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Review

Hydro Deluxe Skin Boosters and the Cutaneous Microbiome: A Narrative Review

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Abstract

Background/Objective: The skin microbiome plays a pivotal role in barrier function, immune regulation, and overall skin health. Age-related changes and environmental stressors disrupt microbial homeostasis, contributing to inflammaging and esthetic concerns. This narrative review aims to explore the potential interactions between the Hydro Deluxe Skin Booster and the cutaneous microbiome, with emphasis on barrier integrity, hydration, and molecular pathways relevant to skin aging. **Methods:** A literature search was performed in PubMed and Scopus up to September 2025. Keywords included skin microbiome, cutaneous dysbiosis, hyaluronic acid (HA), calcium hydroxyapatite (CaHA), amino acids, skin boosters, skin aging, barrier function, and inflammation. Eligible articles included in vitro ex vivo, and clinical studies addressing microbiome-related mechanisms in skin health and esthetic interventions. **Results:** The literature indicates that HA and skin boosters enhance hydration and reduce transepidermal water loss (TEWL), indirectly supporting microbial balance. Aging is associated with sebaceous decline, altered pH, reduced levels of commensals (*Cutibacterium acnes*, *Staphylococcus epidermidis*), and increased opportunists (*Streptococcus*, *Staphylococcus aureus*). Hydro Deluxe, a formulation combining HA, CaHA, and amino acids, may synergistically stabilize the cutaneous environment by restoring hydration, reducing inflammatory mediators, and promoting dermal remodeling. Current evidence, however, is largely limited to in vitro and ex vivo data. **Conclusions:** Hydro Deluxe appears to be a promising esthetic intervention with potential to support cutaneous microbial homeostasis and mitigate age-associated inflammatory changes. Further well-designed clinical trials are warranted to validate its microbiome-related effects and to clarify its role in evidence-based esthetic medicine.

Keywords: cutaneous microbiome; hyaluronic acid (HA); calcium hydroxyapatite (CaHA); amino acids; skin boosters; dermal remodeling; skin barrier; aesthetic dermatology

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1. Introduction

The human skin is a highly dynamic organ that functions not only as a physical barrier but also as a host to a diverse microbial ecosystem. This skin microbiota, comprising bacteria, fungi, viruses, and archaea, plays a pivotal role in maintaining cutaneous health. Dominant bacterial taxa such as *Staphylococcus*, *Cutibacterium*, and *Corynebacterium* colonize distinct skin niches according to local pH, moisture, and lipid composition [1,2]. In equilibrium, this community provides colonization resistance against pathogens, modulates immune responses, and supports epidermal barrier integrity [3,4]. Thus, microbial

balance is increasingly recognized as an important contributor to skin resilience and overall cutaneous function [5].

However, the cutaneous microbiome is sensitive to multiple intrinsic and extrinsic factors. Aging, pollution, diet, stress, and cosmetic practices can all disrupt microbial diversity, leading to dysbiosis and diminished skin function [6]. Age-related physiological changes, such as reduced sebum production and immune modulation, have been linked in observational studies to microbiome shifts, including decreases in *Cutibacterium acnes* and *Lactobacillus* species, and increases in *Corynebacterium kroppenstedtii*, *Streptococcus*, and *Staphylococcus* spp., although current evidence remains preliminary and variable across cohorts [7]. While these microbial shifts do not always manifest as overt disease, they may compromise barrier integrity, heighten inflammatory susceptibility, and accelerate visible signs of cutaneous aging [7,8].

These insights underscore the importance of interventions that not only restore hydration and dermal architecture but also preserve or enhance microbial homeostasis. Within esthetic medicine, injectable skin boosters have emerged as a therapeutic category aimed at improving skin quality beyond volumization. Hydro Deluxe (Neauvia®, Matex Lab, Geneva, Switzerland), a non-crosslinked hyaluronic acid formulation enriched with CaHA and the amino acids L-proline and glycine, exemplifies this approach. Preclinical studies suggest potential benefits in hydration, keratinocyte activity, and bioactive support, although clinical evidence remains limited [9,10].

