ISSN No: 0976-5921

Review Article

Therapeutic Potential of *Terminalia arjuna* (Arjuna) in Managing Melasma: A Review of Mechanisms and Applications

Rashmi Balage[1]*, Jaymala Jadhav[2], Kunal Bandurkar[1]

1. PG Scholar, Datta Meghe Institute of Higher Education And Research Centre, Sawangi Wardha. India.
2. HOD and Professor, Mahatma Gandhi Ayurveda College Hospital and Research Centre Sawangi Wardha. India.

Received: 21-02-2025 Accepted: 07-09-2025 Published: 31-12-2025

Abstract

Background: There are many causes of melasma. Melasma occurs mainly because of heredity, hormones, and the environment, mainly UV radiation. Melasma causes abnormal melanin production in the skin, resulting in patches of irregular pigmentation. It can cause serious cosmetic as well as psychological problems in the afflicted individuals. Although hydroquinone is a widely used man-made drug, its side effects prompted individuals to look for other natural remedies. Objective: This review explains how *Terminalia arjuna* works to bleach the skin. It explains its antioxidant activity, anti-inflammatory activity, and its modulating activity of melanin synthesis, all of which are implicated in Melasma. Discussion: *Terminalia arjuna* contains antioxidants like flavonoids, tannins, and phenolic acids. These reverse oxidative stress, one of the causative factors of Melasma. Its anti-inflammatory effect also protects the skin against harm through inhibition of damaging inflammation. Bark extract can affect melanin production through the control of an important enzyme tyrosinase. It also inhibits protein and skin pigmentation damage owing to environmental and metabolic stress. Conclusion: The therapeutic significance of *Terminalia arjuna* in the management of Melasma results from its multi-action against melanin pigmentation etiology. As a powerful, natural drug, it can be used in skin care routines to remove dark spots. Studies on its active components and products could potentially render it even more beneficial in modern skin care.

Keywords: Antioxidants, Depigmentation, Hyperpigmentation, Melanin, Oxidative stress, Traditional remedies.

Access this article online

Website: https://ijam.co.in

DOI: https://doi.org/10.47552/ijam.v16i4.5873

Introduction

Melasma is a highly prevalent skin disorder that presents as hyperpigmented macules most frequently observed over sun-exposed areas like the face and forearms. Melasma is a benign condition with significant psychosocial concerns owing to its cosmetic appearance. Melasma pathogenesis is complex and multifactorial with influences from genetic susceptibility, hormonal factors, and external exposures like ultraviolet (UV) light. Although the most common conventional treatments include hydroquinone, retinoids, and chemical peels, great interest has been generated regarding the most common side effects and toxicity profiles of these drugs. Among the natural medicines under review is *Terminalia arjuna*, an Ayurvedic herbal drug that has been used for decades in traditional Ayurvedic medicine. The bark of the plant is flavonoids, tannins, and glycosides rich and exhibits good antioxidant, anti-inflammatory, and depigmenting activity (1) The plant has been used traditionally in cardiovascular and skin diseases, and the recent study also ascertained its potential in reducing oxidative stress and melanogenesis. *Terminalia Arjuna* in this respect seems one of the best fit candidates for treatment of Melasma or other pigmentation disorder (2).

The search for natural therapies is a larger step in the way towards the convergence of traditional knowledge and modern science. Natural therapies are more biocompatible and less prone to producing harmful side effects, hence best suited for chronic conditions such as Melasma that require long-term treatment. In this review, existing information on *Terminalia arjuna* and its theoretical uses in treating hyperpigmentation is combined. It is interested in its modes of action and traditional uses and stresses the need for greater research to establish its efficacy and safety profile definitively (3).

Background

Hyperpigmentation disorders, notably Melasma, occur only in a considerable percentage of the world's population, popular among darker-skinned individuals. Symmetrical brown and greyish-brown patches characterise the skin's appearance. It becomes worse under UV rays exposure as well as under hormonal changes such as pregnancy or taking oral contraceptives. Melasma has been linked to an enormous psychosocial burden due to its effect on quality and self-esteem (4).

