

EFFICACY AND SAFETY OF TOPICAL PURE SAW PALMETTO (*SERENOA REPENS*) EXTRACT LOTION IN ANDROGENETIC ALOPECIA

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ABSTRACT

This open-label study evaluates the efficacy and safety of a lotion containing pure Saw Palmetto (*Serenoa repens*) extract in treating androgenetic alopecia (AGA) in 20 male participants. The participants applied the lotion twice daily over a 12-week period. Hair counts and global photographic assessments were conducted at baseline and during follow-up visits at weeks 4, 8, and 12. Statistical analysis showed a significant increase in mean hair count from 49.8 at baseline to 55.9 by week 12. Additionally, participant satisfaction scores rose over time, with 83% of participants reporting high satisfaction by the study's conclusion. Importantly, no adverse effects were observed, supporting the lotion's safety. The study concludes that pure Saw Palmetto extract lotion is an effective and well-tolerated treatment for male AGA, though further research with larger sample sizes and longer follow-up periods is recommended.

Keywords: Androgenetic Alopecia, Herbal Therapy, Saw Palmetto, *Serenoa repens*

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INTRODUCTION

Hair does not perform any vital physiological role in modern human beings. However, it plays an important role in our self-esteem. When it comes to a person's quality of life, emotional stability, body image, and self-esteem, hair loss can have a big impact. (Reid et al., 2012) It might even result in psychiatric problems such as anxiety and depression. (Grimalt, 2005) Regarding the pathogenesis of hair loss, key triggers for baldness are contributed by genetic predisposition, hormonal imbalance, loss of extracellular matrix of hair follicular bulb, localized microinflammation, etc. (El-Domyati et al., n.d.) However, in men, the major contributing factors to male baldness are genetic predisposition and androgen excess. Among them, the latter is the key regulator of hair growth. Men who have a more active 5 α -reductase enzyme in their hair follicles are more likely to have a pattern hair loss called Androgenetic Alopecia (AGA). This enzyme changes testosterone in hair follicles into the more powerful dihydrotestosterone (DHT). By acting on follicular androgen receptors, dihydrotestosterone (DHT) causes dermal papillary cells to produce more transforming growth factor- β (TGF- β). The functions of TGF- β are to inhibit keratinocyte growth and induce inflammation and cellular apoptosis, leading to the death of hair follicles. (Hibino & Nishiyama, 2004) Therefore, increased 5 α -reductase activity with a subsequent increase in dihydrotestosterone and TGF- β is the key pathophysiologic process of AGA.

With regards to the above pathogenesis, there are varieties of treatments targeting these different pathogenesis processes. Standard treatments for Androgenetic Alopecia include FDA-approved topical minoxidil and finasteride. Cutting-edge approaches like Low-Level Laser Therapy, Platelet Rich Plasma Therapy, Micro needling, and Topical Growth Factors are also explored. (Garg & Casper, 2023) On the other hand, these standard treatments, like minoxidil and finasteride, may have side effects such as scalp irritation, itching, and sexual dysfunction, highlighting the need for exploring alternative approaches. (Garg & Casper, 2023)

Herbal therapies like Saw palmetto, Ginseng, Green tea, and Pumpkin seed oil inhibit 5-alpha reductase, reducing hair loss in AGA without significant side effects, offering alternatives to conventional treatments. (Lucca & Lucca, 2024) Among them, Saw Palmetto (*Serenoa repens*) is believed to be able to suppress male AGA progression by inhibiting 5- α -reductase, reducing DHT production, and potentially impacting hair follicle cycle, growth factors, and immune response. (Piwecki et al., 2023) A systematic review indicated that SP supplements led to a 27% increase in total hair count and improved hair quality in 60% of patients with AGA. They concluded that SP extract may have a role in treating hair loss disorders, not limited to AGA. And there was unclear sole contribution of Saw Palmetto in hair growth outcomes because previous preparations of Saw Palmetto contain other minerals and growth factors that may probably influence hair growth. (Evron et al., 2020)

We subsequently carried out an open-label study to assess the efficacy of a lotion containing pure Saw Palmetto extract in the treatment of AGA, with a focus on evaluating both therapeutic outcomes and potential adverse effects during 12 weeks of treatment.

