Alopecia, with Special Emphasis on Rosemary Oil

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Abstract: Androgenetic alopecia is a chronic dermatological condition in which genetically predisposed individuals undergo progressive hair loss secondary to the effects of circulating androgens. It has been well documented that dihydrotestosterone binds to the androgenic receptors prevalent in the scalp, thus inducing miniaturization of the hair follicle. To date, the only FDA approved medications for the treatment of androgenetic alopecia are finasteride and minoxidil. A plethora of studies have been conducted testing the efficacy of various herbal compounds, but additional research is needed to further establish the concrete efficacy of such natural remedies in treating androgenetic alopecia. Of late, rosemary oil has gained mass popularity as a promising natural alternative. This review article will not only provide a detailed background on this ancient herbal component but will additionally overview all other major herbal alternatives including peppermint oil, tea tree oil, green tea, pumpkin seed oil, saw palmetto, and lavender oil and will summarize the latest clinical studies, which have tested their efficacy for the management of androgenetic alopecia.

Keywords: androgenetic alopecia, alopecia, rosemary, *Rosmarinus officinalis*, natural, hair

Introduction

Androgenetic alopecia has long been a troubling chronic condition, which has plagued the lives of many but has fortunately been a field of much research and development. It is a chronic dermatological condition in which genetically predisposed individuals undergo progressive hair loss secondary to the effects of circulating androgens. This alopecia presents in a characteristic male and female pattern hair loss; males are commonly distinguished by their prominent frontotemporal recession and loss of hair in the vertex region, while females usually preserve their frontal hairline but suffer from alopecia affecting the anterior and central aspects of the scalp.[1] Androgenetic alopecia is a polygenic disorder with variable penetrance, and both maternal and paternal genes may be involved. Those with family history of this condition are more predisposed, with sons of fathers suffering from androgenetic alopecia at 5 times increase of their relative risk. In regard to the pathophysiology of this entity, it has been well documented that dihydrotestosterone binds to the androgenic receptors prevalent in the scalp, thus inducing miniaturization of the hair follicle. Biopsied samples additionally revealed a shortened anagen-to-telogen ratio in people with pattern hair loss at around 5:1 as opposed to 12:1 in healthy individuals.[2] Due to its androgenic component, this condition appears post puberty as case reports of those castrated prepuberty showed preservation of the hair with no signs of androgenetic alopecia in the commonly affected areas. This is additionally supported by the absence of androgenetic alopecia in patients with androgen insensitivity syndrome. Furthermore, patients with pattern hair loss often have larger quantities of circulating DHT due to the increased prevalence of 5 alpha reductase, which is responsible for the conversion of testosterone to DHT. Of note, while androgens play a major role in male pattern hair loss, their role in female pattern hair loss is less well understood as women may also develop such alopecia in the absence of excess androgens; this may be linked to several factors predominantly in their genetic predisposition, among others. Evaluation of androgenetic alopecia requires a thorough history

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searching for signs of androgenetic alopecia in family members, review of medication and past medical history to rule out other causes of alopecia, and a comprehensive examination focused primarily on the scalp. Dermoscopy would reveal thinning of the hair shaft and anisotrichosis, with prominent miniaturization of the hair follicles and the presence of yellow spots.[3] Laboratory testing, including ferritin level, serum iron, and thyroid function tests, can be conducted to rule out other treatable causes including alopecia areata secondary to iron deficiency and thyroid abnormalities, in addition to being a valuable asset in the workup for female pattern hair loss. A biopsy is usually not required for the diagnosis of androgenetic alopecia unless the clinical evaluation is unclear and requires supporting histology. To date, there exists only 2 FDA approved medications for the treatment of this entity, those being finasteride and minoxidil. However, a plethora of research has been conducted testing the efficacy of different medical and herbal compounds. Of late, rosemary oil has gained mass popularity as a natural topical alternative with promising results. This review article will not only provide a detailed background on this herbal component but will additionally overview all other major herbal alternatives and will summarize the latest clinical studies, which have tested their efficacy for the management of androgenetic alopecia.

