

Review Article

## Niacinamide efficacy in skin therapy: The multitasking marvel for glowing skin – A comprehensive literature review

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### ABSTRACT

Niacinamide (nicotinamide), a water-soluble form of vitamin B3, is a foundation in the practice of dermatology and cosmeceuticals due to its incredibly wide clinical effects. This review research article compares the cosmetic and therapeutic benefits of niacinamide, outlining its mechanisms and applications, paving the way for future innovative possibilities in skincare. Niacinamide is a powerful antioxidant and anti-inflammatory agent with the additional advantage of rehabilitating the skin barrier and enhancing extracellular matrix integrity. It reduces oxidative stress, erythema, sallowness, and hyperpigmentation through inhibition of melanosome transfer, while randomized controlled trials have demonstrated improvement for fine lines, wrinkles, and the general appearance of skin. In acne vulgaris, sebum production is lowered, inflammatory calming effects are realized, and antimicrobial effects, with the added advantage of boosting the hydration of the skin. Its applications reach beyond cosmetic benefit in successfully treating atopic dermatitis, melasma, psoriasis, rosacea, and cutaneous lupus erythematosus, with topical formulations alleviating symptoms of scaling, redness, and breakdown of the skin barrier. Oral supplements also enjoy the added advantage of reducing the incidence of non-melanoma skin cancers in high-risk individuals. In cosmeceutical product development, niacinamide has been added to sophisticated formulations including nanogels, halloysite nanotubes, and multimodal products with emollients, herbal extracts, and exfoliants to promote stability, deposition, and functionality. Clinical studies show superior results when added to ceramides, sodium hyaluronate, or botanical actives such as calendula oil. In general, niacinamide meets the criteria for a safe, multifaceted, and efficient agent spanning cosmetic improvement and therapeutic dermatology. Its demonstrated efficacy and favorable tolerability profile establish it as a multipurpose agent in skin renewal and disease treatment, and additional studies on optimal delivery vehicles and systemic administration could further enhance its clinical applicability.

**Keywords:** Benefits of niacinamide, Niacinamide applications, Niacinamide in skincare, Skin microbiome

### INTRODUCTION

Niacinamide is a vitamin and a potent antioxidant that is well-tolerated and can lower skin pigmentation. Cosmetic products frequently contain niacinamide as a skin-lightening ingredient. Due to its many advantageous uses for skin health, such as enhancing the flexibility and barrier of the skin, increasing the synthesis of collagen and epidermal ceramides, decreasing the incidence of skin illnesses, and enhancing the appearance of the skin overall, it is currently widely utilized in cosmetic products.<sup>[1,2]</sup> In humans, nicotinamide, whether applied topically or taken orally, has a photoimmunoprotective effect. Nicotinamide, a precursor of nicotinamide adenine dinucleotide

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(NAD), may work at least partially by giving irradiated cells energy replacement after ultraviolet irradiation depletes keratinocytes of their cellular energy.<sup>[3]</sup>

Research on niacinamide is ongoing due to its capacity to lower inflammation, lessen skin pigmentation, encourage anti-aging, and increase intercellular lipid production, which enhances the stratum corneum's barrier functions.<sup>[4]</sup> Niacinamide is used as a body scrub as an exfoliator with Jojoba beads, which has the advantages of removing dead skin cells, cleaning and clearing debris, hydrating the skin, and leaving it smooth.<sup>[5]</sup> It is frequently utilized in skincare products due to its good safety record, anti-aging properties, and demonstrated clinical effectiveness in treating a range of skin conditions.<sup>[3]</sup>

This study emphasizes niacinamide and its increasing importance in dermatology. We will analyze its use in skincare and its benefits, such as improved skin barrier and combating hyperpigmentation. In addition, it also addresses its relevance in cosmetics and uses across many industries. A major aspect of the research is learning about the safety profile and the side effects of niacinamide. By covering all these points, it aims to give a full picture of niacinamide's therapeutic potential for skin health while also identifying areas that need more research.

## MATERIAL AND METHODS

This literature review has been conducted by analyzing 64 articles that were retrieved from 2020 to 2025. The literature searches were conducted using keywords such as niacinamide, skincare niacinamide, skin microbiome, and benefits of niacinamide. Our databases were gathered from websites such as PubMed and Google Scholar. We reviewed each of these articles and collected information from 24 articles to form this critical research paper.