LITERATURE REVIEWS

Herbal Therapies for Androgenetic Alopecia

Although there is a wide range of pharmacological therapies for Androgenetic alopecia (AGA), active ingredients of synthetic origins still have their limitations regarding efficacy and safety, and they usually take a long duration to achieve the maximum effect. Some treatments like low-level laser light therapy are also expensive. Therefore, an alternative approach to management using plants and herbal products becomes popular. Among the herbal preparations, *Curcuma aeruginosa* (pink and blue ginger), *Serenoa repens* (Saw palmetto), *Cucurbita pepo* (pumpkin), *Trifolium pratense* (red clover), and *Panax ginseng* (Chinese red ginseng) are well known herbal treatments for AGA. (Zgonc Škulj et al., 2020) They have a

wide activity spectrum such as the inhibition of 5α reductase, enhancement of scalp circulation, and improvement of nutritional support to hair follicles, etc. These herbs are easily available products at a reasonable price. In contrast to the standard treatments, their side effects are fewer, and this can assure the patient's high compliance. (Zgonc Škulj et al., 2020)

Saw Palmetto in Androgenetic Alopecia

Among the herbal therapies for Androgenetic Alopecia (AGA), Saw Palmetto is popular as a magical treatment for AGA. It is a botanical extract from the berries of the *Serenoa repens* dwarf tree which is about 6-10 feet long with palmately divided thick leaves with very sharp, saw-like teeth resembling a hand with the fingers spread, hence its name called Saw Palmetto. It is a small woody member of the palm family known as *Arecaceae*. Saw Palmetto is also known as *Serenoa serrulata* or *Sabal serrulate*. The berries of Saw Palmetto have an oblong shape and maroon color. (Murugusundram, 2009) Ripe berries contain active ingredients like phytosterols (β sitosterol, campesterol, stigmasterol) conjugated with certain esterified fatty acids (caprinic, caproic, caprylic, lauric, linoleic, myristic, oleic, palmitic, and stearic acid), fixed oil, β carotene, polysaccharides, etc. (Chatterjee & Agrawala, n.d.) The combination of Saw Palmetto's liposterolic extract (LSEsr) and β sitosterol has been claimed to improve AGA. (Murugusundram, 2009) Active extracts can be prepared by grinding ripe berries as a power formulation (or) liquid preparation via hot water or supercritical elicitation with carbon dioxide. (Evron et al., 2020)

The mechanism of action of the Saw Palmetto is mainly by anti-androgen properties. Therefore, it has been popular for the management of benign prostatic hyperplasia, dating back to the 15th century BCE, Egypt. (Wilt et al., 1998) It is a competitive nonselective inhibitor of 5-alpha reductase of types I and II. It blocks the nuclear uptake of dihydrotestosterone (DHT) and decreases DHT binding capacity to receptors by nearly 50%. (Iehlé et al., 1995) This action is mainly by its constituent: phytosterols and flavonoids. Moreover, Saw Palmetto's fatty acid constituents can directly inhibit enzymatic activities e.g., saturated fatty acid like lauric acid inhibits 5-alpha reductase of type I and II whereas monounsaturated fatty acid like oleic acid inhibits the 5-alpha reductase of type I. (Rossi et al., 2012) The active extract of Saw Palmetto can also increase the activity of 3α -hydroxysteroid dehydrogenase, an enzyme converting DHT to its weaker metabolite, Androstanediol. (Evron et al., 2020) Apart from these anti-androgenic effects, Saw Palmetto also had a promising result in increasing hair growth in the murine model via transforming growth factor- β and mitochondrial signaling pathways. (Zhu et al., 2018) In in vitro models, it is also found that Saw Palmetto can inhibit the inflammatory gene expression in human keratinocytes suggesting its use in Androgenetic alopecia. (Chittur et al., 2011)

A systematic review by Evron et al showed the results of using Saw Palmetto in several human studies in Androgenetic alopecia, Female pattern hair loss, Telogen effluvium, and self-perceived hair thinning. They stated that modest improvement in hair regrowth has been achieved by various topical and oral Saw Palmetto containing supplements: 60% improvement in overall hair quality, 27% improvement in total hair count, increased hair density in 83.3% of patients, and stabilized disease progression among 52% respectively. (Evron et al., 2020) However, almost all current formulations of Saw Palmetto contain other ingredients that can affect hair regrowth such as vitamins, minerals, and other plant extracts. Therefore, it is still necessary to elucidate the effectiveness of pure Saw Palmetto extract in Androgenetic alopecia. Previous clinical studies also had some methodological flaws. For example, the absence of standardized measurement tools was found in most studies. They used a qualitative assessment rather than the quantitative one. It is also noted that some research had conflicts of interest with pharmaceutical companies. Therefore, we designed an independent clinical study to evaluate the effectiveness of topical pure Saw Palmetto extract on Androgenetic alopecia with the use of standardized measurements of hair counts quantitatively and qualitatively. We believe that

our research will highlight more about the role of pure Saw Palmetto extract in the management of Androgenetic alopecia.

