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Interactions Between Cosmetics and the Skin Microbiome

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Abstract:

The skin is the largest organ in the human body, and the skin microbiome is a key regulator of skin health. It can address many issues such as dysbiosis, dryness, or skin sensitivity. At the same time, cosmetics can effectively adjust and improve appearance. This article explores the impact of the interaction between the skin microbiome and cosmetics, for instance, changes that occur on the face after cleansing, etc. Different effects are observed among different groups of people, divided into those with healthy microbiota and those with imbalanced microbiota. There are significant differences in the use of cosmetics between these two groups. People with skin disorders need cosmetics containing ceramides, cholesterol, and fatty acids more. Among them, the proportion of ceramides is the highest, accounting for 50% as it has the functions of stabilizing and filling. It can help the skin form a dense and orderly double-layer lipid membrane. Healthy skin is like "soil", and the role of cosmetics is to "fertilize". It can also solve many fundamental problems based on this relational foundation.

Keywords: Cosmetics, Microbiome, Skin

1. Introduction

The skin microbiome is an indispensable part of our body and is also known as an "active" organ. It can fundamentally promote skin health by maintaining and restoring the diversity and balance of the microbiota. The skin microbiome, this ecosystem, provides all-around protection for our skin. With the passage of time, most people use cosmetics. The range is very wide, such as beauty makeup and daily skin care [1].

However, many traditional cosmetic ingredients and usage habits may unintentionally disrupt the balance of the skin microbiome, leading to Dysbiosis and subsequently causing various skin problems.

Firstly, cosmetics have direct and indirect effects on the skin microbiome. The most obvious aspect is the appearance and condition of the skin, and secondly, cosmetics can effectively address skin problems at their root cause. Of course, the effectiveness of different cosmetics is related to the conditions of the skin's microbiome. For example, as one enters adolescence, the skin's microbial ecosystem becomes more vulnerable and prone to damage. At this point, skin care products can interact with each other to provide protection [1].

2. Direct Interactions Between Cosmetics and the Skin Microbiome

Facial cleanser, as a cleansing product, is designed to remove dirt and dust from the surface of the skin, such as PM2.5. The surfactants in the facial cleanser can remove all the oil. Facial cleansers are divided into soap-based cleansers and amino acid cleansers. Soap-based cleansers have strong cleaning power and contain fatty acids and alkaline agents. They produce abundant foam and leave a very refreshing feeling after cleansing. However, amino acid facial cleansers use amino acid surfactants. Its pH value is slightly acidic and is close to that of the skin. It has little irritation to the skin and is very suitable for sensitive individuals. It can effectively clean while not causing excessive de-tanning, and the skin feels moist and not tight after washing [1].

Firstly, during adolescence, about oil and acne on their faces. The active ingredients in facial cleansers can directly clean the surface oil or dead skin cells on the skin. Changes can be seen directly, with the face becoming fresher. Cleaning products on the market contain a high amount of soap, which can damage the keratin layer and barrier on the skin. Many microorganisms were also removed. If this facial dirt is not removed in time, it will cause facial acidification and putrefaction. Long-term and repeated presence of acne marks on the face will also stimulate the facial hair follicles. To prevent "teenage beauty acne", facial cleansing is necessary. Mix the soap with the oil thoroughly and then rinse it off with clean water. Dry it with a clean towel. During this process, avoid touching one's face with one's hands or toilet paper to prevent the introduction of bacteria. From the perspective of pH value, it has changed from a weakly acidic state to a basic one. The moisture in the skin is depleted, and it will become sensitive and dry. Therefore, when choosing cleaning products, people should pay attention to the soap base content, consider the frequency of use [2].

Similarly, the harsh external environment in winter can accelerate water loss and damage the skin's moisture barrier. In a low-temperature environment, sebaceous glands become "lazy", and sebum secretion is overly reduced. Therefore, the most direct effect of cosmetics on the skin in winter is to moisturize and soften it. Then, in winter, the pH value of the skin microbiome is imbalanced, and the proportion of dominant bacterial groups changes. This means that the surface of healthy skin is weakly acidic, with a pH value of 4.5 to 5.5. Then, beneficial bacteria may decrease, as some beneficial bacterial groups for skin health may not adapt to the changed environment.

The key to protecting the microbiome lies in "protecting the barrier" and "maintaining balance". Moisturizers in face creams, such as glycerin or hyaluronic acid, can directly absorb moisture from the environment and replenish the stratum corneum. Vaseline, commonly found in convenience stores, can be applied to the lips to prevent chapping as it forms a film on the skin surface, which helps with moisture retention. Various oils can directly fill the gaps between shed keratinocytes, making our skin instantly soft and smooth, while significantly reducing dryness and cracking.

