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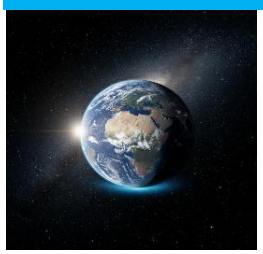

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Topical niacinamide in the management of melasma and facial hyperpigmentation – a narrative review

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Abstract

Background: Melasma is a common facial hyperpigmentation condition and has an impact on patients' quality of life. This and other facial hyperpigmentation disorders are common problems in women of reproductive age. The standard of care remains topical hydroquinone, often combined with a retinoid and a corticosteroid. However, its long-term use is associated with a risk of irritation, paradoxical hypopigmentation and exogenous ochronosis. Niacinamide is a well-established dermocosmetic ingredient with anti-inflammatory, antioxidant, barrier-protective and depigmenting properties.

Aim: To summarise current knowledge on the mechanisms of action of niacinamide in the regulation of skin pigmentation and to review clinical studies on topical niacinamide in melasma and other facial hyperpigmentation disorders.

Material and methods: A review of the literature was conducted in PubMed, PubMed Central and Google Scholar from 2015 to 2025. The articles were included if they were full-text original reviews and addressed topical niacinamide use.
Results: Topical 4% niacinamide demonstrated efficacy comparable to 4% hydroquinone. The advantages are better tolerability, less erythema and dryness, and no reports of ochronosis. Niacinamide acts mainly by inhibiting melanosome transfer, modulating oxidative stress and the inflammatory response. Combinations of niacinamide with other depigmenting agents and procedural interventions, like laser therapy, microneedling or chemical peels, were effective in melasma, post-inflammatory acne hyperpigmentation, and photoaging. It is a safe alternative to hydroquinone-containing preparations.
Conclusions: Topical niacinamide is a safe and versatile depigmenting agent with a pleiotropic mechanism of action. It should be considered an important component of modern treatment algorithms for facial hyperpigmentation, both as an alternative to hydroquinone and as a key element of combination and maintenance regimens.

Keywords: niacinamide; melasma; facial hyperpigmentation; post-inflammatory hyperpigmentation

INTRODUCTION

Melasma is an acquired pigmentary disorder featuring symmetric, well-demarcated brown to dark-brown macules and patches. That chronic, relapsing condition has a predilection for women aged 20–50 years, especially those with darker skin phototypes (Fitzpatrick III–V). Its typical location is on the forehead, cheeks, temples, upper lip and nasal dorsum. Melasma may affect several to more than ten percent of women in tropical and subtropical populations, as well as a substantial proportion of pregnant women and users of hormonal contraception [7,10,13]. Other common facial hyperpigmentation disorders, beyond melasma, include post-inflammatory hyperpigmentation (PIH; e.g. after acne, laser procedures and chemical peels), drug-induced hyperpigmentation, solar lentigines and changes related to photoaging. Despite their benign nature, these conditions are associated with considerable psychosocial burden and impaired quality of life, comparable to chronic inflammatory dermatoses [7,11]. The mainstream treatment for melasma is hydroquinone-containing formulations, most commonly in the form of triple-combination creams (hydroquinone 4%, tretinoin 0.05%, fluocinolone acetonide 0.01%). The efficacy is well documented. However, its long-term use is limited by a

safety profile, including risk of irritation, telangiectasia, epidermal atrophy, confetti-like leukoderma and the rare but difficult-to-treat exogenous ochronosis [5,6,13]. Niacinamide is a biologically active form of vitamin B3. For more than a decade, it has gained increasing attention in aesthetic dermatology. Niacinamide exhibits anti-inflammatory, antioxidant, barrier-protective, anti-wrinkle and depigmenting properties, mainly by inhibiting the transfer of melanosomes to keratinocytes and modulating oxidative stress [4,8,14]. The aims of this narrative review are to discuss the pathogenesis of melasma and other facial hyperpigmentation disorders in the context of potential targets for niacinamide, to summarise current knowledge on topical use of niacinamide in the treatment of melasma and other facial hyperpigmentation disorders, and to position niacinamide in contemporary treatment algorithms.