This review aims to contextualize the skin microbiota within esthetic medicine and to examine how Hydro Deluxe may influence microbial homeostasis through barrier reinforcement, hydration, and bioactive stimulation. By synthesizing evidence from dermatology, microbiology, and esthetic practice, this article highlights injectables as a promising frontier in microbiome-conscious skin rejuvenation.

To our knowledge, no previous review has specifically examined the potential interactions between Hydro Deluxe, a combined HA and CaHA skin booster and the cutaneous microbiome. Although both HA and CaHA have been individually studied, their integrated effects within this specific formulation have not been analyzed in the context of microbial ecology, barrier physiology, and skin homeostasis. This narrative review synthesizes existing evidence and outlines hypothesis-generating mechanisms that may explain how Hydro Deluxe could influence microenvironmental factors relevant to cutaneous microbial balance.

1.1. Skin Microbiota and Its Role in Skin Health

Skin Microbial Ecosystem

The skin surface is colonized by a rich microbial community that includes bacteria, fungi, viruses, and archaea. The composition of this microbiota varies across distinct ecological niches shaped by sebaceous activity, hydration level, and pH [11]. Sebaceous sites such as the face and back are dominated by *Cutibacterium acnes*, while moist areas (e.g., axillae, groin) harbor more *Staphylococcus* and *Corynebacterium* species. Dry regions, such as the forearm or leg, typically display greater microbial diversity but lower density [1]. Fungal organisms, particularly *Malassezia*, are abundant in lipid-rich areas, whereas bacteriophages and viruses regulate bacterial diversity [1,4].

In physiological conditions, these microbes are not passive inhabitants but active partners in skin health. Commensals produce antimicrobial peptides and metabolites that inhibit pathogen overgrowth, modulate keratinocyte signaling, and reinforce barrier lipids [12,13]. They also influence local immune activity by promoting regulatory T cell differentiation and maintaining tolerance to resident microbes, thereby preventing unneces-

sary inflammation [3]. Balanced microbial diversity has thus become a recognized marker of healthy and resilient skin [5].

The distribution of microbial communities and their key ecological features across different anatomical regions can be summarized as shown in Table 1.

Table 1. Overview of dominant bacterial and fungal taxa and key ecological characteristics across sebaceous, moist, and dry skin habitats.

Skin Habitat	Dominant Bacteria	Dominant Fungi	Key Features
Sebaceous areas	*Cutibacterium acnes*	*Malassezia* spp.	Lipid-rich environment; low bacterial diversity; high sebum concentration supporting lipophilic taxa
Moist areas	*Staphylococcus* spp., *Corynebacterium* spp.	Variable presence of *Malassezia* spp. depending on site	Warm, humid microenvironment; high microbial density; stable bacterial clusters
Dry areas	Diverse, mixed low-biomass bacterial communities	Minimal fungal presence; mostly transient or environmental species	Low humidity; fluctuating pH; greatest ecological heterogeneity

1.2. Factors That Alter the Microbiota

The skin microbiota is a dynamic ecosystem highly responsive to intrinsic and extrinsic influences. Intrinsic factors include age, sex, hormonal status, genetic predisposition, and immune function, while extrinsic factors encompass hygiene practices, climate, ultraviolet (UV) radiation, pollution, and cosmetic use [6,14–16].

Environmental exposures are among the most potent modulators. Air pollution introduces particulate matter and polycyclic aromatic hydrocarbons that disrupt the lipid barrier and promote oxidative stress, conditions that selectively favor pro-inflammatory bacterial species [6,17,18]. UV radiation alters microbial diversity by damaging both host cells and microbial DNA, further weakening immune surveillance [16].

Lifestyle factors also exert significant influence. Psychological stress, mediated by neuroendocrine pathways, may alter sebum production and skin immunity, indirectly shifting microbial composition [19]. Diets rich in sugar or fat may increase systemic inflammation and indirectly favor dysbiosis, whereas diets high in fiber and antioxidants appear protective [20,21].

Cosmetic practices represent another critical determinant. Excessive use of aggressive cleansers or alcohol-based formulations can increase skin surface pH, strip lipids, and reduce colonization by beneficial commensals such as *Staphylococcus epidermidis* [22]. Conversely, products formulated with prebiotics, probiotics, or microbiome-friendly lipids may promote microbial diversity and barrier function [23,24].