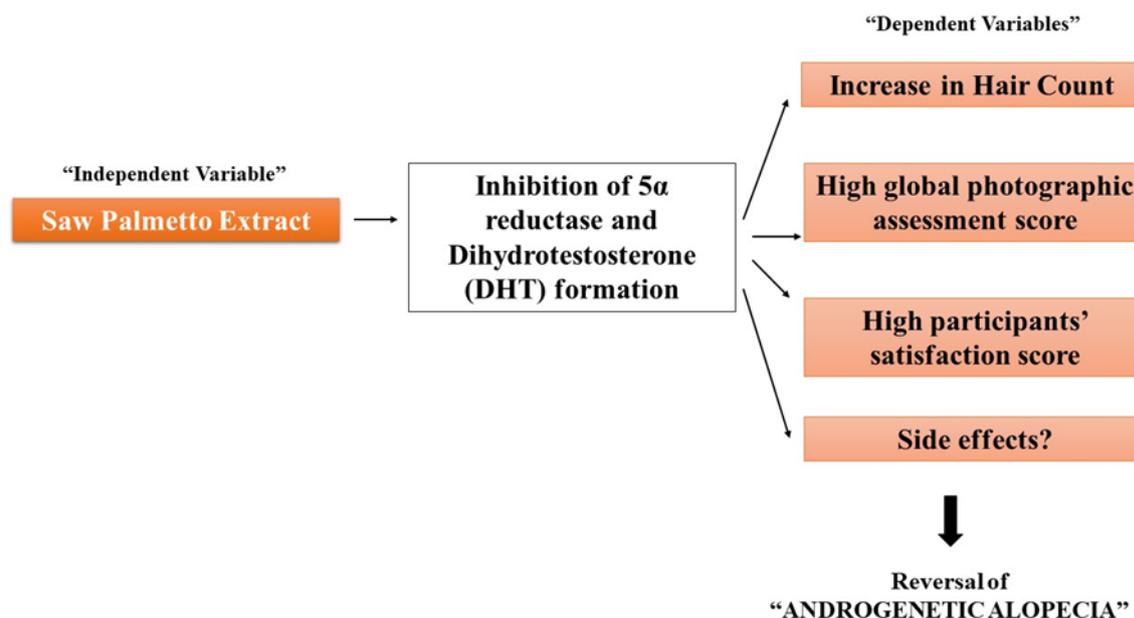


Figure 1 Conceptual Framework

RESEARCH METHODOLOGY

This research was designed as an open-label clinical study, with the study protocol receiving approval from the Ethics Committee of Mae Fah Luang University, Thailand. We recruited 20 male volunteers diagnosed AGA based on predefined inclusion and exclusion criteria. Prior to enrollment in the trial, each participant provided written informed consent. The hair lotion used in the study was formulated with a single active ingredient, *Serenoa repens* fruit extract. It was produced by Derma Innovation Co., Ltd., located in Nonthaburi, Thailand, and received approval from the Thai Food and Drug Administration (FDA). The comprehensive list of ingredients includes: *Serenoa repens* fruit extract, water, glycerin, methylpropanediol, ethoxydiglycol, polysorbate 20, phenoxyethanol, disodium EDTA, chlorphenesin, fragrance, and potassium sorbate.

Prior to the study, we conducted a self-patch test with the saw palmetto extract lotion on the participants' arms, applying it under a waterproof patch for 24 hours. The tested area was examined at 48 and 96 hours, with no reactions observed in any of the participants. Participants were instructed to apply 5 puffs of hair lotion, equivalent to approximately 1 ml, to their scalp twice daily—once in the morning and once at night—focusing specifically on the affected bald areas. The participants' adherence to the study protocol was indirectly evaluated through monitoring their daily usage of the hair lotion. Participants were instructed to bring the bottles to each visit, allowing the research team to assess the residual volume of medication remaining, thereby verifying consistent usage as per the study's requirements. For the duration of the 12-week study period, each participant was allocated a total of six bottles, each containing 30 ml of hair lotion.

