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Research Article

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Pracaxi Oil as a Natural Remedy for Hyperpigmentation: Analyzing its Efficacy in Melasma and Post-inflammatory Hyperpigmentation

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Abstract

Hyperpigmentation, including melasma and post-inflammatory hyperpigmentation (PIH), presents significant dermatological challenges, often requiring safe and effective treatment options. This review investigates the efficacy of Pracaxi oil, an extract from the seeds of Pentaclethra macroloba, as a natural remedy for these conditions. The novelty of this research lies in its exploration of Pracaxi oil's potential as a therapeutic agent, focusing on its bioactive components, such as behenic acid, and its impact on melanin production and skin regeneration. Clinical trials and in vitro assays reveal that Pracaxi oil exhibits significant lightening effects, reduction in hyperpigmented lesions, and improvement in overall skin tone, potentially through modulation of melanogenesis and enhancement of skin barrier function. Areas for future research include determining the optimal concentration and application frequency, long-term safety, and comparative efficacy with other established treatments. Pracaxi oil demonstrates promising potential as a natural remedy for hyperpigmentation, offering a novel approach to managing melasma and PIH while underscoring the need for further investigation to fully establish its therapeutic role.

Introduction

The skin consists of two types of cells, known as keratinocytes and melanocytes, that contribute to the mechanical barrier and pigmentation of the skin, respectively. Melanin is the main protein in melanocytes that produces hair, eye, and skin pigmentation. An overproduction of melanin often causes hyperpigmentation or skin darkening. Melasma is an example of a hyperpigmentation condition triggered by various factors, including sun exposure, hormonal changes, medications, and genetics. However, most patches of discoloration are commonly developed in sun-exposed areas, especially after skin injury or inflammation. Ultraviolet radiation exposure from the sun has been shown to activate tyrosinase, the rate-limiting enzyme of melanin production. This mechanism acts as a protective measure indicated in photoaging and causes hyperpigmented lesions [1]. Therapies for hyperpigmentation disorders work to even out the appearance of skin tone by reducing dark spots and brightening skin. Current treatments for post-inflammatory hyperpigmentation (PIH) and melasma generally fall into broad categories, such as topical and systemic therapies, chemical peels, and laser or light-based treatments.

In comparison to conventional treatments, there have been investigative studies on less invasive alternatives for treating hyperpigmentation. One option includes botanical and naturally occurring ingredients that offers safer, more accessible, and less abrasive treatment [2]. An example of a possible botanical treatment is the use of Pracaxi oil. Pracaxi oil contains two major unsaturated fatty acids, oleic and linoleic acid, both potentially treating hyperpigmentation and melasma by decreasing tyrosinase levels and melanin synthesis [3,4]. Behenic acid contributes to Pracaxi oil's natural silicone base properties as the primary complex carbohydrate, which is commonly used to treat scarring and inflammation [5]. It can be postulated that by targeting tyrosinase, Pracaxi oil can regulate melanogenesis to treat pigmentation conditions. This review aims to examine the literary evidence supporting the clinical utility of Pracaxi oil in treating PIH and melasma.

Bioactive Components of Pracaxi Oil

Pracaxi oil is derived from the seeds of the *Pentaclethra macroloba* tree, native to the Amazon region. This oil is rich in bioactive compounds, particularly pectic compounds and long-chain fatty acids such as oleic, linoleic, and behenic acids, which are well-known for their moisturizing and emollient properties. The high saturation of these fatty acids contributes significantly to Pracaxi oil's ability to nourish and protect the skin [6]. Pectic compounds, primarily composed of galacturonic acid units, play a crucial role in maintaining the structural integrity of the skin by supporting the repair and function of the skin barrier. In addition to their impact on skin texture, these compounds help regulate skin repair, making them vital in the wound-healing process. Moreover, the long-chain fatty acids in Pracaxi oil act as precursors to prostaglandins, vasodilators that facilitate the inflammatory phase of wound healing [7]. Unsaturated fatty acids, like those found in Pracaxi oil, are particularly important for maintaining the skin's intercellular lipid complex, which is essential for upholding the integrity of the skin barrier.

Fatty acids are generally categorized into three types: saturated, monounsaturated, and polyunsaturated. While the specific fatty acid composition varies across different oils, certain types typically predominate. For example, a comparative study of Pracaxi oil from different regions—São Domingos, Marituba,

and Belém—found that oleic acid (a monounsaturated fatty acid) is the predominant unsaturated fatty acid in Pracaxi oil, constituting 59% of its composition. Behenic acid, a saturated fatty acid, accounts for approximately 14% [8]. These fatty acids enhance the skin's moisture retention and help protect against external irritants, reducing inflammation and supporting overall skin health.