At the same time, ingredients in cosmetics, after exerting their direct effects, can trigger biological responses in the deeper layers of the skin, leading to long-term functional changes. In the "brick wall structure" of the stratum corneum, the "bricks" and "mortar" are keratinocytes and intercellular lipids, respectively. These lipids consist of 50% ceramides, 25% cholesterol, and 15% free fatty acids.

Finally, be cautious when exfoliating and reduce the use of scrubs, alpha hydroxy acids (AHAs), and beta hydroxy acids (BHAs). These products can cause strong irritation to the skin, further damaging the skin's barrier. The external environment is also especially important, so research suggests using an indoor humidifier to maintain the temperature at 40%-60% [1] [2].

3. Indirect Effects on Skin Microbiome and Skin Health

Apart from cosmetics and the microbiome having a direct impact on the appearance, they also have an indirect effect on the skin's deeper layers. These cosmetic ingredients, such as oils, proteins, and polyols, can provide nutritional sources. Adding prebiotics like α-glucan oligosaccharides can selectively stimulate the growth of beneficial bacteria, thereby helping to maintain the balance of the microbiome. The most magical effect of cosmetics is to improve the skin's barrier function and anti-aging. Serums have three major characteristics. Firstly, the highly concentrated active ingredients and the essence are the most effective and highest concentration products in the entire skincare range, which means the product's effect is stronger and more direct. Secondly, the essence has a smaller molecular structure, a finer texture, and stronger permeability. It can effectively meet the lower layer of the skin. The most important point is its strong targeting ability. The skin is the outermost tissue that constitutes the human body. It is composed of the epidermis, dermis, and subcutaneous tissue. The epidermis is the outermost layer of the skin and is composed of keratinocytes, melanocytes, Langerhans cells, and Merkel cells. Keratinocytes are the most abundant cells found in the epidermis and function

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as a barrier against the external environment. Wrinkles are a typical symptom of skin aging, caused by the loss of elasticity. This loss of elasticity is related to the reduction of collagen and elastin, which are proteins associated with the elasticity of the dermis. Collagen accounts for approximately 90% of the extracellular matrix (ECM) of human dermis. Type I collagen is the most abundant structural protein in skin and connective tissue, making up 80% of total collagen. Changes in its structure are considered the main cause of skin aging and wrinkle formation [3].

Essences are usually designed to solve specific skin problems, such as anti-aging or whitening. Middle-aged women attach great importance to anti-aging products in their daily skincare routines because these serums contain ingredients such as retinol (A alcohol) and its derivatives, peptides, and bethanin. These are the most effective anti-aging ingredients, which can stimulate the regeneration of collagen and elastin, truly reducing wrinkles, improving sagging, and enhancing skin firmness. La Prairie is a brand that everyone is familiar with. Caviar extract is its signature ingredient. It is rich in proteins, amino acids, vitamins, minerals, and fatty acids. In theory, these nutrients can nourish the skin, help promote cell metabolism, and enhance skin firmness and luster. This is also the origin of its „caviar“ concept. Cell Elixir Complex is La Prairie‘s patented technology, usually containing a series of plant extracts, vitamins, and cytokines [1]. The brand claims that it can simulate the communication between skin cells, stimulate cell regeneration vitality, and help improve skin density and elasticity. At the same time, peptides are the most crucial ingredient in anti-wrinkle essence. Peptides are short chains of amino acids that can synthesize more collagen and elastin, both of which can ensure highly effective anti-aging [3].

Similarly, there is a very subtle influence between cosmetics and the skin microbiome. Cosmetics do not kill the added microorganisms but change the environment on the skin surface. This can profoundly affect the balance of the microbiota. Altering the pH value is the most crucial impact. The pH value of healthy skin is maintained within a weakly acidic range (4.5 - 5.5), which is known as the „acid mantle.” It can inhibit harmful bacteria, such as Staphylococcus aureus, and promote beneficial bacteria, such as Staphylococcus epidermidis. The regulation of pH value between cosmetics and the microbiome involves three aspects. First, protecting the skin barrier function: The acidic environment on the skin surface helps maintain the integrity of the skin barrier [3]. A reasonable pH value can promote the close adhesion of keratinocytes, reduce water loss, prevent the invasion of harmful substances from the outside, and protect the skin from irritation and infection. Secondly, cosmetics can maintain the balance of skin microorganisms. On the surface of normal skin, there are many beneficial bacterial groups, such as lactic acid bacteria and Staphylococcus. These bacterial groups can produce acidic substances, maintaining a healthy skin ecosystem. The appropriate acid-base balance helps to inhibit the growth of harmful bacteria and promote the reproduction of beneficial bacteria, maintaining the balance of skin microorganisms [2].