*** Corresponding Author:**
Rashmi Balage
PG Scholar,
Datta Meghe Institute Of Higher Education And Research Centre, Sawangi, Wardha India-517561.
Email Id: rashmibalage0@gmail.com

The core causes of this condition are oxidative stress, inflammation, and hormonal disturbances through the overproduction of melanin. Although well-established treatments yield good results, they are connected with adverse reactions, opening the way to safer alternatives for treatment. More specifically, such natural remedies of plant origin come into consideration and are viable based on their strong composition of biologically active substances that act by targeting several paths involved in pigmentation (5).

Terminalia arjuna is a South Asian deciduous tree that has been extensively used for centuries due to its medicinal importance. The drug from this tree, with antioxidant and anti-inflammatory activity, was traditionally used in treating several diseases (6).

Review of Literature

Melasma is a condition that is difficult to treat due to its multifactorial aetiology and chronic nature. Recent studies have highlighted the importance of oxidative stress and inflammation in its pathogenesis. Traditional plant-based medicines, including *Terminalia arjuna*, have been considered promising due to their multifunctional actions directed towards both symptoms and aetiopathogenesis of Melasma. Though the present literature, further work is needed in establishing standardised preparations and dosing for clinical use, as shown in Table/figure 1 (6).

Table 1: Previous Work Done (7,8,9,10,11,12)

Author (Year)	Study Design	Intervention/Focus	Primary Outcomes	Key Findings	Limitations/Remarks
Perera et al. (2024) (7)	*In vitro* experimental	T. arjuna bark extracts vs glycation/ oxidative stress	Protein glycation, tyrosinase activity, antioxidant capacity	Significant reduction in glycation ($p<0.05$), enhanced antioxidant activity, tyrosinase inhibition	Limited to laboratory conditions; requires clinical validation
Parvizi et al. (2024) (8)	Scoping review	Herbal remedies for melasma treatment	Safety and efficacy profiles	Identified 15 promising plant-based therapies with moderate evidence quality	Heterogeneous study designs; need for standardized protocols
Merecz-Sadowska et al. (2022) (9)	Narrative review	Plant compounds modulating melanogenesis	Mechanistic pathways, bioactive compounds	Documented multiple anti-melanogenic pathways; highlighted flavonoids and phenolic acids	Primarily theoretical; limited clinical translation
Kheirieh et al. (2024) (10)	Randomized controlled trial	T. chebula 5% cream vs hydroquinone 2%	MASI score reduction, skin tolerance	Comparable efficacy (MASI reduction: 65% vs 70%, $p>0.05$), better tolerance profile	Small sample size; 12-week follow-up only
Tekade & Khendkar (2021) (11)	Single-arm clinical trial	T. arjuna bark lepa application	Pigmentation intensity, patient satisfaction	73% improvement in pigmentation, 90% patient satisfaction after 8 weeks	Lack of control group; subjective outcome measures
Shelotkar et al. (2021) (12)	Comparative clinical study	Arjun Twak Lepa vs Kukkutand Pottali	Clinical improvement score, adverse events	Both treatments effective (80% vs 75% improvement), minimal side effects (<5%)	Open-label design; short follow-up period

Legend: The information synthesized in this review underscores the importance of integrating traditional knowledge with scientific research to develop safe and effective treatments for Melasma. Future studies should standardize formulations and establish clinical guidelines for using *Terminalia arjuna* in dermatology.

Methodology

Data Extraction: A systematic review of the available literature in the published peer-reviewed articles, clinical studies, and traditional knowledge sources relevant to *Terminalia arjuna*, particularly on treating hyperpigmentation, was performed. Keywords were searched on PubMed, Scopus, and Google Scholar with a keyword set containing "*Terminalia arjuna*," "pigmentation disorders," "antioxidants," and "melasma treatment."