Current Medicated Topical Options for the Treatment of Androgenic Alopecia

Androgenetic alopecia (AGA) has long been a topic of much research and drug development, yet to this day only two United States Food and Drug Administration (USFDA) approved medications for the treatment of AGA exist. The first is a type II 5 alpha reductase inhibitor that is administered orally in the form of a 1 mg finasteride tablet, commonly sold under the brand "Propecia". This drug was approved for daily consumption and has shown to be extremely efficacious at managing AGA as it targets one of the root causes behind the follicle miniaturization, which is dihydrotestosterone (DHT). Finasteride inhibits the conversion of testosterone to its more potent form DHT, thus preventing DHT from binding to the androgen receptors found in the scalp, which is responsible for inducing follicular miniaturization in AGA.[4] This drug was approved for use on men suffering from male pattern hair loss; however, it may be used in postmenopausal women with female pattern hair loss in the absence of clinical or laboratory signs of hyperandrogenism. Although it is an effective medication, finasteride does affect total serum concentration of DHT, which can lead to a plethora of sexual side effects in a small subset of individuals and can include decreased libido, ejaculatory dysfunction, and reduced semen volume. Additionally, in very rare cases, finasteride has been associated with depression and suicidal ideation. Thankfully, however, in most scenarios, these changes are reversible, but a small subset of individuals may continue suffering from these adverse reactions despite discontinuation of the drug.[5] In an effort to reduce the systemic adverse effects, Finasteride has recently been compounded and formulated into a solution or gel that can be applied topically and has shown promising results with a reduced side effect profile. The commonly utilized concentration of the formulated solution is often 0.25%. A Phase 3 clinical trial conducted in 2022 assessed topical finasteride and compared it to its oral counterpart and a control placebo group. The results of the trial indicated that both the oral and topical finasteride groups had a significant degree of new hairs grown per square centimeter compared to the placebo group, but there was no statistically significant difference between the amount of new hair grown in both oral and topical groups. Of note, patients using topical finasteride formulation, which was administered at a concentration of 0.25% had nearly 2% less incidence of sexual side effects and were able to maintain their DHT levels closer to baseline.[6] Thus, concluding that topical finasteride was as effective as its oral counterpart but with a reduced incidence of sexual side effects.

The second prominent medicated topical approved by the USFDA for AGA is minoxidil. This medication comes in both liquid and foam solutions, and at a concentration of 2% or 5%. It is applied twice daily for best efficacy and works by opening adenosine triphosphate-sensitive potassium channels in the vascular smooth muscle of the arterioles, thus inducing arteriolar vasodilation surrounding the hair follicle. Minoxidil has displayed throughout the years a potent ability to grow hair in cases of androgenetic alopecia and has shown efficacy in managing other forms of alopecia including alopecia areata as an off-label use. In addition to inducing vasodilation, it has also been shown to increase the expression of prostaglandin E2 receptors, thus prolonging the anagen phase in dermal papilla. Despite its effectiveness, Minoxidil is not a potent antiandrogen and functions primarily as growth stimulant without addressing the DHT directly (a primary culprit behind the miniaturization in AGA). Side effects of topical minoxidil commonly include scalp dermatitis, pruritus, and scaling. Some may also complain of headaches and lightheadedness due to hypotension, especially those more sensitive to the mechanism of action of minoxidil.[7]

Prostaglandin analogues have also been shown to have some degree of benefit when treating androgenetic alopecia and other hair disorders including alopecia areata. Commonly they have been utilized for the treatment of ocular hypertension and glaucoma, but its hair growth properties are displayed in several clinical trials to date.[8] A randomized double-blind placebo-controlled study assessed the efficacy of Latanoprost 0.1% and showed a significant increase in terminal and vellus hair density compared to placebo.[9] Bimatoprost at a concentration of 0.03%, which is approved by the FDA for use on eyelash hypotrichosis, showed significant increase in hair diameter and number when tested on patients suffering from androgenetic alopecia.[10] While prostaglandin analogues do show promising results compared to placebo, the specific dose and therapeutic regimen for the treatment of androgenetic alopecia has yet to be decided and unified; further research and clinical trials are required to best optimize the dose and use frequency.