Although dysbiosis does not inevitably cause disease, it is strongly associated with reduced resilience. Common manifestations include *C. acnes* overgrowth in acne, *S. aureus* proliferation in atopic dermatitis, and *Malassezia* dysregulation in seborrheic dermatitis [25]. Additionally, altered Malassezia abundance has been reported in some rosacea subtypes, although findings remain heterogeneous across studies [2]. Even in the absence of pathology, dysbiosis may impair barrier recovery and increase vulnerability to irritants and allergens [2,25].

1.3. Skin Aging and Microbiota

Aging profoundly influences both skin structure and microbial ecology. Intrinsic aging is associated with epidermal thinning, flattening of the dermoepidermal junction, reduced vascularization, and diminished sebum production [8]. These changes alter the microenvironment, decreasing lipid substrates available for lipophilic species such as *Cutibacterium*

acnes while permitting expansion of less beneficial taxa [7,8]. Immunosenescence, characterized by reduced antimicrobial peptide production and impaired T cell responses, further compromises microbial surveillance and tolerance [26–28].

Clinical and metagenomic studies have shown that older skin exhibits reduced commensal abundance (e.g., *C. acnes*, *Lactobacillus* spp.) and increased prevalence of opportunists such as *Corynebacterium kroppenstedtii*, *Streptococcus*, and *Staphylococcus* species [7,29]. This shift is often accompanied by decreased microbial diversity, a marker of ecological instability.

From a functional perspective, age-related dysbiosis may contribute to impaired barrier repair, reduced immune tolerance, and heightened inflammatory signaling. Together, these factors accelerate extrinsic aging processes, such as wrinkle formation and skin laxity, by perpetuating a cycle of chronic low-grade inflammation (*inflammaging*) [30].

In the context of esthetic medicine, these findings underscore the importance of interventions that not only restore hydration and extracellular matrix integrity but also support microbial homeostasis. Strategies aimed at preserving microbial diversity may enhance overall skin vitality and maximize the efficacy of rejuvenating treatments.

1.4. Composition and Properties of Hydro Deluxe by Neauvia®

The formulation of Hydro Deluxe includes hyaluronic acid, calcium hydroxyapatite, and specific amino acids. To contextualize the components referenced in this section, Table 2 summarizes their composition and the functions attributed to them in the literature.

Table 2. Components of Hydro Deluxe skin booster, mechanisms of action, and potential effects on the cutaneous microbiome (hyaluronic acid (HA), calcium hydroxyapatite (CaHA)).

Component	Mechanism of Action	Potential Effect on Skin Microbiome
Hyaluronic acid (HA)	Hydration; reduces transepidermal water loss (TEWL); maintains acid mantle.	Stabilizes commensal growth (*S. epidermidis*, *C. acnes*); prevents dysbiosis associated with dry skin.
Calcium hydroxyapatite (CaHA)	Stimulates neocollagenesis; dermal remodeling; supports extracellular matrix integrity.	Strengthens skin structure → improved niche stability; limits overgrowth of opportunists linked to barrier disruption.
Amino acids (glycine, L-proline, L-lysine, L-valine, L-leucine, L-isoleucine)	Collagen synthesis; antioxidant support; metabolic cofactors.	Enhances dermal resilience → indirectly sustains microbial homeostasis by reducing oxidative/inflammatory stress.
Glycerol (carrier)	Humectant; increases hydration.	Promotes a favorable environment for commensals by lowering barrier stress.

1.4.1. Product Description

Hydro Deluxe (Neauvia®) is a non-crosslinked, biodegradable hydrogel composed of hyaluronic acid (18 mg/mL), enriched with CaHA microspheres and the amino acids glycine and L-proline. Designed for intradermal and superficial injections, it acts as a skin booster, aiming to improve hydration, elasticity, and barrier integrity rather than to provide volumetric correction. The combination of HA with CaHA and amino acids supports both immediate skin quality restoration and long-term regenerative processes, aligning with the therapeutic concept of bioactive stimulation and matrix remodeling [10,31,32].

