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The Review Of Versatile Application Of Collagen In Cosmetics:

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Abstract

This comprehensive review delves into the multifaceted role of collagen in the cosmetics industry, providing an in-depth exploration of its benefits, diverse sources, collagen blends, and extraction methods. As a pivotal structural protein, collagen contributes essential support to various biological structures. The review encompasses an examination of alternative collagen sources and a detailed overview of methods for peptide generation and extraction. Notably, collagen's inherent qualities as a natural humectant and skin moisturizer have captivated the interest of both academia and the cosmetics sector.

The paper systematically covers key aspects, beginning with a thorough discussion on collagen's sources, followed by an exploration of its crucial role in the cosmetics industry. The extraction methods employed for collagen are scrutinized, offering insights into the various techniques utilized in the generation and isolation of peptides. Furthermore, the paper sheds light on the diverse applications of collagen in cosmetics, emphasizing its effectiveness in skincare and beauty products. The discussion extends to the separation of peptides and the strategic blending of collagen for enhanced cosmetic formulations. By synthesizing information on collagen's properties, extraction processes, and applications, this review serves as a valuable resource for researchers, industry professionals, and enthusiasts seeking a comprehensive understanding of the dynamic field of collagen in cosmetics.

Keywords: collagen, cosmetics application, moisturizer, protein, food industry, wound healing, tissue engineering

INTRODUCTION:

Proteins (from the Greek word proteins, which means “of primary importance") play dominant roles in almost all biological processes in living beings. Include: enzyme catalysis, transport and accumulation of tiny molecules and ions coordinated movement, mechanical Assistance, immune system defense production and transmission of nerve impulses, control of development and differentiation(1). Thus, the importance of protein use in cosmetic product is easy to understand.

The primary objective of cosmetics is to contribute to the maintenance of healthy and radiant skin and hair. Achieving this goal involves safeguarding the composition and functionality of these vital components. Therefore, one of the principals aims of cosmetics is to enhance and protect the skin and hair. The incorporation of proteins and their hydrolysates into cosmetic formulations emerges as a beneficial strategy

to attain these objectives, as specific cosmetic enhancements are often sought to improve the appearance of skin or hair (2), (3).
Protein can help improve the texture, hydration ,and overall appearance of the skin and hair.proteins like collagen, keratin, and silk amino acids are commonly used in skincare and haircare products to provide moisturization, strengthen hair and enhance the elasticity of the skin.

2. What is collagen?

Collagen is a structural protein constitutes a large part of the connective tissue, particularly in bones, tendons, joints, and skin(4). The primary structure of collagen consists of amino acids, mostly by glycine (33%), proline, and hydroxyproline (22%).Three amino acids are wrapped around each other in a helix to create the secondary structure is formed of amino acids α chains, which is then sprained to form the tight tertiary structure. The superhelix is related to the basic quaternary structure of collagen. There are currently 29 type of collagen have been discovered(5).Type I collagen is present in skin, tendon, and bone tissue; type II collagen is present in cartilage; and type III collagen is present in the skin and vasculature. A wide range of uses exist for collagen. Because of its great biocompatibility, lack of toxicity, and biodegradability, it is frequently utilized in the cosmetic, pharmaceutical, medical, and food industries (4),(6).

3. ROLE OF COLLAGEN IN COSMETICS:

Collagen stands as a cornerstone in cosmetic formulations, revered for its moisturizing, renewing, and film-forming attributes. Its remarkable capacity to bind water plays a pivotal role in sustaining optimal skin hydration throughout the day, leaving the skin supple and soft (7), (8). Research supports collagen's efficacy in accelerating wound healing and promoting tissue regeneration (9), (10). The multifaceted cosmetic potential of collagen is illustrated in Figure 1.