Excluding the aforementioned medicated topicals, there is a plethora of other drugs that are yet to be approved by the USFDA and lack sufficient independent research and trials to truly validate their efficacy in growing new hair. These include substances such as stemoxydine developed by L'oreal which acts by inducing hypoxia to stimulate stem cell growth via prolyl-4-hydroxylase (P4H) inhibition.[11] Studies have also shown its ability to increase IGF-1 and suppress TGF-beta1.[12] Other medicated topicals that have yet to be studied in depth include Nanoxidil, which was created by DS laboratories and allegedly resembles the molecular compound of minoxidil but with one reduced carbon ring, thus in theory enhancing its topical absorption and efficacy. The Nanoxidil containing solution also contains other substances such as retinoids that have been reported to enhance absorption of other topical therapies and may indirectly improve hair growth.[13]

Rosemary Oil History/Background

Botany

Rosmarinus officinalis L., better known as rosemary, is an ancient plant belonging to the Lamiaceae family. This family includes the genus *Rosmarinus*, and belonging to this genus are many species other than the commonly known *Rosmarinus officinalis*, including but not limited to, *Rosmarinus tomentosus*, *Rosmarinus laxiflorus*, *Rosmarinus lavandulaceus*.[14,15]

Origins

Rosemary is an evergreen perennial shrub native to the Eastern Mediterranean and has been spread across different nations throughout history as a medicinal and ornamental commodity. In ancient Greece, it was better known as "antos" which translates to "flower" due to its characteristic aromatic smell and its use in incense by the people of those times.[15] Its origins can be tracked to as far as 500 B.C. in the old Roman and Greek empires. Its traces can also be found in ancient Egypt, where tombs from as far as 3000 B.C. have been discovered to contain dried rosemary for the purpose of perfuming the deceased during their journey to the afterlife.[16] Furthermore, ancient Egyptians were known to have used rosemary in addition to other natural ingredients such as thyme and cedar to formulate topical creams for the purpose of sun protection.[17] Rosemary was also reported to be first seen in China at approximately 220 B.C.[18]

Medicinal Uses of Rosemary Throughout History

Rosemary has been used for medicinal purposes since the dawn of existence. Its usage has been documented throughout history, including its use for the management of renal colic and dysmenorrhea due to its antispasmodic properties.[19] *Rosmarinus officinalis* was believed to have been introduced to Great Britain by the Romans, where it was utilized in symbolic rituals, but also in practical uses.[20] It was prominently used in the 14th century during the Great Plague as an inhaled disinfectant and decongestant by those traveling through endemic areas. It additionally was utilized during the second world war in a mixture containing other herbal ingredients that was then burnt for the purpose of disinfecting the air in French hospitals.[21] While some of these use cases are in fact folk medicine, rosemary has been documented and researched heavily in modern times and has been found to contain many beneficial properties that play a pertinent role in healing the ill. These functions include but are not limited to anti-inflammatory and antioxidant effects. Moreover, the safety profile of rosemary has been demonstrated through various clinical studies and has been classified by the United States Food and Drug Administration as "Generally Recognized as Safe" (GRAS).[22]

Therapeutic Properties of Rosemary Oil

Anti-inflammatory properties: *Rosmarinus officinalis* has demonstrated prominent anti-inflammatory effects that make it ideal for medicinal applications. This effect is attributed to the presence of several bioactive compounds including carnosic, ursolic, oleanolic, and micromeric acids which all aid in suppressing the inflammatory cascade.[23] A study by Ai-Hsiang et al demonstrated significant inhibition of nitric oxide (a potent proinflammatory mediator) by carnosic acid, which is highly prevalent in a multitude of natural herbs including *Rosmarinus officinalis*. Carnasol reduced lipopolysaccharide (LPS)-stimulated nitric oxide production and inhibited nuclear factor kB, these mechanisms aid in its ability to lessen inflammation.[24] Furthermore, *Rosmarinus officinalis* has shown to inhibit 82% of platelet aggregation, 71.8% of Nitric Oxide production, and 91.8% of free radical generation, thus clearly signifying its anti-inflammatory and antioxidant properties.[25]

