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## Short Article

### Collagen as a Bioactive Ingredient in Nutricosmetology - A Review

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## **Abstract**

### **Introduction and Purpose**

Collagen is a major structural protein responsible for maintaining the strength and elasticity of the skin, hair, and nails. Its synthesis decreases with age, leading to visible signs of aging. Nutricosmetology focuses on supporting these processes through nutrition and supplementation. The aim of this review was to analyze the role of collagen as a nutraceutical ingredient and to assess the evidence on its effectiveness in supporting the condition of the skin, hair, and nails.

### **Materials and Methods**

This narrative review was based on scientific publications from PubMed and Google Scholar (2015–2025) addressing the structure, biological functions, and dietary sources of collagen, as well as clinical studies evaluating the effects of collagen supplementation.

### **Description of the State of Knowledge**

Evidence indicates that hydrolyzed collagen supplementation (2.5-10 g/day for 8-12 weeks) improves skin hydration, elasticity, and density, reduces wrinkles, and strengthens hair and nails. Marine collagen demonstrates the highest bioavailability and safety. The effectiveness of supplementation increases when combined with vitamin C and trace elements such as zinc, copper, and manganese.

### **Conclusions**

Collagen supplementation effectively supports regenerative and anti-aging processes in the skin and its appendages by providing amino acids essential for collagen fiber synthesis and stimulating fibroblast activity. Further studies are needed to compare long-term efficacy across different collagen sources and demographic groups.

## **Keywords**

collagen, collagen structure, supplementation, hair, nails

## **Introduction**

Collagen is one of the most important structural proteins in the human body, playing a key role in maintaining the proper function of the musculoskeletal system, skin, blood vessels, and internal organs. Its presence ensures adequate tissue strength, elasticity, and integrity, while impaired synthesis or degradation of collagen fibers leads to visible signs of aging and a decline in the condition of the skin, hair, and nails [1-3]. With advancing age, fibroblast activity and the rate of collagen production gradually decrease, resulting in loss of skin firmness, reduced density of connective tissue, and deterioration of epidermal barrier function [2]. In recent years, increasing attention has been paid to supporting these processes through appropriate nutrition and supplementation. In this context, the concept of nutricosmetology has emerged—an interdisciplinary field combining biology, nutrition, and medicine that focuses on the influence of nutrients on the condition of the skin and its appendages. The aim of nutricosmetics is to provide bioactive compounds that act at the cellular level, supporting regenerative processes and antioxidant protection and slowing tissue aging [1]. Among numerous compounds with documented effects, particular attention has been given to collagen and its hydrolyzed forms, which demonstrate high bioavailability and a proven impact on the condition of the skin and its appendages [3,11].

## **Structure and Functions of Collagen**

Collagen is a fibrillar protein with a unique triple-helix structure composed of three polypeptide chains. Its amino acid composition is dominated by glycine, proline, and hydroxyproline, which confer tensile strength and stability to collagen fibers [2,3].

A characteristic repeating Gly-X-Y motif, in which X and Y are most often proline and hydroxyproline, determines its physicochemical properties.

Collagen synthesis occurs primarily in fibroblasts, chondrocytes, and osteoblasts. This process requires vitamin C, iron, zinc, and copper, which participate in the hydroxylation of proline and lysine [4]. Deficiencies of these factors disrupt fiber structure, as exemplified by scurvy. To date, 29 collagen types have been identified, of which the most important are type I (predominant in skin, bone, and tendons), type II (cartilage), and type III (soft tissues and internal organs) [5–8]. Types I and III constitute approximately 90% of all collagen fibers in the skin [6]. Type IV collagen, present in the basement membrane, also plays an important role in the skin by ensuring correct attachment between the epidermis and dermis and participating in wound healing and cellular renewal [5–8].

During aging, collagen synthesis decreases and the ratio of types I and III is altered, which contributes to the loss of tissue elasticity [8]. Collagen also participates in tissue regeneration by accelerating wound healing through support of epithelialization and angiogenesis. The literature emphasizes its role in rebuilding the skin after micro-injuries and cosmetic procedures [3,8].

