

Chemical Components in Cosmetics and Impacts on Functions

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Abstract. Chemical components are the core part of cosmetics, determining their efficacy and safety. However, in recent years, as the safety hazards of some cosmetic ingredients have been exposed, the safety of chemical components has become the focus of consumers' attention. Some chemical components may have negative impacts on human health, such as causing skin sensitivity and allowing harmful substances to be absorbed through the skin and damage internal organs. This paper aims to conduct research and discussion through comparison, data analysis, and exploration of the antioxidant and moisturizing properties of chemical components. The results of this paper show that through the comparison of nicotinamide and hyaluronic acid, it is found that hyaluronic acid has a more significant moisturizing effect in the short term, but in the long term, nicotinamide is more conducive to moisture balance and a healthy state. By comparing nicotinamide and vitamin E, it is understood that their mechanisms and effects are essentially different. Therefore, the choice of which ingredient depends more on specific application scenarios and requirements. By analyzing and comparing chemical ingredients with special functions in cosmetics, we can clarify the structure of cosmetic functional ingredients and the development of the industry, and promote technological innovation in the cosmetic industry.

Keywords: Antioxidation; Moisturization; Ingredient application.

1. Introduction

As time increases, skin aging characteristics manifest themselves in the appearance of wrinkles, sagging skin and hyperpigmentation. This is due to the gradual loss of collagen and elastin fibers in the skin, weakening of the skin barrier function and accelerated water loss. Skin care is very important in order to maintain healthy and youthful looking skin, so choosing the right skin care products is an important part of skin care. Ingredients such as hyaluronic acid, niacinamide, and vitamin E in skin care products can replenish the nutrients required by the skin and enhance the skin's moisture retention ability and elasticity. Hyaluronic acid, also called hyaluronan, is a naturally occurring high-molecular-weight linear mucopolysaccharide with unique biological functions and extensive application values. In recent years, the extraction and production technologies of hyaluronic acid have been continuously advancing. The widespread application of technologies such as microbial fermentation and enzymatic hydrolysis not only reduces production costs but also improves the purity and safety of products. These technological advancements have promoted the application of hyaluronic acid in various fields and provided a solid technological foundation for the rapid growth of its market.

Leading domestic enterprises such as Bloomage Biotechnology have mastered advanced hyaluronic acid production technologies through independent research and development and continuously improved production capacity and efficiency. In the future, with the continuous increase in consumers' demand for beauty and skincare and the continuous progress of hyaluronic acid extraction technologies, the market for hyaluronic acid cosmetics will continue to maintain a rapid growth trend. At the same time, domestic and foreign enterprises will also continue to strengthen technological research, development, and innovation efforts to promote the continuous development and upgrading of the hyaluronic acid cosmetics industry.

Nicotinamide, also known as niacinamide or the amide compound of vitamin B3, is an important member of the vitamin B complex. As a direct precursor of NAD⁺, nicotinamide mononucleotide (NMN) has demonstrated great potential in the field of anti-aging, driving the rapid growth of the market [1]. Domestic enterprises have been continuously innovating in the extraction, synthesis, and

purification technologies of nicotinamide to improve production efficiency and product quality. Overseas research on nicotinamide is more in-depth. It not only focuses on its applications in fields such as medicine and cosmetics but also endeavors to explore its underlying mechanisms in aspects such as anti-aging, immune enhancement, and metabolic improvement. For example, NMN repairs DNA breaks by activating the PARP1 enzyme, reducing the risk of cell mutations [2].

Vitamin E, also known as tocopherol, is a fat-soluble vitamin and one of the most important antioxidants. Domestic cosmetics enterprises have made remarkable progress in the extraction, purification, and formulation research and development of vitamin E. By adopting advanced extraction technologies and production processes, the purity and stability of vitamin E have been improved, thereby enhancing the quality and effectiveness of cosmetics. In addition, domestic enterprises also focus on combining vitamin E with other active ingredients to develop compound cosmetics with multiple functions to meet the needs of different consumers [3]. Foreign cosmetics enterprises started earlier in the research and application of vitamin E and have accumulated rich experience and technologies. Through continuous improvement of production processes and formula design, the stability and activity of vitamin E in cosmetics have been enhanced, thus improving the quality and effectiveness of products. With the increasing global awareness of environmental protection, foreign cosmetics enterprises have begun to focus on the environmental protection and sustainable development of vitamin E cosmetics. By adopting green production processes and recyclable packaging materials, they have reduced the environmental impact and enhanced the environmental attributes of products.

This paper aims to conduct an in-depth exploration of the impacts of different chemical components in cosmetics on specific functional effects (e.g., moisturization, repair and sun protection). The comparative analysis of the content of different chemical components in cosmetics, their mechanisms of action and their direct effects on skin cells will provide a scientific basis for the R&D and production of cosmetics and consumer choice.