This anti-inflammatory activity is desirable when treating androgenetic alopecia due to the presence of perifollicular inflammatory infiltrate. A Lattanand and W C Johnson demonstrated that nearly 50% of 300 punch biopsy samples acquired from AGA patients showed clear perifollicular infiltrate of predominantly lymphocytes and histiocytes.[26] A plethora of other publications noted similar findings in which biopsies and samples collected from patients with AGA demonstrated prominent perivascular and perifollicular infiltrate.[27]

Anti-androgenic properties: *Rosmarinus officinalis* contains prominent anti-androgenic properties, which have been demonstrated in several studies. One study attributed the potent antiandrogenic effect to 12-methoxycarnosic acid primarily.[28] Moreover, a randomized comparative trial conducted in 2015 showed rosemary oil to be comparable in effect to 2% minoxidil for the treatment of androgenetic alopecia.[29] Details of the studies regarding the efficacy of rosemary oil will be discussed below.

Antifungal properties: Studies testing the efficacy of topically applied rosemary oil extract against dermatophytes showed a positive outcome. It has shown prominent efficacy when tested on Candida albicans, Candida dubliniensis, Candida parapsilosis, and Candida krusei; these aforementioned dermatophytes being the most prevalent causes of mycosis globally.[30] Similarly, P Sudan et al demonstrated that 10% of *Rosmarinus officinalis* extract was able to inhibit 86% of new growth when tested on *Microsporum gypseum* and *Trichophyton rubrum*.[31]

Antioxidant properties: The antioxidant properties of *Rosmarinus officinalis* have long been documented and are well reported. Houlihan et al reported the discovery of a novel antioxidant extract from rosemary leaves named rosmaridiphenol, which is a diphenolic dilterpene. Rosmaridiphenol was shown to be superior to butylated hydroxyanisole (BHA) in its antioxidant properties.[32] Wu et al additionally analyzed the plethora of antioxidant components prevalent in rosemary extract. Using liquid chromatography and infrared, mass and nuclear magnetic resonance spectrometry, Carnasol was found to be an active antioxidant agent prevalent in *Rosmarinus officinalis*, with potency greater than that of BHA and equivalent to Butylated hydroxytoluene (BHT).[33] Rosemary, when combined with a-tocopherol, was shown to have significantly stronger antioxidant effect than when using a-tocopherol individually, by effectively inhibiting lipid oxidation catalyzed by Fe+2 and hemoprotein.[34]

UV protection: Exposure to UV irradiation has been linked to a plethora of detrimental outcomes including but not limited to photoaging and cutaneous malignancies. Compounds found in *Rosmarinus officinalis* extracts, specifically rosmarinic acid and carnosic acid, have been shown to protect hair from UV radiation as they displayed less amounts of S100A3 protein fragments indicating reduced protein degradation secondary to UV damage.[35] Additionally, rosemary oil when combined with citrus was able to offer 70% protection from 800J/m2 of UV irradiation. This synergistic effect was potentiated when exposed to an even higher dose of UV at around 1200 J/m2. Subjects intaking this combination for an 8-week period were shown to be more resilient to UV-induced erythema.[36] Rosemary extract has also been reported to inhibit metalloproteinase-1 (MMP), which in individuals exposed to UV, is upregulated playing a major role in photoaging and other negative sequelae.[37]

Efficacy of Rosemary Oil in Treating Androgenic Alopecia

As mentioned previously rosemary oil has important ingredients including caffeic acid, rosmarinic acid, 12-methoxycarnosic acid, and camphor, all of which are recognized for their antioxidant, antimicrobial, and anti-inflammatory value.[38]

Rosemary proved its efficacy in the treatment of androgenic alopecia in a similar way compared to minoxidil, by improving the vascularity and the circulation of blood, in addition to enhancing the regeneration of the hair follicles.[39]