Results

Melasma Pathophysiology

Melasma is a polyfactorial type of pigmentation disorder that characteristically affects predominantly the face but can also reach other sun-exposed parts of the body. It can be described as an over-production and irregular accumulation of melanin. Melanins are produced from melanocytes due to melanogenesis; an enzyme called tyrosinase is necessary for the production of melanins. UV rays also cause oxidative stress, and thus, high levels of ROS damage cellular structures, enhancing melanocyte activity (13).

Another very significant factor in the pathophysiology of Melasma is hormonal imbalances, especially in females. Reproductive hormones, such as estrogen and progesterone, stimulate melanogenic proteins and increase pigmentation. Genetic factors are a part of the etiology of Melasma, with a significantly higher prevalence among individuals of Fitzpatrick skin types III-V (14).

Chronic inflammation also contributes to it because cytokines and inflammatory mediators stimulate melanogenesis and cause disruption of the epidermal barrier. Vascularization and alteration in dermal structure may also contribute further towards the development of Melasma. Such complex pathophysiology makes it challenging to address treatment maneuvers to simultaneously improve pigmentation, oxidative stress, and inflammation (15).

Limitations of the Current Melasma Treatments

The treatment of Melasma is very challenging because it has a complex etiology, chronic nature, and high recurrence rates. Traditional therapies focus mainly on producing melanin, hydroquinone, retinoids, and corticosteroids. They often cannot tackle the root causes of inflammation and oxidative stress. The long-term use of these agents leads to various adverse effects, such as skin irritation, ochronosis, and photosensitivity (16).

Laser and light-based treatments may be associated with temporary improvements but pose risks of post-inflammatory hyperpigmentation, particularly in darker skin types. The response is also typically transient; in many cases, pigmentation recurs when treatment is stopped (17).

Another limitation is that treatment approaches cannot be personalised. Melasma varies significantly between individuals based on skin type, hormonal influences, and environmental factors, thus requiring tailored therapies. In addition, the psychosocial impact of Melasma, including reduced self-esteem and quality of life, necessitates holistic management strategies (18).

These are just some of the challenges why people have been highly interested in natural and plant-based remedies such as *Terminalia arjuna* that would provide a safer, multi-action approach in treating Melasma through pigment, oxidative stress, and inflammation without side effects (19).

Traditional Use of *Terminalia arjuna*

Terminalia arjuna is one of the most medicinally valued trees in Ayurvedic medicine, and it has been used for centuries to treat various diseases, mainly heart-related diseases. This medicinal tree's bioactive-containing bark has traditionally been used as decoction, paste, or powder to treat heart diseases, ulcers, and skin disorders (20).

Ayurvedic texts have quoted *Terminalia arjuna* for its cooling, astringent, and healing properties. The plant is typically used for skin-related issues, such as pigmentary disorders, wounds, and burns. It has an extraordinary holistic value attributed to the phytochemical composition of flavonoids, tannins, glycosides, and saponins (21).

Terminalia arjuna has many established uses by the most recent scientific research as an antioxidant, anti-inflammatory, and antimicrobial, thus making it very effective in managing Melasma by controlling factors like oxidative stress and inflammation (22).

Integration into modern skincare formulation depicts the union of traditional wisdom with newer scientific advancement for a natural approach to managing skin disorders (23).

Phytochemical Composition of *Terminalia arjuna*

Terminalia arjuna's bark is a treasure house of bioactive compounds, and each of these contributes to its therapeutic potential. The key constituents include flavonoids, tannins, saponins, glycosides, and phenolic acids, which exhibit very potent antioxidant and anti-inflammatory properties in combination (24).

Flavonoids such as quercetin and kaempferol are involved in free radical scavenging activities, preventing oxidative stress-related cellular damage in the skin. Due to their property of being an astringent, Tannins give elasticity to the skin and reduce inflammation; they could thus be helpful in controlling disorders such as Melasma (25).