At the baseline visit, a comprehensive history was taken to gather demographic data on the participants. Additionally, hair count assessments by trichoscopy and macrophotography for global photographic evaluations were performed. During the follow-up visits at the 4th, 8th, and 12th weeks, along with repeating hair count assessments and macrophotography for global

assessments, the study also included the collection of participants' satisfaction scores and the evaluation of any side effects.

To ensure consistent measurement of the designated area throughout all visits, a personalized plastic cap template was created for each participant during their initial visit. The template included a 1 cm² circular opening, precisely positioned over the predetermined assessment area. For the global photographic assessment, images were captured with an iPhone 13 Pro, specifically in macro mode. This process was conducted under optimal conditions, including sufficient lighting, 12-megapixel resolution, automatic focus, and automatic white balance correction provided by the camera. The photographic assessments were independently reviewed by three blinded physicians, who were not aware of the specific time points of the study. Participant satisfaction scores were evaluated using a grading system similar to that used for the global photographic assessment. The details of the 7-point grading system employed for both the global photographic assessment and participant satisfaction scores are presented in Table 1.

Table 1 7-point grading system for the global photographic assessment and participant satisfaction scores

-3	Greatly decreased
-2	Moderately decreased
-1	Slightly decreased
0	No Change
1	Slightly increased
2	Moderately increased
3	Greatly increased
Interpretation	
<ul style="list-style-type: none"> • Scores 2 and 3 = High • Others = Low 	

During subsequent visits, participants were also asked to report any local side effects, such as allergic or irritant dermatitis, folliculitis, or other skin reactions, as well as any systemic side effects, including alterations in heart rate or sexual dysfunction.

RESEARCH RESULTS

Statistical analysis for this study was performed using IBM SPSS software, version 20.0. Continuous variables, such as age, onset of disease (year), and baseline hair count, were analyzed using mean \pm standard deviation. Categorical variables, including the Norwood-Hamilton stage of androgenetic alopecia, family history, history of previous treatment, and adverse effects, were evaluated through the calculation of frequencies and percentages. The Shapiro-Wilk test was used to assess the normality of the data distribution. A repeated measures analysis of variance (repeated ANOVA) and post-hoc tests were conducted to compare the mean changes in hair count from baseline across different visits.

A total of 20 male participants with androgenetic alopecia (Norwood-Hamilton Stage I-IIIv) were recruited according to inclusion and exclusion criteria. Table 2. Characteristics of the participants are shown in Table 3.

Table 2 Inclusion and Exclusion Criteria

Inclusion Criteria
- Male participants, aged 30-50 years, with mild to moderate androgenetic alopecia (Norwood-Hamilton type I-IIIv).
- No use of systemic or topical hair loss treatments.
- Agreement to maintain the same hairstyle, avoid hair dyeing, and use the same shampoo throughout the study.
- Willingness to refrain from other hair-affecting treatments.
- Consent to having photographs of the treated area taken.
- Adherence to the treatment and follow-up schedule.
- Non-involvement in other research studies during the trial period.
Exclusion Criteria
- Female participants or those with non-androgenetic alopecia.
- Participation in another study within the last month.
- Presence of significant systemic diseases (e.g., cardiac disorders, diabetes, thyroid dysfunction, neurological conditions).
- History of serious medical conditions (e.g., cancer, immunodeficiency disorders).
- Scalp conditions (scars, ulcers, or active dermatological diseases).
- Recent hair transplantation (within six months) or use of hair weaves/tattoos.
- Use of medications affecting hair loss (e.g., minoxidil, finasteride, hormones, anti-androgens) or those causing hypertrichosis or alopecia.
- Recent use of steroids or hair-promoting nutraceuticals/botanicals.

Table 3 Characteristics of the Participants

Demographic	Number (n)	Percentage (%)
Age		
Mean \pm SD (years)	36.3 \pm 7.24	
Min-Max (years)	27-52	
Stage of AGA		
Stage I	3	15.0
Stage II	13	65.0
Stage III	2	10.0
Stage IIIv	2	10.0
Family history of AGA		
No	13	65.0
Yes	7	35.0
Past treatment		
Yes	6	30.0
No	14	70.0

The statistical analysis of the mean hair count for participants (n=20) who applied pure Saw Palmetto extract lotion was conducted at four time points: baseline, 4th week, 8th week, and 12th week. The normality test results show that the data for Baseline, Week 4, Week 8, and Week 12 are all normally distributed, as the p-values for the Shapiro-Wilk test were all greater than 0.05. A repeated measures ANOVA was conducted to assess the change in mean hair count over time in 20 participants who applied pure Saw Palmetto Extract lotion at baseline, 4th, 8th, and 12th weeks. (Table 4) The results showed a significant increase in mean hair count across the time points ($F = 66.19$, $p < 0.0001$). Mean hair count increased from 49.8 at baseline to 55.9 by the 12th week, with all confidence intervals indicating statistically significant changes.