METHODS

The literature search for this review was performed using PubMed, PubMed Central, and Google Scholar, with a focus on studies of high quality. The time frame used covered the last ten years, from January 2015 to November 2025. The collected materials were published between 2016 and 2025. Publications were searched using combinations of the following keywords: “niacinamide”, “nicotinamide”, “vitamin B3”, “melasma”, “facial hyperpigmentation”, “postinflammatory hyperpigmentation”, “tranexamic acid”, “topical”, “clinical trial”, “randomised”, “split-face”. The articles were included if they concerned adults with melasma or other facial hyperpigmentation (including PIH, photoaging, and post-treatment hyperpigmentation). Studies describing the topical use of niacinamide (alone or in combination with other active substances or treatments) were analysed. Qualifying study designs included randomised controlled trials (including split-face designs), before-and-after studies, case series, and mechanistic or review articles on niacinamide and pigmentation. In total, 25 full-text papers were included in this review.

RESULTS

1. Pathogenesis of melasma and other facial hyperpigmentation disorders.

Melasma is a multifactorial disorder. Its pathogenesis involves excessive exposure to ultraviolet (UV) radiation and visible light, hormonal factors (pregnancy, oral contraception, hormone replacement therapy), genetic predisposition, skin phototype and iatrogenic factors (e.g. photosensitising cosmetics). It has also been suggested that the interaction between hormonal influences and chronic low-grade inflammation partly explains the strong association between

melasma and reproductive age in women [7,10,13]. Histopathological studies consistently show an increased number of active melanocytes, increased melanin deposition in the epidermis and upper dermis, disruption of the basement membrane and enhanced vascularisation with a low-grade inflammatory infiltrate [9,16,20]. Oxidative stress induced by UV radiation appears to play a key role in pathogenesis, leading to activation of melanogenesis via mitogen-activated protein kinase pathways and increased expression of tyrosinase and melanosome-associated proteins [3,16]. Products of lipid peroxidation and higher levels of reactive oxygen species, together with reduced endogenous antioxidant capacity, have been demonstrated in melasma skin compared with adjacent normal skin [3,20]. Reviews on pigmentary disorders have highlighted elevated levels of reactive oxygen species, lipid peroxidation products and impaired endogenous antioxidant defences in melasma skin [18,20]. Epigenetic regulation also appears to be an important component of melasma biology. In malar lesions, versus perilesional skin, increased expression of DNA methyltransferases (DNMT1, DNMT3b) has been documented. The expression levels were correlating with pigmentation severity [11]. In this context, photoprotection combined with 4% niacinamide or 0.05% retinoic acid reduced DNMT expression and led to significant clinical improvement in hyperpigmentation. The effect is clinical lightening of melasma. This suggests that epigenetic mechanisms are modifiable therapeutic targets [1,11]. Post-inflammatory hyperpigmentation (PIH) results from excessive melanogenesis and abnormal pigment distribution following inflammatory dermatoses (such as acne vulgaris) or procedures including lasers and chemical peels [13,17,19]. Pro-inflammatory cytokines and reactive oxygen species stimulate melanocytes and disrupt melanin handling in the epidermis, which explains the frequent co-occurrence of PIH with inflammatory conditions and aesthetic procedures, particularly in darker skin phototypes [14,17,19,24].