In a single-blind, randomized clinical trial, 100 male patients aged 18–49 years with AGA were randomly divided to receive topical rosemary oil (n 1⁄4 50) or minoxidil 2% (n 1⁄4 50) for 6 months. Both groups had a significant increase in hair count at the 6-month ($P < 0.05$). No significant difference was found between the study groups regarding hair count (>0.05). However, scalp itching was more frequent in the minoxidil group compared to the other group treated with rosemary oil. ($P < 0.05$).[28]

A study that was conducted using mouse models in order to investigate the antiandrogenic effect of *Rosmarinus officinalis* leaf extract in comparison to finasteride and minoxidil, through the inhibition of testosterone 5-alpha-reductase, which has a well-known impact on managing androgenic alopecia. The study revealed that *Rosmarinus officinalis* has a potent inhibitory activity on 5-alpha-reductase of 82.4% and 94.6% at 200 and 500 mg/mL, respectively, in comparison to finasteride at 250 nM, which showed 81.9% inhibition ($P < 0.01$). Subsequently, inhibit the binding of Dihydrotestosterone to androgen receptors. In addition, further investigation revealed 12-methoxycarnosic acid to be the most active inhibitory constituent.[29]

Indeed, further studies have to be conducted to support the promising therapeutic benefits of rosemary oil in the management of androgenic alopecia. As in other studies, rosemary oil showed good tolerability with minimum irritation.

Other Natural Alternatives for the Treatment of Androgenic Alopecia

Natural alternative preparation has a high safety profile compared to the conventional FDA approved medications for the treatment of androgenic alopecia.[40] Therefore, their use in the management of androgenic alopecia can be considered a potentially effective treatment strategy.

Peppermint Oil

Peppermint oil is known as Mentha piperita is natural hybrid species extracted from watermint and spearmint.[41]

Menthol is the major constituent of peppermint oil (40.7%), which is a cyclic monoterpene alcohol commonly used in food and healthcare products, including cosmetics, dental-hygiene products, analgesics, and cough medicines all attributed to its strong fresh odor and flavor. The second major constituent is Menthon (23.4%). Other constituents of peppermint oil include menthyl acetate, 1.8-cineole, limonene, beta-pinene, and beta-caryophyllene.[42]

In addition, therapeutic properties of peppermint oil showed efficacy in managing medical conditions throughout the centuries including inflammatory, gastrointestinal, respiratory, and reproductive.[43]

Randomized controlled trial animal study was done on mice to investigate the potential efficacy of peppermint essential oil in enhancing hair growth.[44] The animals were randomized into four groups based on different topical applications: saline, jojoba oil, 3% minoxidil, and 3% peppermint oil. The results were evaluated based on hair growth, histologic analysis, enzymatic activity of alkaline phosphatase (ALP), which is found at higher levels during the anagen phase as it relaxes vascular smooth muscles, which leads to increased blood circulation, and lastly, insulin-like growth factor (IGF-1) which is a potent bio-marker known for enhancing hair growth and increase hair thickness. At 4-week of the study, peppermint oil group showed the most remarkable results in form of; promoting growth of hair 92% compared to 55% in minoxidil group, significant hair follicle elongation into the subcutis, increased dermal thickness, and increased hair follicle number in histologic analysis, increase activity of (ALP) 192% compared to 90% in minoxidil group, in addition to a remarkable increase in IGF-1 mRNA expression 89% ($p < 0.001$) and 34% ($p < 0.01$) greater than saline and jojoba oil, respectively, comparable to minoxidil group.[44]

This study may illustrate the vasodilatory effect of menthol, which is the active constituent of peppermint oil, leading to enhancing the vascularization along hair dermal papillae and increase ALP activity.[43]

Up to date, no studies have been done to evaluate the potential efficacy of peppermint oil in enhancing the growth of hair and treating androgenic alopecia on human.