1.4.2. Active Ingredients and Biological Roles

Hyaluronic Acid (HA)

Hyaluronic acid is a fundamental glycosaminoglycan within the dermal extracellular matrix, where it plays a pivotal role in maintaining tissue hydration, viscoelasticity, and mechanical resilience. Owing to its high molecular weight and unique ability to bind and retain

water, HA ensures optimal dermal turgor and contributes to the preservation of skin elasticity and firmness. Beyond its mechanical functions, HA also regulates cellular behavior by influencing proliferation, migration, and differentiation of keratinocytes and fibroblasts, thereby actively participating in wound healing and tissue remodeling [10,33–35].

The non-crosslinked form of HA, as used in injectable skin boosters, demonstrates excellent biocompatibility and rheological adaptability. Its lower viscosity allows for rapid and homogeneous integration into the skin, enhancing hydration without creating excessive volumization. At the cellular level, non-crosslinked HA has been shown to stimulate fibroblast activity, upregulate extracellular matrix synthesis, and promote keratinocyte function, which together contribute to the restoration of skin quality and regenerative capacity [9,10,32].

Calcium Hydroxyapatite (CaHA)

CaHA microspheres are well-established biostimulators that initiate a cascade of regenerative processes within the skin. By activating fibroblasts, they promote neocollagenesis, angiogenesis, and extracellular matrix remodeling, which translate into long-term improvements in dermal thickness, elasticity, and resilience [36]. In Hydro Deluxe, CaHA is incorporated at lower concentrations than in volumizing fillers, striking a balance between structural support and seamless physiological integration [10]. Beyond their subtle lifting effect, CaHA microspheres contribute to durable dermal reinforcement and enhanced barrier function, helping the skin withstand environmental and microbial stressors while maintaining hydration and overall quality [37].

Amino Acids: L-Proline and Glycine

L-proline and glycine are critical amino acids that serve as indispensable substrates for collagen biosynthesis, particularly in the formation of the characteristic triple-helical structure of collagen fibers [38]. Their availability directly influences collagen maturation, dermal density, and stabilization of the extracellular matrix (ECM), thereby enhancing the biomechanical strength and resilience of the skin. Beyond their structural role, these amino acids contribute to tissue repair processes by supporting fibroblast function and accelerating ECM turnover, which helps maintain dermal integrity over time [15].

The combination of hyaluronic acid, calcium hydroxyapatite, and amino acids acts synergistically to restore skin hydration, reinforce barrier integrity, and stimulate tissue regeneration. Beyond esthetic rejuvenation, this integrated activity potentially contributes to creating a dermal microenvironment supportive of microbial homeostasis, thereby promoting broader improvements in overall skin health.

2. Methods

A comprehensive narrative literature search was performed in PubMed, Embase, Scopus, and Google Scholar up to December 2024. Search terms included “Hydro Deluxe”, “skin booster”, “hyaluronic acid AND microbiome”, “calcium hydroxyapatite AND skin”, “cutaneous microbiota”, “skin barrier”, and “dermal remodeling”. Both free-text keywords and MeSH terms were used. Eligible publications included original research articles, reviews, in vitro and ex vivo studies, clinical investigations, and mechanistic works related to HA, CaHA, skin physiology, or microbial ecology. No restrictions on publication date, study design, or language were applied.

Study selection was conducted by a single reviewer (CJTC). Titles and abstracts were screened for relevance, and full texts were assessed when necessary. Ambiguous or borderline cases were re-evaluated to ensure conceptual coherence within the scope of this narrative review. Given the limited availability of microbiome-specific research on Hydro Deluxe, broad inclusion criteria were adopted to capture all potentially informative dermatological, microbiological, and esthetic evidence. A simplified PRISMA-ScR flow

diagram summarizing the study identification process is provided in Supplementary Materials (Figure S1).