Saponins and glycosides help in skin cell repair and regeneration by inducing collagen synthesis and maintaining skin elasticity. In addition, phenolic acids act as photoprotectors by nullifying the effects of UV-induced damage (26).

Together, these compounds act synergistically, making Terminalia arjuna a potential candidate for dermatological applications. With its ability to target various pathways involved in melasma pathogenesis, the phytochemical profile of this drug provides a safe, natural, and effective alternative to synthetic treatments, as shown in Table/figure 2, (27).

Table 2: Phytochemical Properties and Benefits of *Terminalia arjuna* (28,29,30,31,32,33)

Authors et al.	Phytochemical Components	Key Benefits	Mechanism of Action
Darenskaya MA et al., 2021 (28).	Flavonoids	Antioxidant reduces oxidative stress	Neutralizes free radicals, supports skin repair
Dearlove RP et al., 2008 (29).	Tannins	Anti-inflammatory enhance skin tone	Suppresses inflammation, promotes collagen synthesis
Di Petrillo A et al., 2016 (30).	Saponins	Anti-aging supports hydration	Improves skin elasticity and moisture retention
Działo M et al., 2016 (31).	Arjunic acid	Tyrosinase inhibition reduces hyperpigmentation	Regulates melanin production
Enujiugha VN, 2010 (32).	Glycosides	Antimicrobial properties	Protects skin from microbial infections
Gaikwad D et al., 2019 (33).	Proanthocyanidins	Prevents photoaging	Reduces UV-induced damage

Legend: The table outlines *Terminalia arjuna*'s phytochemical components, dermatological benefits, and mechanisms of action, highlighting its potential as a natural agent for skin care and treatment.

Mechanisms of Antioxidant Action in Skin Health

Antioxidants are pivotal in maintaining skin health by combating oxidative stress, a primary factor in skin aging and pigmentation disorders like Melasma. Oxidative stress occurs when reactive oxygen species (ROS) overwhelm the skin's natural antioxidant defences, leading to cellular damage and the overproduction of melanin (34).

In the skin, antioxidants balance ROS, inhibiting the effect of damage in melanocytes and keratinocytes. This would prevent the stimulation of tyrosinase, an enzyme responsible for melanin production. In addition, antioxidants support collagen synthesis that reduces wrinkle appearance, thereby maintaining the general integrity of the skin (35).

Terminalia arjuna contains various natural antioxidants, including flavonoids and phenolic compounds. These bioactive molecules protect the skin from oxidative damage and make it more resistant to environmental stressors like UV and pollution. Antioxidants in *Terminalia arjuna* help reduce inflammation and support the skin's repair mechanisms, resulting in a balanced, even skin tone, hence a holistic approach to managing pigmentation and skin care in general (35).

Role of *Terminalia arjuna* in Melanogenesis Modulation

The process of melanogenesis is regulated by tyrosinase and other enzymes, which are responsible for the synthesis of melanin and its pigmentary manifestations on the skin. Hyperactivity of melanocytes is a causative factor in disorders like Melasma, where hyperpigmentation occurs. Modulation of melanogenesis by the bioactive compounds, such as flavonoids and phenolic acids, that inhibit tyrosinase activity plays a vital role in *Terminalia arjuna* (36).

It reduces oxidative stress caused by the scavenging of reactive oxygen species (ROS), thus suppressing the hyperactivity of the abnormal melanocytes through the decreased activity of the melanogenic enzyme and the return of melanin balance. On the other hand, the antioxidant property of *Terminalia arjuna* protects the melanocytes and keratinocytes from UV-radiation-induced damage and exerts control over excessive pigmentation (37).

Terminalia arjuna has also been found to down regulate other signalling pathways, including the melanogenesis pathway that involves MITF. Thus, Terminalia arjuna addresses multiple mechanisms in the management of pigmentation. Its natural ability to normalise melanogenesis without causing irritation or adverse effects makes it a promising candidate for treating Melasma and other pigmentation disorders, especially when compared to synthetic agents like hydroquinone, as shown in Table/figure 3, (38).