## RESULTS

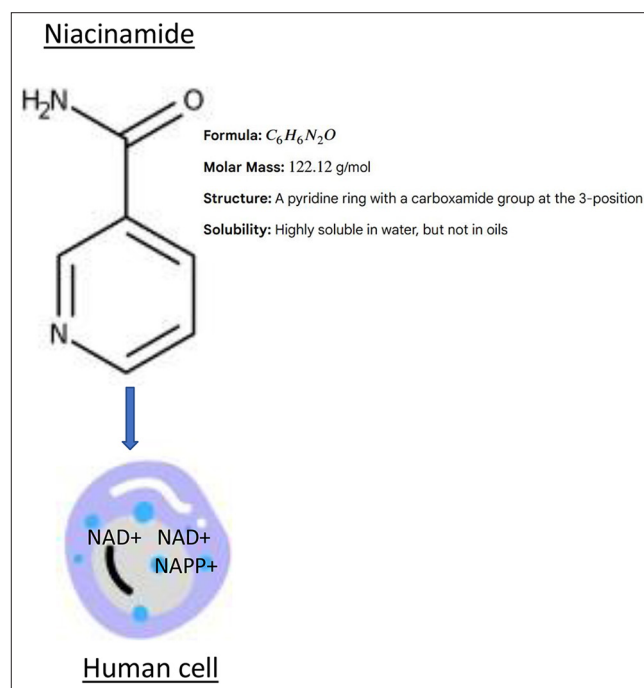
According to our research material review process carried out, there are numerous advantages of niacinamide in the world of dermatology. Niacinamide confirms its role in decreasing hyperpigmentation and uneven skin tone by inhibiting melanosome transfer, causing lighter, uniform skin tone and achieving certain anti-ageing benefits such as reduction of fine lines and wrinkles, improving skin texture. Topical niacinamide adjuvants ceramides, free fatty acids, and cholesterol synthesis in keratinocytes improve skin barrier, confirmed by randomized clinical trials. Due to its capacity to control sebum production, clinical investigations indicate advantages in acne and atopic dermatitis. Certain autoimmune conditions, such as cutaneous lupus erythematosus, have also shown significant improvement with topical preparations and oral supplements in high-risk

groups, which significantly reduced non-melanoma skin cancer incidence. In addition, niacinamide improves hair thickness and fullness. Therefore, these findings highlight niacinamide's therapeutic role and its effectiveness as a safe treatment for a variety of dermatologic conditions.

## DISCUSSION

### Niacinamide composition

Chemically referred to as pyridine-3-carboxamide, niacinamide is a water-soluble amide derivative of Vitamin B3, having a variety of modes of action that have been documented in the literature.<sup>[6]</sup> This active component ranges in concentration from 2% to 5% in several dermatological and cosmetic compositions.<sup>[7]</sup> This molecule participates in several biological oxidation–reduction processes and is naturally present in human cells as a precursor of the co-dehydrogenases NAD and nicotinamide adenine dinucleotide phosphate.<sup>[8]</sup> However, the exact mode of action in treating skin conditions or managing pigmentation and aging of the skin is unclear. Furthermore, it is uncertain if nicotinamide's effectiveness stems from its direct action or from its indirect action as a precursor to other active metabolites<sup>[9]</sup> [Figure 1].



**Figure 1:** Niacinamide composition.

### Niacinamide benefits in skincare

Niacin has two potential forms used, namely niacinamide and nicotinic acid. According to numerous studies, niacinamide's natural properties make it a useful treatment for acne because