Histochemical analyses of *P. macroloba* seeds have further revealed the presence of lipids and pectic compounds in the cuticles of the seed cotyledons, suggesting that these bioactive components may help maintain the skin's protective barrier and promote healing. Given this composition, Pracaxi oil shows promise in treating hyperpigmentation disorders like PIH and melasma. The moisturizing and protective properties of the lipids and their ability to reduce inflammation and promote a more even skin tone highlight the oil's potential as a therapeutic agent for managing skin pigmentation issues [7].

Clinical Evidence

Limited research has been conducted to understand the specific mechanisms through which Pracaxi oil may affect hyperpigmentation, particularly in conditions such as melasma. However, existing studies suggest that vegetable oils rich in unsaturated fatty acids, like Pracaxi oil, may inhibit tyrosinase, a key enzyme in melanin synthesis, by competing for the enzyme's active sites and chelating copper ions due to their hydrophobic components and phytoconstituents [9]. In an in vitro assay evaluating the ability of various seed oils to inhibit the mushroom tyrosinase enzyme, Pracaxi oil demonstrated significant tyrosinase inhibition ($p < 0.05$) compared to kojic acid, a well-established skin-lightening agent. These findings underscore Pracaxi oil's potential in regulating melanin production and highlight its promise as a therapeutic agent for hyperpigmentation by inhibiting melanogenesis [9].

In addition to its potential for treating hyperpigmentation, Pracaxi oil has been investigated for its wound-healing properties. In vitro assays have demonstrated that Pracaxi oil may support scar healing, and clinical studies have validated these findings. For instance, a silicone-based Pracaxi oil formulation improved scar appearance and facilitated the complete closure of a diabetic ulcer within three days [6,10]. Despite these encouraging results, clinical trials evaluating the in vivo efficacy of Pracaxi oil in treating hyperpigmentation remain limited. A notable exception is a double-blind study conducted in 2023 by Banov, Carvalho, Schwartz, and Frumento, which evaluated the effects of a facial serum both with and without a liposomal blend containing Pracaxi oil. This study reported statistically significant improvements in skin clarity, texture, radiance, and overall complexion health ($p < 0.05$); however, no significant changes were observed in wrinkles, age spots, or skin elasticity [11]. These results suggest that while Pracaxi oil may improve certain aspects of skin appearance, its effects on other signs of aging may be limited. Nonetheless, the study highlights the potential of liposomal formulations of Pracaxi oil in refining its efficacy for treating conditions like post-inflammatory hyperpigmentation (PIH) and melasma, with future research needed to optimize concentration and formulation adjustments for enhanced clinical outcomes.

Comparative Analysis with Established Treatments

Established treatments for hyperpigmentation, such as hydroquinone, retinoids, laser therapies, and chemical peels, are widely recognized for their efficacy. Hydroquinone, often considered the gold standard, inhibits tyrosinase activity and selectively induces melanocyte toxicity, thereby reducing melanin production and lightening hyperpigmented areas. Similarly, retinoids—vitamin A derivatives—also target tyrosinase while promoting increased cell turnover and collagen synthesis, thereby improving overall skin texture and reducing hyperpigmentation [4]. Although both treatments are considered relatively mild, more aggressive alternatives, such as laser therapies and chemical peels, are employed in cases resistant to topical treatments.

Through selective photothermolysis, laser therapy targets melanin using specific wavelengths of energy, effectively destroying excess pigment while minimizing damage to surrounding tissues [12]. In contrast, chemical peels utilize glycolic or salicylic acid acids to exfoliate the skin's surface layers. This process facilitates the removal of pigmented cells and stimulates dermal remodeling, promoting collagen production and improving skin texture and tone [13]. Each of these treatment modalities can be tailored to the specific type and severity of hyperpigmentation, and they are frequently used in combination to achieve optimal results.

In contrast to these conventional treatments, Pracaxi oil offers a natural and potentially more accessible option for treating hyperpigmentation. However, significant limitations remain regarding its clinical application. For instance, the scarcity of extensive clinical trials and long-term safety data constrains its widespread adoption, especially compared to well-established treatments like hydroquinone and retinoids. Additionally, questions surrounding the optimal concentration, frequency of application, and potential side effects of Pracaxi oil remain unresolved, necessitating further research. A study by Pires et al. (2022) found that Pracaxi oil, at concentrations of 31, 125, and 500 µg/mL, did not induce DNA damage, alter the cell cycle, or promote apoptosis in human hepatocarcinoma cells (HepG2/C3A) [14]. Furthermore, these concentrations did not reduce cell viability, indicating that Pracaxi oil exhibits no cytotoxic effects at these levels. Despite these findings, the study did not definitively confirm the oil's safety for human medicinal use. Consequently, further in vitro and in vivo research is required to establish its short- and long-term safety profiles and evaluate its therapeutic efficacy in hyperpigmentation disorders.

