



“HERBAL AND BOTANICAL AGENTS IN THE TREATMENT OF MELASMA: A REVIEW OF INGREDIENTS, DEVELOPMENT & EVALUATION”

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ABSTRACT

Melasma is a chronic skin pigmentation disorder characterized by symmetrical brownish or grayish patches, primarily on the face, and it predominantly affects women. The condition is influenced by factors such as hormonal changes, genetic predisposition, and sun exposure, making it both persistent and challenging to treat. Conventional treatments like hydroquinone, chemical peels, and laser therapies can provide temporary improvement, but they often come with side effects such as skin irritation, redness, or recurrence of pigmentation after stopping the treatment. In recent years, herbal and botanical agents have gained attention as safer alternatives due to their natural skin-lightening properties and minimal adverse effects. Several plant-derived compounds show promise in managing melasma because of their antioxidant, anti-inflammatory, and tyrosinase inhibitory activities. For example, Aloe vera soothes and hydrates the skin, Licorice (*Glycyrrhiza glabra*) reduces melanin production, Turmeric (*Curcuma longa*)

helps control pigmentation through its anti-inflammatory and antioxidant effects, while Green tea (*Camellia sinensis*) and Mulberry (*Morus alba*) inhibit melanin formation and protect the skin from oxidative stress. Integrating these herbal remedies with conventional therapies may offer a more balanced, safer, and long-term approach to controlling melasma, potentially reducing side effects while improving overall skin health.

KEYWORDS : Melasma, Hyperpigmentation, Facial pigmentation, Skin disorder, Women's skin health, Herbal treatment, Botanical agents, Aloe vera, Liquorice (*Glycyrrhiza glabra*), Turmeric (*Curcuma longa*), Green tea (*Camellia sinensis*), Mulberry (*Morus alba*), Tyrosinase inhibition, Antioxidant, Anti-inflammatory, Skin-lightening, Conventional therapy, Hydroquinone, Chemical peels, Natural remedies, Recurrence prevention.

INTRODUCTION

Melasma is a widespread, long-lasting skin condition that causes dark, discoloured patches on the face. These patches are usually symmetrical and commonly appear on areas like the cheeks, forehead, upper lip, nose, and chin. The condition is particularly common in women, especially those with darker skin tones, and often shows up during the reproductive years. Hormonal changes, such as those during pregnancy, the use of birth control pills, or hormone therapy, can trigger melasma. Sun exposure is another key factor, as ultraviolet (UV) rays stimulate pigment-producing cells in the skin. Other contributors include genetics, certain medications, and even some cosmetic products.

While melasma does not cause physical pain or danger, it can affect a person's confidence and overall well-being due to its visible nature. The condition arises from a mix of factors:

increased activity of melanocytes (cells that produce pigment), abnormal distribution of pigment within the skin, oxidative stress, and changes in the small blood vessels in the skin. Because melasma tends to be persistent and can recur after treatment, managing it can be challenging for both patients and dermatologists.



Types of Melasma

Melasma is commonly categorized by the depth of the pigment in the skin and by its appearance:

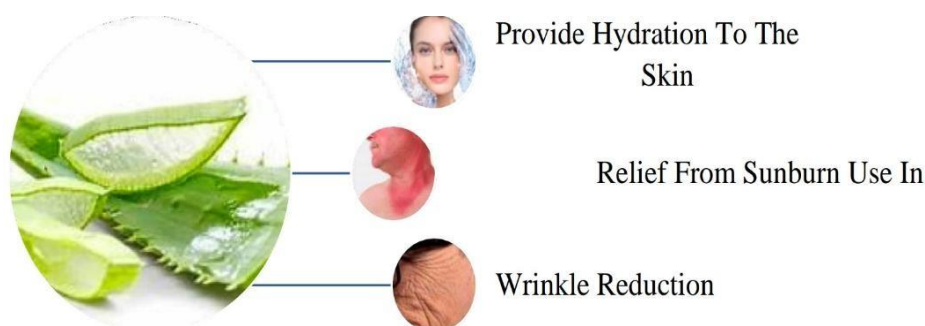
1. **Epidermal Melasma:** This type involves pigment in the upper layers of the skin. It appears as well-defined, dark brown patches. Under a Wood's lamp (a special UV light used in dermatology), the pigmentation becomes more visible, which helps confirm that it is in the epidermis. Epidermal melasma usually responds well to creams and topical treatments combined with sun protection.
2. **Dermal Melasma:** Here, the pigment is deeper in the skin, within the dermis. It shows up as bluish-grey or grey-brown patches with less distinct edges. A Wood's lamp does not make this type more visible. Because it is deeper, dermal melasma is harder to treat and may require procedures like laser therapy or combination approaches.
3. **Mixed Melasma:** This is the most common type, showing characteristics of both epidermal and dermal melasma. The patches are dark brown, irregularly shaped, and vary in intensity. Some parts of the pigment are visible under a Wood's lamp while others are not. Mixed melasma often needs a combination of topical treatments, procedural therapies, and diligent sun protection.
4. **Unclassified or Indeterminate Melasma:** In certain cases, the pigmentation pattern does not clearly fit the above categories. These cases may need closer examination with dermoscopy, Wood's lamp evaluation, or even a biopsy to determine the depth of pigment and guide treatment.



Common Herbal and Botanical Agents Used in Melasma

Aloe-vera (*Aloe barbadensis miller*): A comprehensive study published in December 2024 explored the biochemical composition and dermatological significance of Aloe vera. The findings highlighted that the plant's bioactive constituents—particularly polysaccharides and essential vitamins synergistically contribute to skin hydration, reduction of inflammation, and

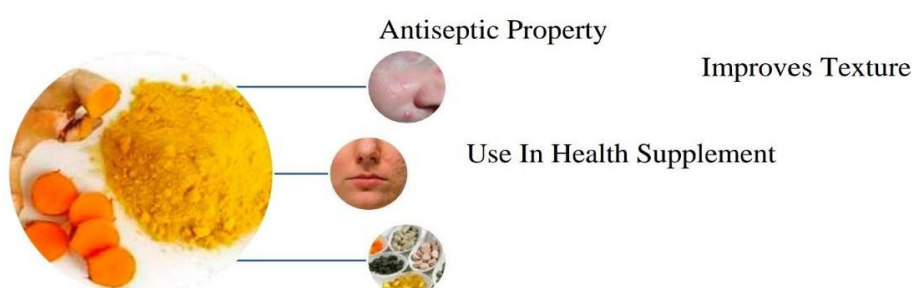
promotion of wound healing. Due to these properties, Aloe vera demonstrates notable efficacy in managing various dermatological conditions, including psoriasis, acne, melasma, and premature skin aging. The study further emphasized its growing importance in cosmetic formulations such as sunscreens and products designed for sensitive skin. Additionally, it suggested that future advancements may focus on integrating emerging technologies like nanotechnology and adopting sustainable cultivation methods to further enhance the dermatological potential and commercial value of Aloe vera.



Liquorice (Glycyrrhiza glabra): Recent studies have focused on improving the extraction of Liquorice (*Glycyrrhiza glabra*) root using a water–glycerol mixture, which has produced extracts with strong antioxidant activity. These extracts can effectively block important enzymes related to skin pigmentation, such as tyrosinase, which helps form melanin, and elastase, which contributes to skin aging. The antioxidant properties of Liquorice help reduce oxidative stress, one of the main causes of melasma. Because of these benefits, glycerol-based Liquorice extracts show great potential for use in skincare products that aim to reduce dark spots and treat melasma. In addition, Liquorice is well known for its calming and anti-inflammatory effects, which can help prevent skin irritation often caused by conventional melasma treatments.



Turmeric (*Curcuma longa*): A detailed study accepted for publication in 2024 examined the growing use of Turmeric (*Curcuma longa*) in the cosmeceutical field. The researchers emphasized its powerful antibacterial, anti-inflammatory, and antioxidant properties, which have made turmeric a key ingredient in many skincare formulations. It is especially valued for its ability to calm skin inflammation, enhance brightness, delay signs of aging, treat dandruff, support hair growth, and maintain a healthy scalp. Although turmeric is generally safe for most people, some individuals may experience mild irritation, highlighting the importance of ongoing research to further optimize its formulations and improve both safety and effectiveness in cosmetic applications.