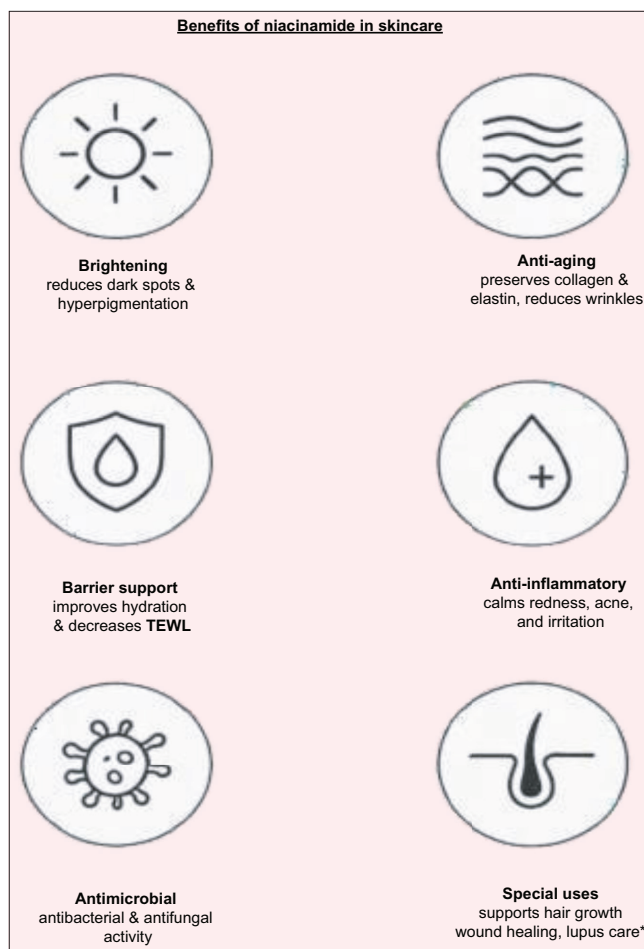
of its multifaceted role in reducing flare-ups.<sup>[10]</sup> It has been seen to be useful for managing rosacea symptoms. Overall, niacinamide can overcome several major issues related to skin aging, positioning itself as a multipurpose functional component in skin rejuvenation. Despite transdermal delivery challenges, new formulations and administration are promising to improve future cosmeceutical applications of niacinamide.<sup>[11]</sup>

Niacinamide is well-known to act with nitric oxide synthase activity. Due to its potent antioxidant activity, niacinamide dampens this natural phenomenon, decreasing sallowness of the skin, with proven efficacy in clinical studies enrolling Caucasian females.<sup>[12]</sup> Furthermore, it was well tolerated by the skin along with the refinement in the skin yellowing (sallowness).<sup>[13]</sup> Sebum production reduction, cutaneous extracellular matrix, and skin barrier enhancement are also done by this component. Niacinamide is well-known for its anti-inflammatory properties. It also possesses antibacterial, antifungal, and antiviral activity.<sup>[12]</sup>

This component possesses anti-melanogenic action, which is dependent on dose and is seen to be reversible.<sup>[12]</sup> According to a study, it was found that niacinamide provided significant improvements in spots of hyperpigmentation, red blotchiness, and erythema.<sup>[5,13]</sup> Niacinamide may help with a number of skin disorders since it stimulates deoxyribonucleic acid repair and cellular energy processes.<sup>[10]</sup> A personalized approach of using niacinamide and sea daffodil-based products according to the patient's skin types and skin conditions is essential to remove blemishes and dark spots and improve skin brightness.<sup>[14]</sup>

Niacinamide has also been used extensively as a multifunctional antiaging ingredient in cosmeceuticals.<sup>[12]</sup> The photoprotective nature of niacinamide can help to explain its nonmelanoma and melanoma preventive actions. According to a study, it was found that niacinamide provided significant improvements in fine lines/wrinkles or texture.<sup>[13]</sup> Several studies have showcased niacinamide's efficacy for stimulating various other components, such as collagen, elastin, and ceramide production. Thus, niacinamide may improve cutaneous extracellular matrix quality by acting at a cellular level, thereby reversing apparent aging signs.<sup>[12]</sup>

Niacinamide has long been used as an active ingredient in anti-hair loss preparations. There are few studies, however, on the efficacy and underlying mechanisms of niacinamide for anti-hair loss that have been reported. Data demonstrate that niacinamide could promote hair growth, possibly by preventing premature catagen entry and cell senescence of human dermal papilla cells via down-regulation of *dickkopf protein-1*, *p16*, and *p21*, leading to elongation of the anagen phase with increased versican expression<sup>[15]</sup> [Figure 2].