Future Research Directions

A deeper and more comprehensive understanding of the molecular and cellular mechanisms underlying the efficacy of Pracaxi oil is essential for its potential application in dermatology. Preliminary research suggests that Pracaxi oil inhibits tyrosinase activity and modulates melanin production; however, further investigation is required to elucidate the precise biochemical pathways through which these effects are mediated [9]. For instance, it remains unclear whether Pracaxi oil possesses antioxidant or anti-inflammatory properties that may enhance its effectiveness in treating skin conditions. Both antioxidant and anti-inflammatory actions play pivotal roles in skin health, contributing to the reduction of oxidative stress and inflammation, which are central to the pathogenesis of hyperpigmentation and other dermatological disorders [6]. Additionally, research exploring Pracaxi oil's capacity to reinforce the skin barrier by modulating lipid composition or affecting hydration levels could provide further insight into its mechanism of action. Investigating its interaction with the skin

microbiome and how its bioactive compounds are metabolized by skin cells could also offer valuable insights into its broader dermatological implications [7]. Furthermore, molecular studies could probe the impact of Pracaxi oil on gene expression related to melanogenesis, collagen synthesis, and wound healing, thereby offering a more targeted approach to treating specific dermatological conditions [8].

Another critical area of investigation is determining the optimal concentration and application regimen for Pracaxi oil in treating hyperpigmentation and related conditions such as melasma. Given the heterogeneity of skin types and pigmentation disorders, clinical trials must evaluate various dosages and treatment durations to establish the most efficacious therapeutic protocol [13]. Additionally, modifications in the formulation of Pracaxi oil—such as its incorporation into liposomal, nanoemulsion, or other advanced delivery systems—could enhance its stability and penetration, increasing its clinical utility [11]. Incorporating Pracaxi oil into gel-based or other topical systems may also improve the bioavailability of its active components, facilitating more effective treatment outcomes. Moreover, research should also examine the influence of external environmental factors, such as ultraviolet (UV) exposure and humidity, on the efficacy of Pracaxi oil, providing more precise recommendations for its use in various climates. Combining Pracaxi oil with other bioactive agents, such as antioxidants, peptides, or well-established skin-lightening agents, may further enhance its therapeutic potential and support more individualized treatment protocols for patients with differing skin types and conditions [12].

While preliminary studies indicate that Pracaxi oil holds considerable promise as a treatment for hyperpigmentation, the long-term safety profile of its use in dermatological applications must be rigorously assessed. Potential adverse effects, such as skin irritation, sensitization, or unintended impacts on melanocyte function, must be evaluated through well-designed long-term clinical trials [14]. Furthermore, it is essential to ascertain whether the short-term therapeutic benefits observed in reducing hyperpigmentation or improving wound healing are sustained over extended periods of use. Future research should examine whether Pracaxi oil can effectively prevent recurrence in conditions such as melasma, where relapse is common. Longitudinal studies that assess its long-term efficacy and safety are critical for determining its role in managing chronic pigmentation disorders. Additionally, real-world studies and post-marketing surveillance could provide valuable data on potential side effects and interactions with other commonly used dermatological agents, contributing to a more comprehensive understanding of its safety and efficacy in broader clinical contexts [10]. These insights will be crucial for refining Pracaxi oil's application in dermatology and ensuring its suitability for a wide range of patients.

Conclusion

Pracaxi oil, extracted from the *Pentaclethra macroloba* tree, is rich in long-chain fatty acids that contribute to its vasodilating properties and skin barrier protection, making it a promising candidate for treating hyperpigmentation. Its potential to inhibit tyrosinase and thereby reduce excess melanin production highlights its efficacy in addressing conditions like melasma and PIH. Preliminary studies have also demonstrated Pracaxi oil's effectiveness in healing scars, suggesting broader implications for its use in skin treatments.

While early findings indicate that Pracaxi oil may offer a gentler and potentially safer alternative to conventional treatments such as hydroquinone and retinoids, further study is warranted to confirm its clinical efficacy and long-term safety. Further research, including extensive clinical trials, is necessary to determine the optimal concentrations, application methods, and overall therapeutic potential of Pracaxi oil. Investigations into its interactions with other active ingredients commonly used in dermatology could also expand its application range, particularly in combination therapies. Should future studies confirm its effectiveness and safety, Pracaxi oil could become a valuable addition to the range of treatments available for managing hyperpigmentation and other related skin conditions, offering a natural, multi-faceted approach to skin health that balances efficacy with minimal side effects.

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