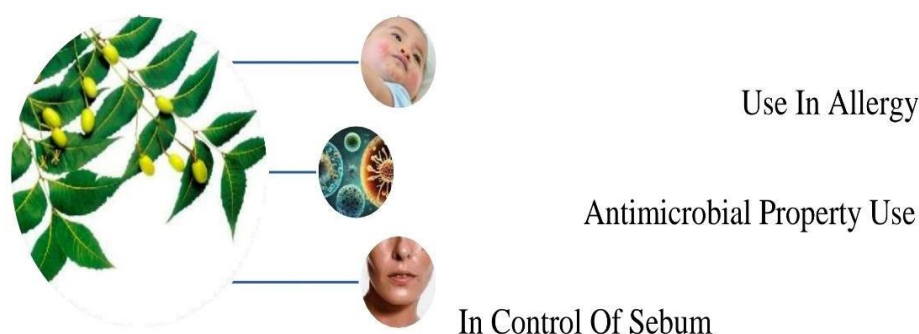
Green Tea (*Camellia sinensis*): A recent scientific study explored the growing interest in Green Tea (*Camellia sinensis*) as a natural ingredient for treating melasma and improving overall skin health. The research highlighted that green tea is rich in polyphenols, especially epigallocatechin gallate (EGCG), which provides strong antioxidant, anti-inflammatory, and depigmenting effects. These compounds help reduce excessive melanin formation by inhibiting the enzyme tyrosinase and protecting the skin from oxidative stress caused by UV exposure. Regular use of green tea extracts in skincare formulations has shown promise in lightening dark patches, soothing irritated skin, and preventing further pigmentation. While generally safe and well-tolerated, mild sensitivity may occur in some individuals, emphasizing the need for further studies to enhance its stability and effectiveness in topical treatments for melasma.



Saffron (*Crocus sativus*): Recent studies have highlighted the growing use of Saffron (*Crocus sativus*) in the management of melasma and other pigmentation disorders. The research emphasizes that saffron contains potent bioactive compounds such as crocin, crocetin, and safranal, which exhibit strong antioxidant, anti-inflammatory, and skin-lightening properties. These compounds help reduce melanin synthesis by inhibiting tyrosinase activity and protecting skin cells from oxidative stress. Regular application of saffron-based formulations has shown promising results in improving skin tone, reducing dark patches, and promoting a natural glow. Generally considered safe, saffron is also known for its soothing effects on the skin, though mild sensitivity may occur in some individuals, indicating the need for further studies to optimize its concentration and stability in topical treatments for melasma.



Neem (*Azadirachta indica*): A recent study developed a Neem (*Azadirachta indica*)-based lotion and tested its effects on the skin, focusing on its antimicrobial activity and safety. The results showed that the lotion had strong germ-fighting properties and did not cause any irritation or discomfort, making it a safe option for regular skincare use. The study also found that using the neem lotion helped reduce excess oil (sebum) on the skin and improved overall hydration, leaving the skin feeling softer and fresher. People who used the product shared positive feedback, mentioning that it was easy to apply, absorbed well, and had a pleasant, natural fragrance. These findings suggest that neem-based formulations can be both effective and gentle, offering a natural alternative for maintaining healthy and clear skin.



Clinical Evidence and Efficacy

Several clinical studies have provided strong evidence supporting the effectiveness of various herbal extracts in improving melasma and other pigmentation-related disorders. These natural agents, known for their bioactive compounds, have been increasingly explored as safer alternatives to conventional depigmenting agents like hydroquinone, which often carry risks of irritation and rebound pigmentation. For example, a well-controlled randomized clinical trial evaluating the use of topical Liquorice (*Glycyrrhiza glabra*) extract reported a significant decrease in pigmentation intensity within eight weeks of regular application. The improvement was attributed to the presence of glabridin, a potent tyrosinase inhibitor that helps regulate melanin synthesis without damaging skin cells.