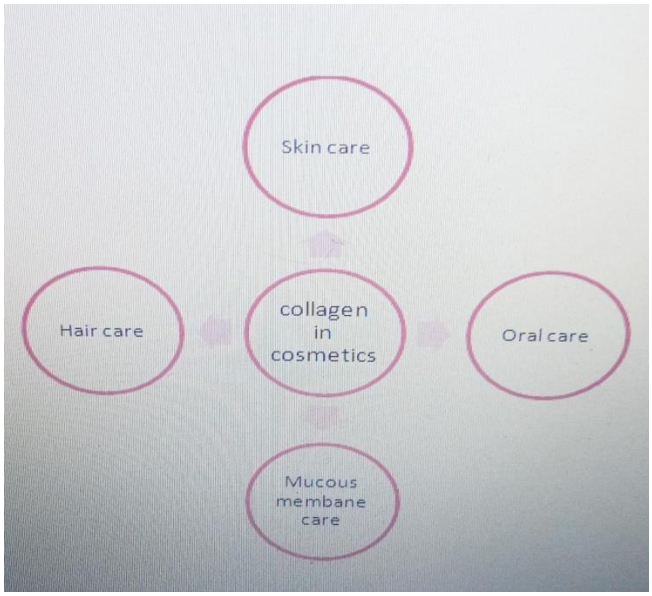

Figure 1: cosmetic potential of collagen

Figure 1 underscores collagen's pivotal role, constituting 30% of the body's protein and providing essential structure, support, and strength to skin, muscles, and bones. Recognized for its biological functions, collagen has become a focal point in cosmetics, medicine, and healthcare (11). The integration of collagen into cosmetic formulations has led to the development of creams and gels with robust moisturizing effects. However, its applications extend beyond hydration, encompassing anti-aging, anti-wrinkling, UV radiation protection, and wound healing, among other uses (12). Collagen's film-forming abilities further enhance its utility in cosmetics, forming a protective layer on the skin that reduces transepidermal water loss and shields the skin from corrosive elements (13). Notably, various hydrogels, often featured in "beauty masks," prominently include collagen. These cosmetic innovations are designed not only to boost anti-aging

capabilities but also to restore skin elasticity, exemplifying collagen's versatility in cosmetic applications (14).
This section highlights the pivotal role of collagen in cosmetics, emphasizing its diverse benefits and applications in skincare formulations. The subsequent sections will delve into the extraction methods, alternative sources, and blends of collagen in cosmetics.

4. Diverse Sources of Collagen for Cosmetic Applications:

Collagen, a versatile ingredient in cosmetics, can be derived from various sources, each offering unique benefits. The following list highlights some prominent sources of collagen for cosmetic use:
Aloevera
Silica
Vitamin C
Vitamin E
Porcine
Bovine
fishes
sea urchin

5. Collagen Extraction Methods for Cosmetic Use:

The extraction of collagen macromolecules for cosmetic use involves various methods, with the specific technique chosen often dependent on the collagen source. A comprehensive process for separating collagen from fish by-products typically involves three key steps: assembling, removing, and recovering. Throughout this extraction process, one of three primary methods—acid-solubilized collagen, neutral salt-solubilized collagen, or pepsin-solubilized collagen—must be employed (15).
For collagen extracted from young animals with fewer crosslinked bonds, neutral salt solutions prove effective in the extraction process (16). The subsequent purification involves techniques such as centrifugation, precipitation, and dialysis. In contrast, collagen from older organisms, featuring a higher number of crosslinked connections, requires acid for extraction, making the process more efficient. Solvents like hydrochloric acid, acetic acid, and lactic acid are commonly used in this method. Additionally, consideration should be given to the collagen triple helix's resistance to proteases like pepsin and chymotrypsin (17),(18).
Fish by-products, including skin, bones, and scales, constitute a substantial percentage of the material generated during fish processing (19). These by-products, rich in collagen, have garnered attention as valuable collagen sources. Fish skin collagen, in particular, holds great potential for cosmetic applications. The extraction process involves mincing the skin and treating it with an alkaline solution, followed by stirring for 24 hours to eliminate non-collagenous proteins. Subsequent steps include passing the mixture through a coarse sieve to remove impurities, homogenizing with an acidic solution, and further stirring. The process continues with centrifugation, collecting the supernatant, and subsequent steps to ensure purity and proper pH levels. Depending on the desired final product, collagen extraction may involve a drying procedure such as lyophilization (20).