Finally, it regulates sebum secretion. Changes in the skin‘s pH value can affect the secretion activity of sebaceous glands. An appropriate pH value helps to maintain the balance of sebum secretion, avoiding the occurrence of oily skin and acne. When the skin‘s pH value deviates from the normal range, that is, when it shifts towards acidity or alkalinity, the skin‘s barrier function may be compromised. An overly acidic environment causes the keratinocytes to shed too quickly, resulting in a thinner stratum corneum and weakened barrier function, making the skin more susceptible to external stimuli and infections. An overly alkaline environment damages the lipid layer on the skin surface, disrupting the barrier function and leading to water loss and dryness of the skin. Therefore, maintaining a normal skin pH value is of great importance for protecting the skin‘s barrier function and maintaining skin health. Therefore, „pH balance“ has become an important selling point for many facial cleansers and skin care products, aiming to reduce interference with the natural acid-base environment of the skin and maintain the stability of the microecology. Reasonable use of mild cleansing products, avoiding the use of overly acidic or alkaline cleaners, and maintaining appropriate skin moisture can maintain the normal pH value of the skin and enhance the skin‘s barrier function [4].

4. Selection of Cosmetics Under Different Skin Conditions

Meanwhile, there is a significant difference between using cosmetics by people with imbalanced facial skin microbiota and those with highly diverse facial microbiota. Therefore, the criteria for choosing cosmetics also vary. For people with imbalanced skin microbiota, their skin condition is unstable, they are sensitive and prone to inflammation, and are thus more susceptible to irritation. When choosing products, they tend to prefer mild ones, with the core goal being to repair the barrier and have antibacterial and anti-inflammatory properties [5]. However, for those with highly diverse skin microbiota, their skin is more stable and healthier. Therefore, they can prefer to choose skincare products with diverse functions and

strong activity. A total of 1082 female cosmetic consumers participated in a whitening test, including those with highly active facial microbiota as well as those with sensitive facial microbiota disorders. After using the cosmetics, the overall incidence of side effects was 26.2%, while the incidence of side effects of whitening cosmetics was 10.3%. The side effects mainly manifested as itching, redness, pain, and pigmentation. The study found that people with highly active facial microbiota showed more rapid and obvious effects after using whitening products. However, those with facial imbalance would experience various discomforts. Therefore, both groups of people should be cautious when choosing cosmetics [4] [5].

5. Discussion

The main findings of this investigation are that cosmetics have both benefits and drawbacks for the skin microbiome. However, one should choose the appropriate skincare products based on their own facial condition. Like the research, cosmetics can indirectly alter the skin's pH value, promoting the absorption of beneficial bacteria. Although many products on the market are alkaline, they will increase the "acidic coat" after use. Changes in pH value can significantly alter the environmental ecology. This study clearly reveals the significant differences between people with disrupted microbiota and those with balanced microbiota in terms of their reactions to cosmetics. Therefore, the core purpose of choosing cosmetics differs. It is advisable to understand skin conditions before selecting products that are tailored to specific needs.

6. Conclusion

This paper reviews the complex and dynamic two-way interaction between the skin microbiome and cosmetics. The traditional view holds that cosmetics affect the microbiota through antibacterial strategies. However, the latest research indicates that this interaction is far more complex, covering multiple aspects such as inhibition, destruction, nourishment, and regulation. This paper delves into how cosmetic components indirectly regulate the balance and diversity of the microbiome by altering the skin pH value, providing nutritional sources, and influencing the barrier function; it also explains how the skin microbiome metabolizes cosmetic components and affects their efficacy and safety. Finally, this paper presents new strategies for cosmetic research based on microecological balance, such as the application of prebiotics, postbiotics, and probiotics. The conclusion is that future cosmetic research should shift from simple "antibacterial" to complex "promoting balance", by collaborating with the skin microbiome to jointly maintain skin health. The skin microbiome and cosmetics do not have a simple "attack and defense" relationship; rather, they form a connected ecosystem. Cosmetics are powerful environmental regulators that can profoundly shape the composition and function of the skin microbiota; conversely, the microbiome also actively participates and modulates the final efficacy of cosmetics. Future cosmetic science must consider the skin microbiome as a core factor and collaborate with the symbiotic microorganisms on the skin through the development of "microbial ecology-friendly" innovative products, jointly promoting and maintaining the health and beauty of the skin.

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