Table 3: Role of *Terminalia arjuna* in Modulating Melanogenesis (39,40,41,42,43,44)

Authors et al.	Category	Mechanism of Action	Bioactive Compounds	Therapeutic Benefits	Advantages Of Synthetic Agents
Mojtabaee M et al., 2016 (39).	Tyrosinase Inhibition	Blocks melanin biosynthesis pathway	Arjunic acid, flavonoids	Reduces hyperpigmentation	Fewer side effects, natural origin
Suksaeree J et al., 2022 (40).	Antioxidant Activity	Neutralizes free radicals, prevents oxidative stress	Polyphenols, tannins	Protects skin from UV-induced damage	Dual action as skin protector and antioxidant
Mpofana N et al., 2022 (41).	Anti-inflammatory Properties	Reduces cytokine production in skin cells	Ellagic acid, gallic acid	Calms skin inflammation, reduces redness	Better tolerability in sensitive skin types
Yakaew S et al., 2016 (42).	Collagen Synthesis Support	Enhances fibroblast activity	Saponins	Improves skin elasticity and texture	Promotes natural repair mechanisms
Whitehead AL et al., 2016 (43).	UV Protection	Mitigates UV-induced DNA damage	Antioxidant compounds in bark	Prevents photoaging and sunburn	Long-lasting effects with lower chemical load
McKesey J et al., 2020 (44).	Synergistic Effects	Acts in combination with other bioactive	Triterpenoids, lignins	Enhances efficacy in herbal formulations	Broad-spectrum benefits support holistic care

Legend: The table summarises Terminalia arjuna's bioactive compounds, mechanisms, and therapeutic applications, highlighting its advantages as a natural, multifunctional, multifunctional alternative to synthetic dermatological agents.

Anti-inflammatory Activity of *Terminalia arjuna*

Chronic inflammation is one of the major contributors to Melasma and other skin disorders, as it causes melanocyte hyperactivity and derangement of skin homeostasis. Terminalia arjuna possesses potent anti-inflammatory activity and thus helps to reduce inflammation-induced pigmentation (45).

The bark extract of Terminalia arjuna contains tannins, flavonoids, and saponins that inhibit pro-inflammatory cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α). These compounds reduce the infiltration of inflammatory cells into the skin and suppress the release of mediators that exacerbate melanogenesis (46).

In addition, the astringent properties of tannins in Terminalia arjuna help soothe irritated skin and strengthen the epidermal barrier, thus minimising environmental triggers contributing to inflammation. It addresses acute and chronic inflammation, promoting skin repair and restoring pigmentation balance (47).

Compared to the usual anti-inflammatory treatment that results in skin thinning, Terminalia arjuna has the potential to be a safer natural alternative. This multi-potency action of the inflammation suggests its possible holistic approach for pigmentary disorders and other skin inflammatory diseases (48).

Comparison with Conventional Treatments

Conventional treatments for Melasma include hydroquinone, corticosteroids, and chemical peels, which primarily act by inhibiting melanin synthesis or exfoliating the hyperpigmented layers of the skin. These treatments have short-term efficacy but are associated with side effects such as irritation, thinning of the skin, and post-inflammatory hyperpigmentation (49).

Contrasted with the present pigmentation manager, which primarily targets only pigment overproduction, Terminalia arjuna addresses underlying disorders like oxidative stress and chronic inflammation. As differentiated from hydroquinone, directly inhibiting the tyrosinase enzyme by reducing the deposition of melanins, Terminalia arjuna directly neutralises oxidative free radicals involved in inflammation mechanisms responsible for protecting melanocytes and the actual inflammatory pathways-ensuring much steadier results with mild side effects, if any (50).

Table 4: Comparative Analysis of Treatments (52,53,54,55,56).