2. The Moisturizing and Skin-lightening Effects of Nicotinamide

Nicotinamide is an important chemical component in cosmetics, and its content and effects when combined with different other ingredients vary. Experimental results have shown that using 4% niacinamide product after the eighth week only has the function of reducing wrinkles. However, adding motor proteins can not only reduce wrinkles and pores, but also decrease redness and increase elasticity. Several other clinical trials evaluated products containing niacinamide and several other active ingredients (retinol, fatty alcohols), which collectively demonstrated the effect of improving wrinkles. In the second whitening experiment, the effectiveness of moisturizing products containing or not containing niacinamide was compared among women with pigmentation. The conclusion was that moisturizing products containing niacinamide significantly reduced facial pigmentation in the experimental subjects [1]. Niacinamide not only plays a role in skin whitening, wrinkle resistance, and elasticity enhancement, but more importantly, it also has antioxidant and moisturizing properties.

3. Moisturizing Properties of Ingredients and Nicotinamide

Hyaluronic acid, hailed as the "natural moisturizing factor," is a large non-sulfated glycosaminoglycan. It possesses extremely strong water-absorbing capabilities, capable of providing sustained moisture replenishment to the skin. Simultaneously, it promotes skin metabolism and enhances skin elasticity. In cosmetics, hyaluronic acid typically exists in the form of micromolecules to ensure its excellent skin permeability, bringing deep nourishment and care to the skin. Compared with other humectants (such as polyethylene glycol, glycerin, ethylene glycol, propylene, and sorbitol), the more significant advantage of HA lies in its independence from relative humidity. Different from other humectants, HA exhibits good water retention capabilities under both high and low relative humidity conditions [4].

The moisturizing ability of hyaluronic acid enables humans to adapt faster because it naturally exists in the human body. When applied to the surface of the skin, it increases the body's water content through a hydration network. In terms of direct absorption and retention of moisture, the moisturizing effect of hyaluronic acid may be more significant. It can quickly increase the moisture content and moisturization of the skin, thereby improving dry skin conditions. After entering the skin, hyaluronic acid may trigger local inflammatory reactions, manifested as discomfort symptoms such as local burning sensations, stinging pains, or erythema. This is typically because hyaluronic acid, as a macromolecular compound, exerts a certain degree of irritation on the skin. Reportedly, the incidence of allergies ranges from approximately 0.05% to 0.69%. Allergic reactions to hyaluronic acid are classified into immediate reactions and delayed reactions. Immediate reactions generally occur within one to two hours, while delayed reactions may occur even after 24 hours [5]. When using hyaluronic acid fillers for injection in the case of hyaluronic acid-based filling, if the operation is improper or an individual has an allergic-prone constitution, it is prone to trigger inflammatory reactions, resulting in symptoms such as redness, swelling, and pain at the injection site.

Unlike the direct action of hyaluronic acid, niacinamide emphasizes long-term maintenance of skin moisture balance and health status. By strengthening the skin barrier, niacinamide helps the skin maintain moisture and elasticity, reducing skin dryness and aging caused by environmental factors [1]. This is because nicotinamide can enhance the biosynthesis of ceramides and other stratum corneum lipids, thereby improving the epidermal permeability barrier and enhancing the structural and functional integrity of the skin barrier [6]. Experimental personnel applied cosmetics containing 5% nicotinamide and found that people did not experience any side effects within a certain period [1]. For example, there were no stinging sensations or flushing. This indicates that at normal concentrations, the skin has a relatively good tolerance to nicotinamide. However, if an excessive amount of nicotinamide is used over an extended period, it may cause the skin to become dry, accompanied by a tight feeling. This may be because nicotinamide has the effect of regulating sebum secretion in the skin. Overuse may lead to a decrease in sebum, resulting in dry skin. However, the effects of nicotinamide on the skin are mainly related to an individual's skin condition. For example, allergic individuals may experience allergic symptoms such as rashes, itching, and swelling after use. In addition, people with sensitive skin may experience irritating symptoms such as redness, itching, or stinging. Not only on the skin, but when used as a nutrient, high doses may also cause side effects on the liver or other organs.

4. Comparison of the Antioxidant Properties of Components

In terms of antioxidant activity, nicotinamide mainly exerts its antioxidant effect indirectly by participating in the synthesis and metabolism of NAD (P) H and regulating the intracellular redox state, with a greater emphasis on regulating the intracellular redox state and promoting cell repair [7]. Consuming niacinamide can prevent lipid peroxidation and restore reduced levels of antioxidants and antioxidant enzymes to normal levels [1]. The antioxidant activity of nicotinamide can reduce the production of ROS and the accumulation of lipofuscin, which is related to anti-aging activity and can inhibit cell size and particle content. Niacinamide has a wider range of effects, including multiple aspects inside and outside the cell.