3. Results

Possible Microbiological Mechanisms of Hydro Deluxe

The skin's acidic surface pH (typically 4.5–5.5) is essential for epidermal barrier integrity, enzymatic function, and microbial balance. When this pH shifts toward neutral or alkaline values, lipid-processing enzymes such as β-glucocerebrosidase and acid sphingomyelinase become less effective, weakening the stratum corneum and accelerating TEWL [39,40]. Such alterations commonly occur with aging or under external stressors—including harsh surfactants, cosmetics, and urban pollution—and predispose the skin to dysbiosis with increased colonization by opportunistic pathogens like *Staphylococcus aureus* [41]. In contrast, an acidic medium favors the growth of commensals such as *Staphylococcus epidermidis* and *Cutibacterium acnes*, organisms that promote antimicrobial peptide production and enhance defense against pathogens [42].

Hydration plays a synergistic role in maintaining this equilibrium. Adequate water content in the stratum corneum optimizes enzyme activity, supports natural moisturizing factor (NMF) function, and sustains the acid mantle [43]. Clinical data confirm that improving hydration and reducing TEWL help restore physiological pH and reinforce the epidermal barrier [44,45].

By enhancing hydration and limiting TEWL, Hydro Deluxe may indirectly contribute to the stabilization of the skin's acid mantle [32]. This acidic environment favors the growth of commensal microbes while restricting pathogen overgrowth, thereby supporting cutaneous resilience and microbial homeostasis. Improved dermal integrity and moisture also create conditions that facilitate the persistence of beneficial taxa [45–47].

In vitro studies illustrate this relationship: lipid metabolism disrupted by *Malassezia* lipases can activate inflammatory cascades through mediators such as IL-1α, IL-6, IL-8, and TNF-α [48]. By maintaining hydration and dampening inflammatory triggers, Hydro Deluxe may help counteract these detrimental pathways and limit the expansion of pro-inflammatory microbes, including *Staphylococcus aureus*.

Preclinical data further suggest that Hydro Deluxe exhibits antimicrobial, antibiofilm, and anti-inflammatory properties, including a reduction in IL-8 release in reconstructed epidermis models exposed to microbial stimuli [9,10,46].

Since dysbiosis is strongly implicated in conditions such as acne, atopic dermatitis, and rosacea—often linked to barrier dysfunction and chronic inflammation—therapies that restore hydration, stimulate collagen synthesis, repair the barrier, and indirectly modulate immunity may help mitigate these risk factors [2,26,30]. In this context, Hydro Deluxe demonstrates potential for a multifaceted microbiological impact: by enhancing hydration, reinforcing barrier integrity, stabilizing the acid mantle, and attenuating inflammatory signaling, it creates conditions that favor commensal species while restricting opportunistic pathogens. Through these mechanisms, Hydro Deluxe may preserve microbial diversity and promote long-term skin resilience and ultimately support long-term skin resilience and homeostasis, even in the face of aging or environmental stress.

The mechanisms discussed should be interpreted as hypothesis-generating. While several biological pathways are supported by existing evidence on HA, CaHA, and ECM biology, no clinical studies have directly evaluated the microbiome-specific effects of Hydro Deluxe. Therefore, the proposed microbiological pathways should be considered extrapolations based on related research and require future in vivo validation.

4. Discussion

This review positions Hydro Deluxe within the broader framework of microbiome-conscious esthetic medicine. While hyaluronic acid–based skin boosters are widely recognized for their ability to restore hydration, elasticity, and dermal architecture, the integration of CaHA and amino acids in Hydro Deluxe introduces an additional layer of biological activity with potential microbiological implications [10]. The findings summarized here suggest that the formulation may influence the cutaneous ecosystem not merely through structural enhancement but also by fostering conditions that support microbial balance [9].

The role of hydration emerges as a central mechanism. By reducing TEWL and maintaining stratum corneum water content, Hydro Deluxe indirectly stabilizes the acid mantle, a critical determinant of microbial composition [32]. The acidic surface pH favors beneficial commensals such as *Cutibacterium acnes* and *Staphylococcus epidermidis*, while deterring colonization by opportunistic pathogens including *Staphylococcus aureus* [41,42]. This indirect modulation of the microbiota aligns with evidence that barrier integrity and hydration status are among the strongest predictors of cutaneous microbial stability.