2. Mechanisms of action of niacinamide in pigment regulation.

Niacinamide (nicotinamide) is a hydrophilic amide of nicotinic acid and a precursor of the coenzymes NAD+ and NADP+, coenzymes that are central to cellular redox reactions [2,3,4,25]. Its depigmenting effect results mainly from inhibition of melanosome transfer from melanocytes to keratinocytes by modulating the expression of adhesion and cytoskeletal proteins, without directly inhibiting tyrosinase activity [3,4,18]. In vitro studies and ex vivo studies demonstrate that niacinamide decreases melanosome endocytosis by keratinocytes and reduces the release of pro-inflammatory mediators (IL-1, TNF-α) [2,3,8,18]. At the same time, it attenuates oxidative stress in keratinocytes and fibroblasts by increasing NADPH levels and

enhancing the function of antioxidant enzymes. Cell culture models have also demonstrated that niacinamide modulates the Nrf2–ARE pathway, promoting the expression of genes with antioxidant activity [3,15,18]. In the study by Campuzano-García et al., the use of a sunscreen in combination with 4% niacinamide not only decreased MASI scores but also reduced DNMT1 and DNMT3b expression in melasma skin, suggesting an effect of niacinamide on epigenetic regulation of melanogenesis [1,4,11]. This suggests that niacinamide can influence both classical and epigenetic pathways involved in pigment production. Beyond direct effects on pigmentation, niacinamide improves epidermal barrier function by stimulating the synthesis of ceramides, free fatty acids and cholesterol [4,18,22,25]. In a clinical trial using a vitamin B3 (niacinamide) cream, improvements in skin hydration, fine wrinkles and skin tone uniformity were observed. These molecular effects translate into measurable clinical benefits, like reduced transepidermal water loss, more even skin tone, and improved surface texture in niacinamide-treated skin [3,15,18,25].

3. Topical niacinamide in melasma – monotherapy.

The key clinical trial documenting the efficacy of niacinamide in melasma is a randomised, double-blind, split-face study comparing 4% niacinamide cream with 4% hydroquinone cream over 8 weeks [3,6,12]. Both sides showed comparable reductions in MASI (approximately 60–70%), but the niacinamide-treated side exhibited fewer local adverse effects such as erythema, burning and dryness [6,12]. These findings are supported by reviews of topical melasma therapies, in which niacinamide is listed as an important alternative to hydroquinone. It is important for patients with sensitive skin, and those with contraindications to hydroquinone, and in maintenance therapy following intensive bleaching regimens [3,12,18]. From a practical standpoint, niacinamide offers an attractive balance between efficacy and safety in the context of a chronic, relapsing condition. In studies involving women with uneven facial tone, daily use of a cream or serum with niacinamide together with moisturising agents and N-acetylglucosamine led to a significant reduction in the visibility of solar lentigines and PIH, as reflected by both clinical assessments and colorimetric analyses [2,3,18]. Reviews therefore recommend niacinamide monotherapy, particularly for patients with mild to moderate epidermal melasma, sensitive skin or those who are unwilling to use hydroquinone [3,6,12]. These data support the use of niacinamide for classical melasma to broader categories of facial dyschromia.

4. Niacinamide in combination therapies for melasma.

Numerous studies have evaluated the efficacy of topical niacinamide in combination with other depigmenting agents or procedural interventions. A review on niacinamide in dermatology and a comprehensive melasma review indicate that niacinamide is frequently included in multi-ingredient formulations containing, for example, tranexamic acid, kojic acid, ascorbic acid, arbutin, retinoids and biomimetic peptides [3,6,12,19]. Such combinations are designed to target complementary steps in melanogenesis and photoinduced damage while maintaining acceptable tolerability. Formulations combining niacinamide and tranexamic acid in creams, emulsions and serums have consistently produced clinically meaningful reductions in melasma severity. The results were better than those with different vehicles and, in some cases, better than those of comparable formulations lacking niacinamide [10,11,18]. Examples include an emulsion with tranexamic acid, an azelaic acid derivative and niacinamide, as well as a serum containing tranexamic acid, kojic acid and niacinamide, both of which improved MASI or mMASI scores and patient-reported outcomes in women with facial melasma [5,6,11,23]. Depigmenting creams uniting tranexamic acid, niacinamide and antioxidant components have also shown favourable results, with progressive lightening of melasma patches and a high level of satisfaction, while maintaining a low incidence of irritation [6,11,17,23]. The barrier-supporting and anti-inflammatory properties of niacinamide likely contribute to the improved tolerability of these multi-active regimens [3,18,22]. Niacinamide has additionally been used alongside fractional and vascular laser therapies, including laser-assisted delivery of topical mixtures containing tranexamic acid, niacinamide and kojic acid. Formulations containing niacinamide are among those with the best balance between efficacy and tolerability [6,23]. In these settings, the addition of niacinamide-based topicals appears to enhance the pigment-lightening effect of laser treatment and may help reduce procedure-related irritation [6,9,23]. In addition to conventional formulations, advanced delivery systems are investigated. Such methods optimize cutaneous bioavailability of niacinamide. A formulation using microneedle-like particles enhanced the penetration of niacinamide into the skin without compromising safety [18,21,22].