6. Types of collagen in cosmetics:

The majority of the collagen in skin is of types I, III, and V. Type I collagen is the most prevalent form in the skin.(21) In the cosmetic industry, marine collagen is the most sought-after collagen source. When collagen from tilapia skin was examined, it was discovered that it possessed the same characteristics as type I collagen as well as acid-soluble collagen (ASC) and pepsin-soluble collagen (PSC). The PSC denaturation temperature was 34.4 °C compared to 36.1 °C for ASC.(22) As evidenced by SDS-PAGE patterns, extracted acid-soluble collagen from the skin of silver carp (Hypophthalmichthys molitrix) also contained type I collagen, with the denaturation temperature for ASC found at around 29 °C. Three chains α1, α2 and α3were detected by column chromatography.(23),(24). Types I and V of collagen were found in Atlantic salmon (Salmo salar L.). Salmon collagen's denaturation temperature was determined by circular dichroism (CD) to be 27 °C.(25) The I and V types of collagen were also found in cod, according to research on the fish's collagen composition.(26), Executed experiments on the skin and bone of the bigeye snapper (Priacanthus tayenus) revealed two distinct chains α1, α2 as type I collagen. Both the skin and bone of the bigeye snapper

produced identical electrophoretic patterns.(19), Collagen type 1 is present in both the hybrid sturgeon-derived ASC and PSC, as shown by SDS-PAGE and FTIR. Circular dichroism (CD) and differential scanning calorimetry (DSC) measurements revealed that the ASC denaturation temperature oscillated between 26.8 and 26.5 degrees Celsius for PSC.(27),

7. Application of collagen :

The brief description of collagen applications are:

7.1. Pharmaceutical industries:

Collagens are frequently used in the biomedical and pharmaceutical industries because of their many beneficial properties, including their capacity for cell attachment, weak antigenicity, biocompatibility, and biodegradability. utilized as injectable dispersions, microparticles, drug delivery systems, and shields in ophthalmology sponges in the pharmaceutical industry.(28) Comparing collagen and gelatin-based biomaterials to other synthetic polymers, their biocompatibility is the main advantage of employing them in drug delivery systems. They are utilized as microspheres, nanospheres, films, and capsules.(29) Anti-cancer medications like methotrexate were delivered using gelatin microspheres.(30) For the purpose of drug administration in the healing of wounds, researchers have created a marine collagen-based dressing that contains L-cysteine hydrochloride.(31)

7.2. Medical fields:

In the field of dermatology, collagens are used for a variety of purposes, including the augmentation of soft tissues, skin replacement, skin tissue engineering, and artificial skin dermis.(32) Additionally, collagens in the form of powders, collagen films, and scaffolds are helpful for treating burns and dressing wounds.(33) for the replacement of heart valves in cardiology.(34) Collagen plays an important role in treating and healing wounds during surgery(35) and also in orthopedics, tendon, ligament, and bone repairs.(36) In ophthalmology, corneal and contact lens grafts are made of collagen.(37)

7.3. Food application of collagen:

Milk and other dairy products are the main sources of calcium, but some people are unable to eat milk due to lactose intolerance and indigestion.(38) Therefore, a number of studies have conducted for supplements that are utilized as a substitute source of calcium. The primary elements that support health and are potential sources of minerals and calcium are fish wastes such as bone, skin, and skeleton.(39) Cardiovascular health is also improved by calcium and vitamin D together.(40) Additionally, collagen has been employed in dietary supplements, beverages, and confections, as well as functional food additives.(41) It is a crucial protein that nourishes our skin and helps it become more elastic and supple. Aging is brought on by changes in collagen production or assembly. Consequently, the resilience and use of collagen increase the hydration of skin tissue.(42)

8. Separation of collagen peptides:

Collagen hydrolysis yields biologically active peptides known as collagen peptides, and the potential biological activity of these peptides has garnered significant attention in various research fields. The processing of seafood often results in substantial waste, including skin, fins, scales, bones, and gall bladders, which can be repurposed for the extraction of collagen peptides. This underutilized waste is becoming a focal point in biomedicine, nutrition, pharmaceuticals, and tissue engineering, aligning with the growing consumer preference for foods that enhance health and mitigate disease risks (43). Collagen peptides, through their diverse actions, also have the potential to increase the stability of food products by reducing oxidative processes (44).