Tea Tree Oil

Tea tree oil is known as Melaleuca alternifolia, an essential oil originating from the southeast coast of Australia, traditionally known for its tremendous benefits in managing infectious and inflammatory conditions. Active constituents of tea tree oil are terpinen-4-ol, c-terpinene, p-cymene, a-terpinene, 1.8-cineole, a-terpineol, and a-pinene.[45]

A randomized controlled trial was conducted to investigate a compound formulation that are known to treat the multi-factorial etiology of AGA including increased hair follicle sensitivity to androgen, microinflammation, and microbial infection.[46] Thirty-two men aged between 18 and 30 with AGA were randomized into three groups based on 1mL topical application of microemulsion compound treatment (5% minoxidil, 0.5% diclofenac, and 5% tea tree oil) group, 5% topical minoxidil group, and topical placebo group. The treatment was applied to the affected area twice daily for 32 weeks. At the end of the pilot study, the mean hair count in the microemulsion compound treatment group was 217.3, higher result compared to 170.5 in the topical 5% minoxidil group ($P < 0.009$), and 82.9 in the topical placebo group ($P < 0.001$). In addition, photographic assessment revealed a 79% increase in hair growth in the compound treatment group, compared to 41% increase in hair growth in the 5% topical minoxidil group, and 13% hair growth in the topical placebo group. Patient self-assessments questionnaire was also supporting a satisfactory result in the compound treatment groups vs 5% topical minoxidil group alone and the topical placebo group. Hair shedding reduction noted earlier during the first week of application in the compound treatment group compared to week 4–5 in the 5% topical minoxidil group. In the topical placebo group, hair shedding was significant. Incidence of scalp pruritus and sebum production also decreased in the compound treatment group.[46]

This randomized controlled study suggests a potential promising benefits of tea tree oil. However, more studies have to be conducted to investigate the efficacy of tea tree oil in the management of AGA.

Green Tea

Green tea is known as *C sinensis* extracted from leaves belonging to family Theaceae.[38] It has many advantages including antioxidant and anti-cancer benefits. Powerful antioxidant property of green tea is attributed to its constituents, which include polyphenols and flavonoids containing catechins and its derivatives epicatechin (EC), epigallocatechin gallate (EGCG), epigallocatechin, and epicatechin gallate.[38]

Epigallocatechin gallate (EGCG) is a major polyphenolic constituent of green tea that features hair growth stimulation through enhancing the proliferation and preventing apoptosis of dermal papilla cells in addition to selective inhibition of 5-alpha-reductase which converts testosterone to dihydrotestosterone.[40]

Pumpkin Seed Oil

Pumpkin seed oil is an essential oil most commonly extracted from *C pepo* species belongs to family Cucurbitaceae.[41] Pumpkin plant has been used in many countries throughout the history for its known effect as antioxidant, anti-inflammatory, and antimicrobial properties.[38]

Cucurbita *pepo* species is rich in polyunsaturated fatty acids about 80%- palmitic acid, myristic acid, stearic acid, oleic acid, and linoleic acid, vitamin E like α-tocopherols, γ-tocophe- rols and carotenoid, phytoestrogens, and phytosterols and trace components.[47]

The mechanism of action of pumpkin seed oil in reduce hair loss, is attributed to the inhibitory effects of b-sitosterol and linolenic acid on 5a-reductase, and decreasing IL-6 activity.[47]

In a randomized, controlled trial to investigate the clinical efficacy of pumpkin seed oil compared to minoxidil 5% foam in treating androgenic alopecia. Sixty female patients with female pattern hair loss were sub-divided into two groups. Thirty women received 1 mL of topical pumpkin seed oil vs thirty women received 1 mL of minoxidil 5% foam. The results after 3 months were for the PSO group, hair shaft diversity showed significant decrease before and after treatment ($30.5 \pm 6.2\%$ vs 24.0 ± 4.02, $P < 0.001$). For the minoxidil group, hair shaft diversity showed significant decrease before and after treatment ($31.5 \pm 6.3\%$ vs 21.3 ± 2.2, $P < 0.001$).[48]