## **Collagen in the Diet**

Collagen synthesis depends on the availability of amino acids and trace elements.

The most important cofactor is vitamin C, which stabilizes the triple helix and enables proper fiber formation [11]. Zinc, copper, silicon, sulfur, manganese, and other micronutrients also play significant roles in the regenerative processes of connective tissue and support collagen cross-linking and stabilization [12].

Natural dietary sources of collagen include animal-derived foods such as meat, fish, offal, broths, and gelatin [3,9]. After ingestion, collagen is broken down in the stomach into amino acids and small peptides, which are then distributed to tissues with the greatest functional demand [3].

The composition and bioavailability of collagen depend strongly on its origin. Gauza-Włodarczyk et al. demonstrated that bovine Achilles tendon collagen, fish-skin collagen, and bone collagen differ in hydroxyproline content, which influences their thermal stability and resistance to degradation [13]. Fish collagen, due to its lower molecular weight, is digested and absorbed more efficiently than bovine or porcine collagen, and is also considered microbiologically safer [11].

Conversely, environmental and lifestyle factors such as oxidative stress, vitamin deficiencies, cigarette smoking, alcohol consumption, poor diet, insufficient sleep, and UV radiation negatively affect collagen synthesis by reducing fibroblast activity and accelerating degradation of collagen fibers [11-12]. Diets rich in simple sugars contribute to collagen glycation, which stiffens fibers and impairs their elasticity, intensifying visible signs of skin aging [11].

## **Collagen Supplementation**

Collagen supplementation is currently one of the most widely used approaches in nutricosmetology. According to SW Research [14-16], an increasing number of consumers choose preparations containing collagen, hyaluronic acid, biotin, and vitamin C.

The most common supplemental form is hydrolyzed collagen (HC)-a product of enzymatic hydrolysis of native collagen composed of short peptides with low molecular weight (2,000-5,000 Da) [11,17]. HC is characterized by high bioavailability (90–95%) and rapid absorption [18]. Collagen peptides appear in the bloodstream as early as 1 hour after ingestion and persist in tissues for up to 2 weeks [18]. The most active form is marine collagen, whose structure is closest to human collagen, enhancing its assimilation [9,19]. Plant-derived collagen-like materials produced by biotechnological methods are also available [11].

Recommended daily doses of hydrolyzed collagen range from 2.5 to 10 g, depending on the intended goal [3,11]. Intakes below 2.5 g are considered ineffective, whereas longer use (over 12 weeks) increases durability of effects [20-21]. Collagen is frequently combined with vitamin C, zinc, and biotin to support endogenous synthesis [12].

In studies by Campos et al. [21] and Bolke et al. [22], supplementation with collagen peptides in combination with antioxidants effectively improved skin condition, reduced dryness, and increased connective tissue density. The efficacy of supplementation depends on age and regularity-best outcomes are observed in individuals over 30 years of age, in whom natural collagen synthesis has already declined. Biological effects persist for several weeks after discontinuation, confirming fibroblast activation and longer-term support of skin metabolism [20-22].

### **Effects of Collagen Supplementation on Skin Condition**

Numerous clinical studies confirm the effectiveness of collagen supplementation in improving skin appearance and function. Asserin et al. [18] observed a 12-28% increase in skin hydration after 8 weeks of hydrolyzed collagen (HC) of marine or porcine origin in women with initially dry facial skin. In that randomized, placebo-controlled trial involving over 100 participants, skin hydration was measured with a corneometer at baseline, after 4 weeks, and after 8 weeks of supplementation. No changes were recorded in the placebo group, whereas women receiving fish-derived HC showed a 12% increase in hydration, and those supplemented with porcine HC achieved up to a 28% improvement, accompanied by an increase in dermal collagen content. Evans et al. reported a 25% improvement in skin elasticity and a visible reduction in wrinkles after 12 weeks of daily intake of 500 mg marine collagen in women with clinical signs of photoaging. In this study, conducted on 85 women aged 45–60 years, collagen supplementation led not only to improved elasticity and firmness of the cheeks, but also to better skin radiance, more uniform tone and a 15% reduction in the visibility of nasolabial folds compared with placebo [20.] Campos et al. [21] and Tomaszewicz et al. [23] confirmed increased firmness and density of the skin after 3 months of hydrolyzed collagen use. In women aged 30–72 years, three-month supplementation with fish-derived HC resulted in higher water content in the epidermis and dermis, which translated into improved hydration, elasticity and overall clinical appearance of the skin [23]. Other trials using collagen-based complexes enriched with vitamins, antioxidants and co-factors demonstrated additional benefits such as increased dermal density, smoother skin texture and a visible reduction in periocular wrinkles and fine lines [21].