Beyond hydration, CaHA contributes to structural reinforcement and long-term dermal remodeling [36]. By promoting fibroblast activity and neocollagenesis, it may counteract age-related barrier fragility and reduce susceptibility to inflammation, thereby diminishing ecological niches that favor pathogenic taxa [37]. Similarly, the inclusion of L-proline and glycine provides substrates for collagen synthesis and extracellular matrix stability, further supporting a skin environment that is less permissive to dysbiosis [38]. These synergistic actions reflect a shift from purely esthetic correction toward biologically informed interventions that influence both tissue and microbial health.

Although direct clinical evidence on microbiome modulation by Hydro Deluxe remains limited, preliminary in vitro findings support its antimicrobial and anti-inflammatory effects. A study evaluating the Hydro Deluxe formulation in inflammatory scalp conditions demonstrated antimicrobial, antibiofilm, and anti-inflammatory activity against *Cutibacterium acnes*, *Staphylococcus aureus*, *Staphylococcus epidermidis*, and *Malassezia furfur*, along with a reduction in IL-8 release in a reconstructed human epidermis model [9,10]. When combined with hydration-driven stabilization of the acid mantle and reinforcement of dermal architecture, these effects provide a biologically plausible rationale for a microbiological impact. Importantly, this positions Hydro Deluxe not only as a skin quality booster but also as a potential adjunct in mitigating risk factors underlying dysbiosis-related conditions such as acne, atopic dermatitis, and rosacea [9,46].

Nevertheless, several questions remain. Most available data are derived from preclinical or ex vivo models, and translation to clinical outcomes requires rigorous investigation. Longitudinal studies incorporating microbiome sequencing, barrier function assays, and clinical endpoints will be critical to establish whether the hypothesized microbiological effects of Hydro Deluxe manifest consistently in vivo. Moreover, inter-individual variability in baseline microbiota, lifestyle, and environmental exposures may influence treatment outcomes and should be accounted for in future research designs [6,26].

Taken together, the available evidence suggests that Hydro Deluxe operates at the intersection of structural rejuvenation and microbiome support. By promoting hydration, reinforcing barrier integrity, stabilizing the acid mantle, and attenuating inflammatory signaling, the formulation creates conditions favorable to commensal persistence and hostile to opportunistic overgrowth. This multifaceted activity underscores the emerging paradigm of microbiome-conscious esthetics, where interventions not only improve visible skin quality but also sustain the ecological balance underlying long-term skin resilience.

Translating in vitro findings to in vivo outcomes must be performed cautiously. Antimicrobial, anti-inflammatory, or ECM-modulating effects observed in controlled models

may not reflect the complexity of human skin, where microbial interactions, host immunity, and environmental factors interact dynamically. Future clinical studies should include microbiome-specific endpoints to determine whether these mechanistic hypotheses translate into measurable in vivo effects.

5. Limitations of the Evidence

The available evidence evaluating Hydro Deluxe in relation to microbiome outcomes is limited. No clinical trials have assessed microbial diversity, composition, or ecological changes following treatment with this specific formulation. Most mechanistic interpretations in this review are extrapolated from in vitro and ex vivo studies, small sample investigations, or research evaluating HA and CaHA individually rather than in combination. Variations in molecular weight, formulation, injection depth, and device-specific features further limit the generalizability of these findings. Additionally, heterogeneity in study designs and the absence of standardized or high-resolution microbiome endpoints restrict comparability across studies. At present, no randomized controlled trials directly examining Hydro Deluxe and the cutaneous microbiome are available, underscoring the need for well-designed in vivo studies to validate these proposed mechanisms.

6. Conclusions

Hydro Deluxe combines HA and CaHA in a formulation that may improve hydration, ECM support, and barrier integrity, which are factors that influence the skin microbiome. No studies have directly examined microbiome outcomes after Hydro Deluxe treatment, and current interpretations are based on evidence from HA and CaHA separately. Future research should include clinical studies with microbiome-specific endpoints to clarify whether these mechanisms translate into measurable effects in vivo.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/cosmetics12060272/s1, Figure S1: PRISMA-ScR simplified flow diagram of the literature search strategy.

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