Similarly, formulations containing Turmeric (*Curcuma longa*) have demonstrated comparable depigmenting effects to 2% hydroquinone creams, yet without the adverse effects commonly associated with synthetic agents. Turmeric's active compound, curcumin, exhibits both antioxidant and anti-inflammatory actions, helping to reduce oxidative stress and suppress melanocyte activity, resulting in a more even skin tone over time.

In addition, Green Tea (*Camellia sinensis*) and Aloe vera (*Aloe barbadensis* Miller) gels have been shown to produce measurable improvements in melanin index and overall skin appearance. Clinical observations have reported increased patient satisfaction due to better skin texture, reduced redness, and mild brightening effects. These natural extracts act through multiple pathways—by inhibiting tyrosinase, reducing free radical damage, and enhancing skin hydration—making them suitable for long-term use in individuals with sensitive skin.

However, the degree of improvement in melasma varies depending on several factors, including the formulation type, concentration of active compounds, frequency of application, and duration of treatment. Differences in extraction methods and carrier bases can also influence the stability and absorption of herbal actives. Therefore, while current findings are

promising, further standardized and large-scale clinical trials are needed to establish optimal dosages, treatment protocols, and long-term safety profiles for herbal-based therapies in the management of melasma.

Safety and Advantages of Herbal Therapy

Herbal formulations are generally recognized as safe and well-tolerated for long-term use, making them a preferable alternative to conventional chemical depigmenting agents. Unlike synthetic treatments such as hydroquinone or retinoids, herbal-based products rarely cause skin irritation, redness (erythema), or rebound pigmentation after discontinuation. Their gentle nature allows for prolonged application without compromising the skin barrier, which is particularly beneficial for individuals with sensitive or reactive skin.

Another key advantage of herbal formulations lies in their multi-targeted mode of action. The bioactive compounds found in plant extracts often work synergistically to inhibit melanin synthesis, neutralize free radicals, and promote skin repair. Their strong antioxidant and anti-inflammatory properties not only help in managing pigmentation disorders like melasma but also contribute to overall skin rejuvenation by improving texture, hydration, and elasticity.

However, despite their therapeutic potential, certain challenges still limit the widespread standardization and clinical reliability of herbal products. Factors such as variability in plant sources, differences in extraction techniques, and formulation stability can lead to inconsistency in product efficacy. Moreover, the absence of universally accepted dosing guidelines and clinical standardization often makes it difficult to compare results across studies. Addressing these issues through advanced extraction methods, improved formulation technology, and rigorous clinical testing could significantly enhance the credibility and effectiveness of herbal formulations in dermatological care.

Future Prospects and Challenges

Future research in the field of melasma management should prioritize the development of standardized herbal formulations with consistent composition and potency. Efforts should be made to optimize extraction techniques to ensure maximum yield of active phytochemicals while maintaining their stability and bioactivity. Additionally, there is a need for well-designed, large-scale clinical trials to rigorously evaluate the safety and efficacy of these herbal treatments across diverse patient populations. Emerging technologies, such as nanotechnology-based delivery systems—including herbal nanoparticles, nano emulsions,

and liposomes—offer promising approaches to enhance the penetration of active compounds into the skin, improve their stability, and increase therapeutic effectiveness. Moreover, combining herbal agents with conventional therapies may provide synergistic benefits, potentially enhancing treatment outcomes while reducing the risk of adverse effects. Such integrated strategies could ultimately contribute to the development of safer, more effective, and sustainable therapeutic options for the management of melasma.

CONCLUSION

Herbal and botanical agents offer a promising, safe, and effective alternative to conventional synthetic depigmenting therapies in the management of melasma. These natural compounds exhibit a range of beneficial properties, including antioxidant, anti-inflammatory, and tyrosinase-inhibiting activities, which allow them to act on multiple pathways involved in melanin production and accumulation. Although existing studies support their therapeutic potential, variability in plant sources, extraction methods, and formulations can lead to inconsistent clinical outcomes. Therefore, future research should focus on standardizing herbal preparations, optimizing delivery methods, and conducting rigorous clinical trials to ensure reproducible efficacy and long-term safety in diverse patient populations.

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