An animal study aimed to explore the efficacy of topical pumpkin seed oil in promoting hair growth in male pattern alopecia. Mice were randomized into five groups: (A) Control – did not receive testosterone (B) 5% testosterone solution only (C) 5% testosterone + 5% pumpkin seed oil (D) 5% testosterone and 10% pumpkin seed oil, and (E) 5% testosterone

and 2% minoxidil solution. Three weeks analysis of follicles in anagen phase showed that local application of testosterone to the mice significantly decreased the percentage of anagen-phase follicles. More results revealed marked hair growth for the 2% minoxidil group ($P < 0.01$) and for the 10% pumpkin seed oil group ($P < 0.05$) Proposing that 10% pumpkin seed oil and 2% minoxidil could significantly ($P < 0.001$) inhibit the effects of testosterone on the anagen phase and promoting hair growth in testosterone-induced alopecia in mice.[49]

These studies suggest promising results; however, more research should be conducted to confirm the previous results as well as to determine the exact mechanism of pumpkin seed oil on hair growth.

Saw Palmetto

Saw palmetto is also known as Serenoa repens. It is extracted from palm tree berries that belongs to Arecaceae family in West Indies and Atlantic coast of North America.[47] The extracted oil obtained from the berries of Saw palmetto has an extremely high percentage of fatty acid (85–90%) in addition to other constituents including sterols.[40]

This herbal preparation had been proved to be effective in treating benign prostatic hyperplasia with limited data regarding its efficacy in alopecia.[47] The mechanism of action of saw palmetto in enhancing hair growth and prostate health, is via the inhibition of 5a-reductase, thus reducing dihydrotestosterone the serum levels.[47]

The principle fatty acids that may be playing a role in suppressing 5-alpha-reductase enzyme are lauric acid, myristic acid, and oleic acid.[47]

A prospective cohort study aimed to investigate the potential therapeutic effect of products containing Serenoa repens extract (serum and lotion form) in the treatment of male androgenic alopecia. Fifty males aged between 20 and 50 years were analyzed after 24 weeks of receiving topical Serenoa repens products. Analysis of the results was primarily based on a hair count in an area of 2.54 cm^2 at week 24. Followed by hair restoration, investigators' photographic assessment, patients' evaluation and discovering adverse events. The average hair count and terminal hair count increased at weeks 12 and 24 when compared to baseline.[50]

Lavender Oil

Lavender is known as Lavandula, commonly used natural plant in cosmetic fragrant products and food flavoring.[51]

Lavender constituents are mainly, linalool, linalyl acetate, 1.8-cineole, B-ocimene, terpinen-4-ol, I-fenchone, camphor, and viridiflorol.[51]

An RCT animal study investigated the hair growth effect of lavender oil.[51] The mice were randomly categorized into the 5% lavender oil group, 3% lavender oil group, 3% minoxidil positive control group, and the topical saline control group. Analysis after 4-weeks revealed, the 3% minoxidil group, 3% lavender oil group, and 5% lavender oil group showed 99.8% ($P < 0.05$), 90% ($P < 0.05$), and 95% ($P < 0.05$) of hair growth, respectively.

Further investigational studies have to be conducted to support the possible therapeutic potential of lavender oil in promoting hair growth.

Conclusion

Androgenetic alopecia is a chronic disease that affects a large percentage of the population, yet to date there exists only two FDA approved medications, minoxidil and finasteride. Natural components have recently gained popularity and are emerging as a suitable alternative to medicated solutions. Some compounds, prominently rosemary oil, have been shown to be an effective natural alternative, showing efficacy similar to that of 2% minoxidil. The promising therapeutic effects of rosemary oil that were displayed in this work were derived from a comprehensive review of published articles, as well as a study in men, and a study in mice. However, further research is required to better understand the efficacy and safety profile of these herbal alternatives in managing androgenetic alopecia.

Abbreviations

USFDA, United States Food and Drug Administration; DHT, Dihydrotestosterone; P4H, prolyl-4-hydroxylase; GRAS, Generally Recognized as Safe; LPS, lipopolysaccharide; BHA, Butylated hydroxyanisole; BHT, Butylated hydroxytoluene; MMP, metalloproteinase-1; ALP, alkaline phosphatase; IGF-1, insulin-like growth factor; EC, epicatechin; EGCG, epigallocatechin gallate.

Disclosure

The authors report no conflicts of interest in this work.

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