8.1. Chemical hydrolysis:

Acid and alkali hydrolysis are both types of chemical hydrolysis. Acid hydrolysis is comparably more affordable and straightforward to use, however it lacks specificity and selectivity and carries a significant danger of amino acid contamination. destruction. Additionally, because powerful acids are used, acid hydrolysis processing compromises their nutritional value. Hydrolysis by chemical means typically done with hydrochloric acid or acetic acid (CH3C00H). (HCl) subjected to a protracted, high-temperature treatment at 110°C to 120°C (18–48 hours). The most common HCl concentration for peptides is 6M. Bond

rupture (45),(46). studied the acid hydrolysis of the Pony fish (Eubleekeria splendens), Mackerel (Decapterus maruadsi), and Yellow stripe trevally (Selaroides leptolipis). In this case, acidic hydrolysis produces 30–35% more peptides than enzymatic hydrolysis (15.9%–59.6%).(46) Additionally, alkali hydrolysis is performed at high temperatures (130–180 o C) using powerful alkalis like potassium or sodium hydroxide. Additionally, this approach is inappropriate as it could degrade the peptides' amino acid content .(45)

***8.2. Enzymatic hydrolysis*:**

The most popular approach for collagen hydrolysis is enzyme hydrolysis, which enhances the peptides made from collagen's nutritional and functional qualities. Enzymatic hydrolysis occurs when a molecule connections between collagen polypeptides and polypeptides break down chain is hydrolyzed to produce molecular weight-less bioactive peptides 1-4 kDa (45). Enzymatic hydrolysis has been described using a variety of techniques, including one-, two-, and three-step hydrolysis. Seafood hydrolyzes in a single step.By-products undergo a single hydrolysis step using an enzyme such as Trypsin, pepsin, papain, alcalase, or flavorzyme.(47) In two-step hydrolysis, two different enzymes, such as alcalase and protease, are used to hydrolyze seafood byproducts. These two recently Enzymes were utilized to separate the two peptides that cause ACE.(48) By-products of seafood are hydrolyzed in three steps using three different enzymes. Collagen peptides have recently been found to include the angiotension-I converting enzyme.Three different enzymes are used to produce inhibitory actions, including as well as trypsin, pepsin, and chymotrypsin.(49) Additionally, three-step hydrolysis results in the production of more powerful bioactive peptides with high As contrasted to one- and two-step hydrolysis, biological activities.(50)

9. Blends of Collagen for Cosmetic Use :

Collagen's capacity to form films could be improved by combining it with other polymeric molecules or biopolymers.(51),(52). By combining collagen with polyvinylpyrrolidone (PVP) and polyvinyl alcohol (PVA), collagen's film-forming characteristics can be changed.(53) Since the two macromolecules interacted differently, some research suggested that certain features could be tailored by altering component ratios. You can alter collagen film by adding of hyaluronic acid(54), (55) ,silk fibroin(56), (57)elastin(58), and keratin(59) These film characteristics are all crucial for aesthetic application. [51–60] illustrates the polymers and biopolymers that were utilized to artificially blend collagen.

Blends of collagen with other polymers and/or biopolymers also suggest some possibilities for biomedical uses, such as in membranes, hydrogels, artificial skin and bones, and many other items.(57-61)

10. Conclusions—future perspectives:

Collagen plays a significant role in numerous cosmetic preparations, contributing to skin hydration and combating the aging process. The film-forming characteristics of collagen materials can be altered through collagen cross-linking or by combining collagen with other proteins and polysaccharides. As the cosmetic industry continues to harness the potential of collagen, future research directions and perspectives may include the following:

Enhancing Denaturation Temperature:

- Future studies could focus on raising the denaturation temperature of various isolated collagen types. Increasing the denaturation temperature holds the potential to expand the utilization of collagen beyond the cosmetic industry.

Diversifying Applications:

- Exploring additional applications of collagen, both within and beyond the beauty industry, could provide innovative solutions. Collagen's versatility may lead to new developments in areas such as wound healing, tissue engineering, and medical treatments.

Rejuvenating Treatments:

- Collagen is likely to play a crucial role in rejuvenating treatments, especially for the aging population. Given the direct impact of skin aging on daily life, as well as psychological and social well-being, collagen-based interventions can contribute to maintaining a youthful appearance and overall wellness.

Holistic Impact on Well-Being:

Recognizing the holistic impact of collagen on well-being, both physically and psychologically, suggests broader societal benefits. The appearance of youth, facilitated by collagen applications, may positively influence an individual's overall health and societal integration.

In conclusion, collagen's significance in cosmetic formulations extends beyond surface-level aesthetics, impacting the well-being and confidence of individuals. Future research endeavors are likely to explore new avenues, pushing the boundaries of collagen applications and advancing its role in addressing broader health and societal challenges, particularly in the context of an aging population

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