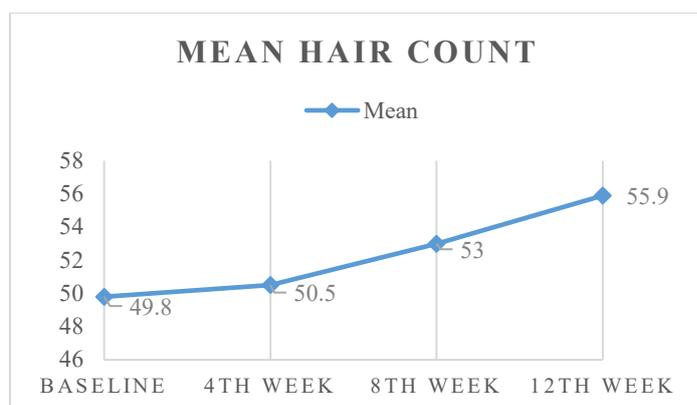


Figure 2 Mean Hair Count

Table 4 Repeated Measures ANOVA: Mean Hair Count

Time	Mean	SD	95% Confidence Interval	
			Lower Bound	Upper Bound
Baseline	49.8	3.955	47.949	51.651
4 th week	50.5	3.818	48.713	52.287
8 th week	53	3.866	51.191	54.809
12 th week	55.9	4.051	54.004	57.796

Repeated Measures ANOVA: $F = 66.19, p < 0.0001$

The post-hoc analysis using Tukey's HSD for the mean hair count across Baseline, Week 4, Week 8, and Week 12 revealed several important findings. A significant increase in hair count was observed between Baseline and Week 12 (mean difference = 6.1, $p < 0.001$), while no significant differences were noted between Baseline and Week 4, Baseline and Week 8, or between Week 4 and Week 8. However, a significant difference was found between Week 4 and Week 12 (mean difference = -5.4, $p < 0.001$). These results suggest a marked improvement in hair count by Week 12 compared to both Baseline and Week 4, indicating the treatment's effectiveness over time.

Table 5 Post Hoc Test: Mean Hair Count

		Mean diff	p-adj	lower	upper	reject
Baseline	Week 12	6.1	0	2.8408	9.3592	TRUE
Baseline	Week 4	0.7	0.9424	-2.5592	3.9592	FALSE
Baseline	Week 8	3.2	0.0562	-0.0592	6.4592	FALSE
Week 12	Week 4	-5.4	0.0002	-8.6592	-2.1408	TRUE
Week 12	Week 8	-2.9	0.0986	-6.1592	0.3592	FALSE
Week 4	Week 8	2.5	0.1916	-0.7592	5.7592	FALSE

The Global Photographic Assessment (GPA) scores for hair density are divided into two categories: 'High' (≥ 2) and 'Low' (< 2). A summary of the scores assigned by each physician is provided in Figure 3. At week 4, the majority of evaluations across all three doctors were classified as 'Low.' By week 8, there was a marked increase in 'High' assessments across all doctors, with Doctor C demonstrating the greatest increase (approximately 40%), followed by Doctor B (around 30%) and Doctor A (about 20%). By the study's end, a substantial shift was observed in 'High' assessments, with Doctors A and C reporting nearly 95% of cases as 'High,' while Doctor B reported approximately 80% of cases in the 'High' category. This suggests an improvement in hair density by pure Saw Palmetto extract in AGA being assessed over the 12-week period.