**Figure 2:** Benefits of niacinamide.

### Niacinamide applications in diseases

Niacinamide or nicotinamide is utilized in systemic medicine and dermatology. Historically, it has been utilized to prevent and treat pellagra, which is marked by skin irritation, diarrhea, and dementia, while avoiding the flushing associated with niacin.<sup>[12]</sup> Niacinamide is beneficial for the skin in more ways than simply when it is lacking. Topical formulations help with disorders such as atopic dermatitis, rosacea, psoriasis, melasma, and acne vulgaris.<sup>[9]</sup> The use of a niacinamide-containing commercial cream resulted in measurable improvements in skin hydration and tone. A key strength of this study is its focus on real-life product application, offering practical insights into the performance of commercial skincare products under typical user conditions.<sup>[16]</sup> They also reduce oxidative stress and improve signs of photoaging, such as hyperpigmentation, fine wrinkles, and uneven tone.<sup>[9]</sup> Without functioning as a conventional keratolytic agent, Niacinamide (NIA) has a clear interaction with keratin, increasing the distance between keratin monomers in dry conditions.<sup>[17]</sup>

In addition, niacinamide shows potential beyond dermatological uses. It may function as an adjuvant therapy in arthritis (anti-inflammatory), chronic kidney disease (phosphate reduction), type 1 diabetes ( $\beta$ -cell preservation), neurological disorders, and malignancy prevention.<sup>[18]</sup> It's shown clinical performance, a superior safety profile, a wide range of skin type applicability, and compatibility with other anti-aging treatments, which make it so appealing. Niacinamide is perfect for a variety of formulation applications due to its water solubility, chemical stability, and absence of photosensitizing qualities.<sup>[19]</sup> It appears to be a successful medication for autoimmune illnesses, especially systemic lupus erythematosus and its associated dermatological manifestations. Clinical trials for discoid lupus erythematosus show significant decreases in the topical application of 2–4% niacinamide improves inflammation, scaling, and overall outcomes, with the 4% formulation proving to be more advantageous despite causing greater discomfort.<sup>[3]</sup> The metabolic profile in cutaneous lupus erythematosus shows that the NAD<sup>+</sup> pathway is not working properly, which suggests that nicotinamide supplementation could be beneficial<sup>[20]</sup> [Figure 3 and Table 1].

**Table 1:** Systemic applications of niacinamide in medicine.

Systemic applications of niacinamide in medicine (systemic/oral therapy)	Mechanism
Chronic kidney disease	Potential for phosphate reduction.
Type 1 diabetes	Potential for beta-cell preservation
Neurological disorders	Potential adjuvant therapy
Malignancy prevention	Potential for prevention.
Systemic lupus erythematosus	Suggested as a successful medication, possibly due to correcting dysfunctional NAD <sup>+</sup> pathway metabolism.
Arthritis	Functions as an adjuvant therapy with anti-inflammatory action

NAD: Nicotinamide adenine dinucleotide

### Niacinamide products and combinations

Niacinamide helps aging skin look and feel smoother, reduces wrinkles and fine lines, and keeps the skin from drying out and drooping.<sup>[7]</sup> Niacinamide can enter the human skin's percutaneous layer when applied topically.<sup>[5]</sup> Topical niacinamide formulations have demonstrated a number of positive effects on skin protection and health. With less penetration, the transthesomes and carrageenan polyvinylpyrrolidone hydrogels (nanogels) effectively enhance niacinamide skin deposition.<sup>[6]</sup> In fact, carrageenan may help the skin in a number of ways. It has been used in cosmetic products for its thickening and water-retaining qualities in addition to its moisturizing ones. Based on their drug diffusion characteristics, gel formulations with niacinamide and calendula oil combined with carrageenan as a gelling agent were found to be the best and can be utilized for additional formulation and research. When compared to the drug release profile of the pure drug, all gel formulations demonstrated more than 60% drug release within 180 min, which was much better. According to the findings of Maddukuri *et al.*, calendula oil and medications that cure acne can be combined to create gels.<sup>[21]</sup> When compared to a pure drug, this approach could improve the medication's antimicrobial spectrum by more than 1.5 times because of improved permeability.<sup>[21]</sup> In addition, using halloysite nanotube systems for topical formulations in skincare can enhance the favorable adsorption of active principles such as niacinamide.<sup>[22]</sup> Niacinamide is one of the most chosen active ingredients in over 600 dermatological products, ranging from 45 various categories such as shampoos, skin moisturizers, and cleansing formulas with different applicative methods and combinations with other ingredients.<sup>[7]</sup> Body scrubs can contain a gentle cream that has a coarse exfoliating ingredient and niacinamide at a therapeutically appropriate concentration.<sup>[5]</sup> In individuals with moderate atopic dermatitis, the use of body emollients