Authors	Conventional Treatments for Melasma	Mechanism of Action of *Terminalia arjuna*	Benefits Of Synthetic Agents	Adverse Effects and Limitations
Victor FC et al., 2004 (52).	Includes hydroquinone, retinoids, and corticosteroids.	Antioxidant properties reduce oxidative stress and inhibit melanogenesis.	Natural, safe, and reduces dependency on chemical agents.	Requires longer duration for visible effects.
Parvizi MM et al., 2024 (53).	Common side effects include irritation and rebound hyperpigmentation.	Anti-inflammatory activity promotes skin repair and reduces pigmentation.	Better tolerability and fewer side effects compared to hydroquinone.	Limited large-scale clinical evidence is available.
Jain S et al., 2009 (54).	Cost-effective and widely used for initial treatment phases.	Phytochemicals like flavonoids and tannins combat free radicals.	Potential for use in combination therapies for enhanced results.	Limited standardization in formulation and concentration.

Shelotkar P et al., 2021 (55).	Results may vary depending on patient compliance and skin type.	Supports melanin regulation through tyrosinase inhibition.	Sustainable with minimal environmental impact.	Requires further research on long-term safety and efficacy.
Joshi MS et al., 2021 (56).	It may require adjunct therapies to maintain results.	Improves skin tone by reducing hyperpigmentation naturally.	Easier accessibility in Ayurvedic practices.	Needs modernization for global dermatological applications.

Additionally, it is safer for long-term use and, therefore, ideal for use in sensitive individuals or those bound to develop complications from the more conventional treatments. The absence of side effects alongside its multiple mechanisms of action presents Terminalia arjuna as a better replacement or adjunct in treating some traditional therapies. Further research and formulation advancement would confirm its efficacy in dermatology, as shown in Table/figure 4, (51).

Legend: This table contrasts conventional treatments for Melasma with the benefits, mechanisms, and limitations of *Terminalia arjuna*, emphasising its potential as a safer, natural alternative

***Terminalia arjuna* Extracts Biocompatibility**

Terminalia arjuna is very safe and biocompatible; hence, it is attractive for dermatological applications. Being of natural origin, the extract of its bark is a non-toxic bioactive compound that is well tolerated by the skin. Most synthetic treatments risk adverse effects like irritation, sensitisation, or phytotoxicity, whereas Terminalia arjuna is minimal risk (57).

It has been well proven that safety tests upon topical preparations have clearly shown its excellent safety profile. Its active components further enhance its compatibility with the skin, inhibiting the mechanisms that may lead to inflammation and oxidative damage. Therefore, in cases of sensitive skin and possibly skin conditions that are irritated by harsh chemicals, Terminalia arjuna is especially recommended (58).

Also, tannins provide natural astringent properties without creating dryness and irritation. It thus underlines its biocompatibility as it would be gentle on the skin and effective in correcting pigmentation disorders (59).

Future approaches toward standardising extracts and optimised delivery systems would assure consistent safety and efficacy of Terminalia arjuna in the therapeutic and cosmetic fields so that it establishes its place in modern skincare applications (60).

Future Perspectives in Dermatological Applications

This has placed Terminalia Arjuna at the forefront of dermatological research and innovation in natural and sustainable solutions for skin disorders. With its antioxidant, anti-inflammatory, and tyrosinase-inhibiting properties, Terminalia arjuna presents a multi-dimensional approach to managing pigmentation disorders such as Melasma (61).

Future directions will involve the standardisation of extracts and advanced formulations, including nanoparticles or liposomal systems, to enhance the delivery and efficacy of its bioactive compounds. Terminalia arjuna can also be combined with other natural or synthetic agents for synergistic effects, improving outcomes in difficult-to-treat conditions (62).