5. Niacinamide in post-inflammatory hyperpigmentation and photoaging.

In a study of patients with post-inflammatory acne hyperpigmentation, topical combinations that include tranexamic acid, niacinamide and other lightening agents have led to significant

reductions in dark spot intensity and more homogeneous facial skin tone [17,19]. These benefits have been documented by both investigator assessments and patient self-evaluations, reinforcing the role of niacinamide-containing regimens in PIH management [14,19]. Owing to its anti-inflammatory properties and barrier-enhancing effects, niacinamide is an attractive component of PIH treatment both after acne and following invasive procedures, where the skin is prone to irritation [13,17,24]. Incorporating niacinamide into post-procedure skincare protocols may therefore reduce the risk and severity of procedure-induced hyperpigmentation. In the context of photoaging, niacinamide-containing products used in daily skincare (moisturising creams, eye creams) improved hydration, elasticity and skin tone uniformity and reduced the visibility of fine lines and sun-induced spots [3,15,22]. Anti-ageing studies further show that many patients perceive improvements not only in mottled pigmentation but also in overall radiance and texture when niacinamide is in their daily skincare routines [3,15]. Reviews on nicotinamide and photoaged skin further support its role in controlling both pigmentary and textural signs of ageing [3,4]. The combination of barrier restoration, modulation of oxidative stress and regulation of pigment distribution makes niacinamide a rational choice in comprehensive anti-ageing regimens targeting mottled pigmentation and dull complexion [3,8]. In patients with darker skin phototypes, niacinamide-based combinations may lower the risk of rebound or worsening hyperpigmentation compared with more irritating protocols [17,19,24].

6. Limitations of the current evidence and future directions.

This study has several limitations, including small sample sizes (often 20–50 participants) and short follow-up periods (8–12 weeks). The individual products have differences in the concentration of niacinamide, the composition of the carrier substance, and additional ingredients. The outcome measures also show variability (MASI, mMASI, visual analogue scales, colorimetry), which complicates direct comparison between studies. Future research should focus on large, well-designed randomised controlled trials directly comparing niacinamide with other emerging melasma therapies (e.g. thiamidol, cysteamine, resorcinol derivatives) and on long-term maintenance of treatment outcomes. Comparative studies of different niacinamide-containing combinations and vehicles, with adequately long follow-up, are necessary to determine optimal recipes and preservation strategies. There is a need for further investigations to clarify niacinamide’s effects on epigenetic and vascular aspects of

melasma. There is also a demand to identify optimal combinations with tyrosinase inhibitors, broad-spectrum sunscreens (including protection against visible light) and tinted photoprotection. Such data will help refine evidence-based algorithms for melasma and PIH management across diverse skin phototypes.