**Applications of niacinamide in diseases**

	<b>Pellagra - reduces skin irritation</b>
	<b>Atopic dermatitis - improves ceramide synthesis</b>
	<b>Rosacea - reduces inflammation &amp; enhances ceramide synthesis</b>
	<b>Acne vulgaris - reduces inflammation</b>
	<b>Systemic &amp; discoid lupus erythematosus - reduces inflammation &amp; scaling</b>
	<b>Psoriasis - reduces trans-epidermal water loss &amp; lowers inflammation</b>
	<b>Melasma - lowers inflammation</b>

Figure 3: Applications of niacinamide.

containing niacinamide can greatly enhance skin barrier function, quality of life, and clinical symptoms.<sup>[15]</sup>

The assessment of niacinamide distribution is equally important to be understood, which can be done by tape stripping and confocal Raman spectroscopy (CRS). There are several benefits of using spectroscopic techniques to evaluate drug distribution to the skin. CRS integrates the concepts of Raman spectroscopy and confocal microscopy with regard to *in vivo* measurements. The authors of these investigations looked into the non-invasive depth profiling of stratum corneum water content and other endogenous components, such as natural moisturizing factor, using CRS.<sup>[23]</sup> Therefore, due to its capacity to replenish cellular energy and the lack of adverse effects at the daily acceptable dosage, these results collectively point to a positive function for its administration in preventing aging and other illnesses<sup>[24]</sup> [Figure 4].

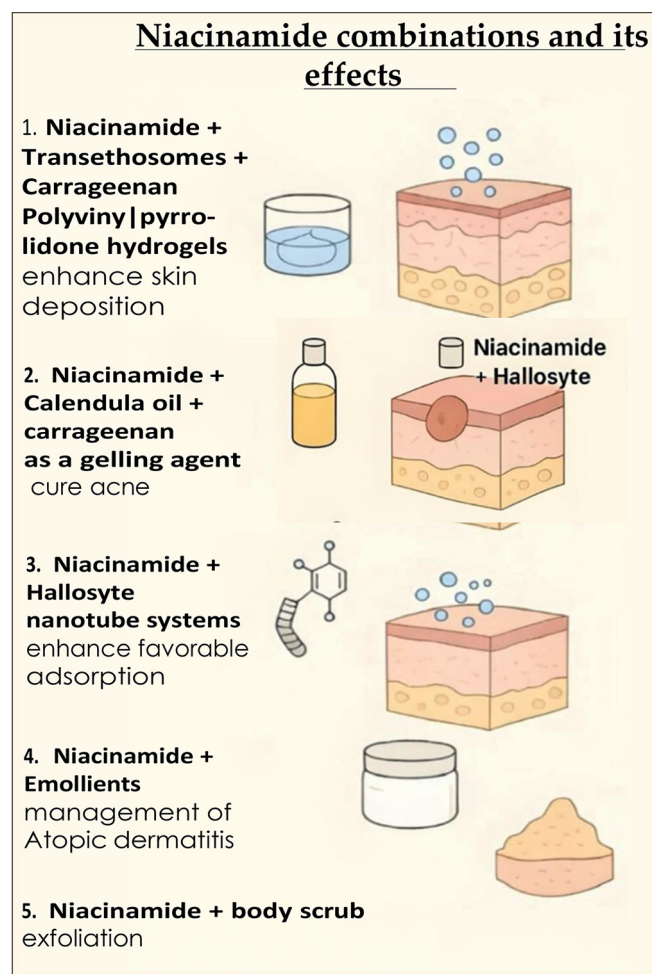


Figure 4: Niacinamide product and combination.

## CONCLUSION

Niacinamide qualifies as a safe, multipurpose, and effective agent in dermatology, having benefits such as skin barrier

restoration, improving pigmentation, anti-aging, anti-inflammatory, and antimicrobial effects. Niacinamide uses range from cosmetic to therapeutic; for instance, it is useful in the treatment of conditions such as acne, atopic dermatitis, and lupus erythematosus. With a commendable safety profile and wide range of efficacy, niacinamide plays a meaningful part in skincare and clinical practice; further research is needed to define its therapeutic role.

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