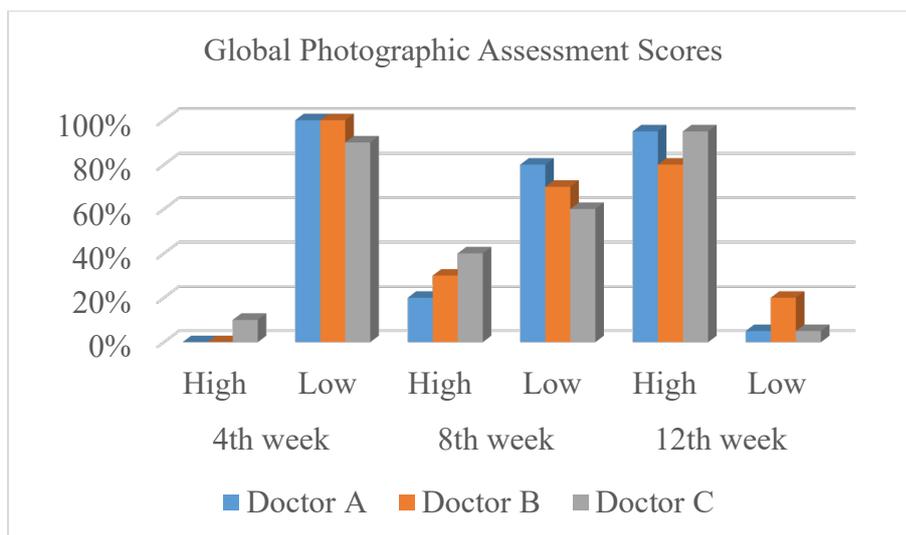


Figure 3 Bar Chart showing global photographic assessment scores by three different doctors



Figure 4 Bar Chart showing Participant Satisfaction Scores

Throughout the study, the application of pure Saw Palmetto Extract Lotion was found to be well-tolerated, with no adverse effects reported by any of the participants.

DISCUSSION & CONCLUSION

The topical use of extracts from plants and their active ingredients has several advantages, such as higher compliance, fewer side effects, and a wider activity spectrum. Moreover, they are usually cheap and more widely available. (Kaushik et al., 2011) Therefore, researchers are continuously searching for alternative herbal therapies for hair loss. A review by Kaushik et al. 2011 discussed the different roles of more than 30 herbs and their preparations in the treatment of hair loss. Most of them are used traditionally, and clinical trials proving their efficacy are still needed. (Kaushik et al., 2011) In 2017, medical perspectives of different therapies for androgenetic alopecia including non-herbal and herbal derivatives, were reviewed, but different levels of use (traditional and scientific) were not differentiated. (Lad et al., 2017) Then, a review by Zgonc Škulj et al. (2020) showed a set of plants that was limited to those with at least one clinical trial in the management of hair loss. This review demonstrated the roles of 11 herbal plants in the treatment of hair loss, especially alopecia areata and androgenetic alopecia. Among them, the extracts from *Camellia sinensis* L (green tea), *Cucurbita pepo* L (pumpkin), *Curcuma aeruginosa* Roxb (pink and blue ginger), *Panax*

ginseng (chinese red ginseng), *Serenoa repens* (saw palmetto), *Sophora flavescens* Aiton (sophora), *Trifolium pratense* L. (red clover), Aetherolum (essential oils), and Procyanidin B-2 (apple) are shown to be effective in the management of androgenetic alopecia. They have a wide activity spectrum, such as inhibition of 5 α reductase, enhancement of scalp circulation, improvement of nutritional support for hair follicles, etc. These herbs are easily available at a reasonable price. In contrast to the standard treatments, their side effects are fewer, and this can assure the patient's high compliance. (Zgonc Škulj et al., 2020)

Among the herbal therapies, Saw Palmetto is a well-known treatment for AGA. It is a small, woody member of the palm family known as *Arecaceae*. Saw palmetto is also known as *Serenoa serrulata* or *Sabal serrulate*. The berries of Saw palmetto have an oblong shape and maroon color. (Murugusundram, 2009) Active extracts can be prepared by grinding ripe berries as a power formulation (or) liquid preparation via hot water or supercritical elicitation with carbon dioxide. (Evron et al., 2020) It is useful in AGA by its anti-androgenic action. This action is mainly due to its constituents: phytosterols and flavonoids. Moreover, saw palmetto's fatty acid constituents can directly inhibit enzymatic activities e.g., saturated fatty acid like lauric acid inhibits 5-alpha reductase of type I and II whereas monounsaturated fatty acid like oleic acid inhibits the 5-alpha reductase of type I. (Rossi et al., 2012) Apart from Androgenetic alopecia, oral or topical Saw palmetto has been evaluated for use in other hair and skin disorders such as telogen effluvium (Pezza et al., 2014; Zanzottera et al., 2017), seborrheic dermatitis (Togni, 2017), reduction of facial sebum (Dobrev, 2007), etc. Therefore, it has become a popular ingredient in over-the-counter hair care products despite limited clinical trials evaluating its efficacy and safety. It is well known for its minimal side effects in comparison with the standard treatments. (Agbabiaka et al., 2009)