Vitamin E is a potent chain breaking antioxidant that can inhibit the production of reactive oxygen species during fat oxidation and free radical reaction propagation. It exerts antioxidant effects by clearing free radicals in the body and preventing lipid peroxidation reactions, and can also protect polyunsaturated fatty acids present in membrane phospholipids and plasma lipoproteins. The antioxidant effect of vitamin E is mainly concentrated on the cell membrane and lipid components, which can increase the orderliness of membrane lipid packaging. Therefore, it can protect the cell membrane and intracellular lipid components from free radical damage, thereby maintaining the normal structure and function of cells. In short, vitamin E can be used not only for cosmetics, but also for disease prevention [8]. However, it has been found that tocopherol and tocopherol acetate can be

safely used in topical skin preparations in clinical studies, as irritants or allergic reactions only account for a small proportion. However, people with allergies may be allergic to vitamin E and may experience symptoms such as rash and itching after use. In addition, for people with oily skin, continuous use of vitamin E may exacerbate skin oiliness and lead to a greasy feeling [5,9].

5. Specific Measures and Recommendations

5.1. Cosmetics Containing Nicotinamide

Firstly, maintaining skin cleanliness is fundamental. Before using nicotinamide products, ensure that your face has been thoroughly cleansed to remove excess oil and dirt, enabling the nicotinamide ingredients to penetrate the skin more effectively. Secondly, select nicotinamide products suitable for your skin type, such as serums, lotions, or creams, and use them correctly according to the product instructions. When using, take an appropriate amount of the product and evenly apply it to the face, gently massaging until fully absorbed. It is recommended to use it in the morning and evening to continuously nourish and repair the skin. In addition, for those who are using nicotinamide products for the first time, it is advisable to start with a low concentration, gradually adapt, and build tolerance. If skin discomfort occurs during use, such as redness or stinging, discontinue use immediately and consult a professional[10].

5.2. Cosmetics Containing Hyaluronic Acid

Firstly, before using hyaluronic acid products, ensure that your skin has been thoroughly cleansed. This can enhance the absorption effect of hyaluronic acid. Select hyaluronic acid products suitable for your skin type, such as facial creams, serums, etc., and use them correctly according to the product instructions. Secondly, hyaluronic acid is classified into three types: large-molecule, medium-molecule, and small-molecule, and their action levels vary. Therefore, when choosing products, it is necessary to select the appropriate type of hyaluronic acid product according to your own skincare needs. In addition, after using hyaluronic acid products, be sure to do a good job in subsequent moisturizing. You can use them in combination with other moisturizing ingredients to build a scientific and reasonable skin care system[11]. Finally, when storing hyaluronic acid skin care products, place them in a cool and dry place, avoiding high temperatures and humid environments, to ensure the stability and effectiveness of the products.

5.3. Cosmetics Containing Vitamin E

Firstly, similar to the measures in the previous two parts, the face should be cleaned first. This helps vitamin E penetrate the skin more effectively. Secondly, select appropriate vitamin E cosmetics according to individual skin types and needs, such as vitamin E creams, lotions, or serums. When using, take an appropriate amount of the product and evenly apply it to the face, gently massaging until fully absorbed. It is recommended to apply at least 15 minutes before makeup to allow it to fully exert its moisturizing effect. In addition, vitamin E products can be used in combination with other skin care products[12]. For example, use toner or essence to prime the skin before applying vitamin E products. Finally, pay attention to observing the skin's reaction. If there is any discomfort or allergic reaction, discontinue use immediately and consult a professional.

6. Conclusion

This paper focuses on introducing the chemical components in three different types of cosmetics, comparing their moisturizing and antioxidant properties, and analyzing their roles in cosmetics. The effects of nicotinamide in skin whitening and wrinkle reduction may be attributed to the inherent properties of nicotinamide, the properties of other metabolites derived from nicotinamide, or both. As a multifunctional skincare ingredient, nicotinamide exhibits remarkable effects in antioxidant activity, skin hydration and skin barrier repair. However, when using it, attention should be paid to

the selection of concentration and avoid mixing it with other ingredients to ensure its safety and effectiveness. Hyaluronic acid has extensive applications in cosmetics, including creams, lotions, facial masks, toners, serums, color cosmetics, hair care products, etc. Hyaluronic acid, a natural moisturizing factor, can endow the skin with a long-lasting hydrated feeling and significantly alleviate skin dryness. Hyaluronic acid exhibits remarkable antioxidant effects in cosmetics, mainly attributed to its ability to scavenge free radicals and enhance the activity of antioxidant enzymes in the body. Vitamin E can penetrate deep into the skin barrier, enhance the skin's water-locking ability, and help maintain skin softness and smoothness. Certain vitamin E derivatives, such as tocopheryl succinate, improve their surface activity by introducing hydrophilic carboxyl groups. Besides their antioxidant properties, they can also effectively moisten and hydrate the skin. Vitamin E can effectively capture free radicals, reduce oxidative damage, and build a strong barrier for skin cells against ultraviolet rays and pollution. This paper only focuses on exploring the more obvious impacts and functions of the ingredients in cosmetics. However, it does not elaborate in detail on other chemical components, their reactions after mixing, the innovation of synthetic ingredients, or the methods to avoid harmful ingredients. In the future, nanotechnology and microencapsulation technology can be utilized as they can significantly enhance the stability and skin permeability of ingredients, enabling cosmetics to function more efficiently and precisely. Additionally, integration with big data and artificial intelligence can be carried out to adjust skincare regimens in real time according to an individual's skin condition.

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