Beyond the management of pigmentation, it could be used in other dermatological conditions, including aging, acne, and wound healing, which would make an entire usage of the holistic benefits on the skin. Clinical trials of higher intensity validate its efficacy and provide dosage guidelines for mainstream use. With increasing consumer demand for natural, safe, and effective skincare, Terminalia Arjuna has tremendous scope to transform dermatological treatment methodologies as alternative options to conventional therapy with minimal side effects and more significant benefits to skin health (63).

Discussion

Melasma is a polyfactorial skin condition described by brown, irregular patches commonly seen on sun-exposed skin. Topical agents, chemical peels, and laser treatments have been used but are constrained by side effects, high rates of recurrence, and individual differences. Plant-based treatments, and specifically Terminalia arjuna, with its bioactive constituents, have thus gained increasing attention due to their apparent therapeutic potential (64).

The bark of T. arjuna contains flavonoids, tannins, and glycosides which are also reported to be antioxidant in nature. These substances counteract oxidative stress by free radical scavenging activity, hence minimising the reactive oxygen species (ROS) responsible for melanocyte and keratinocyte injury and uncontrolled melanin synthesis. The primary mechanism of action includes the inhibition of tyrosinase, an essential enzyme in melanogenesis, thereby preventing excessive formation of melanin (65).

Apart from its antioxidant action, T. arjuna also has anti-inflammatory activity. Inflammation chronically worsens hyperpigmentation by activating cytokines that enhance melanocyte stimulation. Anti-inflammatory phytochemicals of T. arjuna suppress these pathways, facilitate healing of the skin, and restrict excessive pigmentation. It also has antiglycation action, which prevents dermal proteins from oxidative damage and hence from pigmentation abnormalities (66).

Current studies validate the Ayurvedic practice of using T. arjuna in cutaneous disorders. Formulations such as Arjun Twak Lepa, which is prepared from its bark, have registered promising results with fewer side effects, presenting a more natural, safer alternative to standard chemical treatments. Inadequate standardisation of formulations continues to be an overwhelming limitation in attaining reproducible clinical results (67).

In contrast to conventional treatments such as hydroquinone,—which, although effective as a tyrosinase inhibitor, is long-term safety risk-prone in the form of exogenous ochronosis and irritation—T. arjuna offers a more whole-system and eco-friendly alternative. With its multifaceted mechanism targeting oxidative stress, inflammation, and melanogenesis at the same time, efficacy and safety are both boosted (68).

Further studies should aim at characterising and purifying the particular bioactive molecules accountable for its depigmentary action. Standardised formulations accompanied by sound clinical studies could lead to the incorporation of T. arjuna into general dermatological practice, perhaps in combination with other herbal or standard drugs to maximize therapeutic resultsz(69).

Conclusion

Terminalia arjuna is a potential herbal therapy for the treatment of melasma by addressing its main pathogenic determinants—oxidative stress, inflammation, and dysregulated melanogenesis. Its antioxidant, anti-inflammatory, and tyrosinase inhibitory properties enable it to reduce pigmentation and improve the overall health of the skin. Compared to the traditional agents hydroquinone and retinoids, it is a safer profile with reduced side effect potential, in line with the new paradigm of natural, sustainable, and patient-centered dermatology. Ayurvedic traditional use, supported by increasing scientific evidence, strengthens its position as an adjunct as well as an alternative to melasma therapy. Its standardization of extracts and well-designed clinical trials are necessary to prove efficacy, determine optimal formulations, and ensure long-term safety. If effective, Terminalia arjuna has the possibility of transforming dermatological practice, offering an integrated, holistic perspective to the treatment of patients in need of effective management of pigmentation disorders with minimal side effects.

Ethical Considerations

The basis of this review was open-access literature with an adherence to research and publishing. The authors did not employ human or animal subjects in their work.

Acknowledgments

We gratefully acknowledge other researchers and institutions for their contributions to making the existence and use of Terminalia arjuna in managing various forms of hyperpigmentation in clinical practice.

Conflict of Interest and Disclosure

No conflicts are reported by authors associated with the work in the current review.

Funding

No funding was received for the preparation of this review.

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