In a study conducted by Pavithra et al. (2023), a comparative analysis was performed between two treatment regimens for Androgenetic Alopecia (AGA): Topical Procapil with Platelet-Rich Plasma (PRP) Therapy and Topical Redensyl, Saw Palmetto, and Biotin with PRP Therapy. (Pavithra et al., 2023) The findings indicated that Saw Palmetto demonstrated higher patient satisfaction and strong antiandrogenic properties, making it an effective component in combination therapy with PRP. The study concluded that PRP combined with Redensyl, Saw Palmetto, and Biotin represents a superior alternative to existing therapies for AGA. However, the study lacked objective measurements, as trichoscopy was not utilized for hair count assessment. (Pavithra et al., 2023) As a result, the observed hair regrowth cannot be solely attributed to Saw Palmetto, given the presence of multiple hair growth-promoting agents in the treatment. In another study by Arca et al. (2014), the efficacy of topical Saw Palmetto in treating AGA in men was highlighted, with results showing an 11.9% increase in total hair count and a 38% improvement in the anagen/telogen hair ratio. (Arca et al., 2014) While objective measurements were used, the observed hair regrowth in this study also cannot be exclusively ascribed to Saw Palmetto. Therefore, our study contributes by specifically assessing the efficacy of Saw Palmetto alone in the treatment of AGA.

A systematic review by Evron et al. (2020) highlighted the positive effects of Saw Palmetto in treating Androgenetic Alopecia, reporting up to a 60% improvement in hair quality, a 27% increase in hair count, and 83.3% of participants experiencing increased hair density. (Evron et al., 2020) However, the review included both oral and topical forms of Saw Palmetto, leading to potential confounding factors. Additionally, the lack of standardization across studies and the inclusion of formulations mixed with other hair growth-promoting agents make it difficult to determine the sole contribution of Saw Palmetto in these outcomes. Thus, the findings of our study help to specifically validate the efficacy of topical Saw Palmetto in promoting hair regrowth, addressing some of the limitations seen in previous research.

While we were conducting our study, a recent research publication by Sudeep et al. (2023) also explored the effects of oral and topical administration of standardized Saw Palmetto oil in

subjects with Androgenetic Alopecia. Their findings demonstrated a reduction in hair fall by up to 29% and an increase in hair density ranging from 5.17% to 7.61%. Notably, no serious adverse effects were reported throughout the study. (Sudeep et al., 2023) Our findings align with and complement their results, further supporting the efficacy and safety of Saw Palmetto in the treatment of Androgenetic Alopecia.

Regarding safety, while oral Saw Palmetto has been associated with serious side effects, including coagulopathy, evidenced by prolonged prothrombin time and hematuria (Şencan & Doğan, 2024), its topical form appears to be safer. There have been case reports of patients developing severe complications, such as widespread ecchymoses and renal failure, necessitating treatment with vitamin K and fresh frozen plasma. Additionally, acute pancreatitis has been reported in some patients, presenting with symptoms like epigastric pain and elevated pancreatic enzymes. (Şencan & Doğan, 2024) Mild gastrointestinal disturbances are also relatively common but often underreported. (Bruminhent et al., 2011) However, clinical studies suggest that topical Saw Palmetto is generally well tolerated, with no serious adverse events observed. Some individuals may experience mild scalp irritation or allergic reactions, but these effects are uncommon. (Evron et al., 2020) In our study, no adverse effects were reported among participants, supporting the safety of topical Saw Palmetto extract in this context.

In conclusion, the application of pure Saw Palmetto extract lotion topically has proven to be a safe and effective treatment for male Androgenetic Alopecia (AGA). However, our study had several limitations, including a relatively small sample size and short follow-up periods. Additionally, the study was conducted exclusively in a Thai population, leaving potential racial variations in response unexplored. Furthermore, our research focused solely on AGA stages I to III, and the efficacy of the treatment for more advanced stages remains uncertain. Future studies should address these limitations by evaluating AGA across different stages, involving a larger and more diverse patient population, and incorporating extended follow-up periods to better assess long-term outcomes.

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