DISCUSSION

Niacinamide is one of the best-studied dermocosmetic ingredients with both depigmenting and anti-ageing properties. Clinically, this makes niacinamide an attractive alternative to hydroquinone for patients with sensitive skin, in long-term maintenance regimens and for treating melasma in sites prone to irritation. Unlike hydroquinone, it is not associated with exogenous ochronosis and can be used for prolonged periods, which is particularly relevant in a chronic, relapsing disorder such as melasma. Its good tolerability profile is also important in patients with darker phototypes, where irritation itself may trigger or worsen hyperpigmentation. Niacinamide's main strength lies in its multi-targeted mechanism: it inhibits melanosome transfer, modulates oxidative stress, improves barrier function, reduces inflammation and appears to influence epigenetic regulation of melanogenesis. This broad spectrum of action is advantageous in melasma, a multifactorial and recurrent condition driven by UV/visible light exposure, hormonal influences, oxidative stress and low-grade inflammation. The role of niacinamide in hyperpigmentation management is supported by the convergence between data and clinical observations. In most clinical trials, niacinamide was combined with tranexamic acid, kojic acid, azelaic acid, ascorbic acid, arbutin or peptides, as well as with emollients. This complicates attribution of efficacy to a single compound, it mirrors real-world practice in aesthetic dermatology, where combination regimens are the norm. Available data suggest that the inclusion of niacinamide can improve the overall tolerability of depigmenting protocols, reduce erythema and dryness, and thereby enhance adherence. This is particularly relevant for regimens that also include retinoids, chemical peels or laser procedures, which may themselves be irritating. The combinations were effective in melasma, post-inflammatory acne hyperpigmentation, as well as photoaging. In PIH niacinamide-based regimens address both the inflammatory component and the barrier impairment that predispose to persistent discoloration. In photoaged skin, regular use of niacinamide-containing products contributes not only to pigment homogenisation, but also to improved radiance, elasticity and fine-line reduction, which makes it a rational anchor ingredient in multitarget facial skincare. From a practical perspective, its availability in numerous over-the-counter formulations facilitates stepwise, affordable implementation of evidence-based depigmenting strategies, provided that

appropriate concentrations and vehicles are selected. Niacinamide is effectively combined with procedural interventions, like laser therapy, microneedling or chemical peels. It can serve as both a pre-conditioning and post-procedure agent. Also, niacinamide reduces the risk and severity of procedure-induced hyperpigmentation. Taken together, current evidence supports positioning niacinamide as a core component of modern management algorithms rather than as a purely ancillary cosmetic ingredient.

Niacinamide appears especially valuable in:

- epidermal or mixed melasma in patients with sensitive skin,
- maintenance therapy after hydroquinone or after laser/peeling procedures,
- PIH following acne or invasive procedures, and comprehensive skincare regimens in photoaged skin.

CONCLUSIONS

Correlating the available data allows us to draw the following conclusions:

1. Melasma and other facial hyperpigmentation disorders are common, chronic conditions with pathogenesis involving UV/visible light exposure, oxidative stress, inflammation, hormonal influences, and epigenetic mechanisms.
2. Topical niacinamide exerts well-documented depigmenting effects by inhibiting melanosome transfer, modulating oxidative stress, improving epidermal barrier function, and influencing DNA methyltransferase expression.
3. Cream with 4% niacinamide is comparable in efficacy to 4% hydroquinone in the treatment of melasma, with better local tolerability and a more favorable safety profile.
4. Effective and safe options for melasma, PIH, and photoaging are combinations of niacinamide with tranexamic acid, kojic acid, azelaic acid, vitamin C, retinoids, and procedures (laser therapy, microneedling, chemical peels).
5. Niacinamide should be considered as a key component of modern treatment algorithms for facial hyperpigmentation, both as an alternative to hydroquinone and as an important element of combination and maintenance regimens.

Disclosure

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AI.

AI (Grammarly and DeepL) were used in this study exclusively for language editing, including improving readability, text formatting, and verifying bibliographic style. AI tools were used in refining the academic English of the manuscript, ensuring clarity, consistency, and adherence to scientific writing standards. It is important to emphasize that all AI tools were used strictly as assistive instruments under human supervision. The scientific content, data interpretation, and final conclusions were entirely developed and approved by the authors.

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