Sangsuwan et al. [24] showed that collagen may protect against photoaging by improving elasticity in UV-exposed areas. In their study, 36 participants received 5 g of fish collagen hydrolysate daily for 4 weeks; skin elasticity, measured with a cutometer on sun-exposed and photoprotected sites, improved significantly in irradiated areas and remained elevated even several weeks after discontinuation of supplementation [24]. Similar findings were reported in studies conducted under varying environmental conditions, where collagen peptides helped maintain adequate hydration and reduce transepidermal water loss (TEWL) despite fluctuations in temperature, humidity and UV exposure [25]. A meta-analysis by Roseane et al. [25] including multiple clinical trials confirmed that regular collagen supplementation increases elasticity and hydration, reduces wrinkles and dryness, and improves overall facial skin appearance.

Collagen acts indirectly-by supplying amino acids required for new collagen synthesis (particularly glycine, proline and hydroxyproline) and by stimulating fibroblasts to produce extracellular matrix proteins such as collagen, elastin and proteoglycans [26,22]. Clinical studies in elderly patients have also shown that prolonged supplementation with hydrolyzed collagen improves skin resilience, firmness and resistance to mechanical injury, which further supports its regenerative and anti-aging potential [26,22].

## Effects of Supplementation on Hair and Nails

Collagen provides amino acids (glycine, proline, hydroxyproline) necessary for keratin synthesis-the main structural protein of hair and nails. Dzikowska and Wójcik [27] demonstrated that 16 weeks of supplementation with 2.5 g of bioactive collagen peptides increased hair thickness by 1.9  $\mu\text{m}$  and stimulated a 31% rise in hair follicle cell proliferation. Reilly et al. [28] confirmed improvements in hair structure, shine, and volume after 12 weeks of marine collagen with vitamin C. Similar results were obtained by Hwang et al. [29], who demonstrated activation of the Wnt/ $\beta$ -catenin pathway in dermal papilla cells responsible for hair growth.

For nails, collagen improves hardness, growth rate, and mechanical resistance.

Hexsel et al. [30] reported a 12% increase in nail growth rate and a 42% reduction in brittleness after 24 weeks of daily 2.5 g collagen peptides.

Sparavigna et al. [31] demonstrated that both oral supplementation and topical application of biomineral collagen-based preparations significantly improved nail plate structure. In their study involving 50 women over 18 years of age, nail hardness increased by 40% in the topical group, by 43% in the oral supplementation group, and by 50% in the combined therapy group. A visual analysis also revealed a reduction in surface roughness of the nail plate (by 12-18%), with most participants reporting better texture, enhanced mechanical resistance, and accelerated growth.

Vleminckx et al. [32] conducted a clinical study on an East Asian female population aged 43-65 years, in which participants received 2.5 g of collagen peptides daily for 84 days. The treatment led to visible improvements in nail brightness and color uniformity, while brittleness and susceptibility to mechanical damage were significantly reduced. These findings confirmed the beneficial effects of collagen supplementation on nail hardness, structure, and overall appearance.

Overall, available clinical evidence supports the beneficial effects of collagen supplementation on both hair and nails. Regular intake of hydrolyzed collagen improves keratin structure, increases nail hardness and hair strength, and enhances their overall appearance and resilience. These findings emphasize the role of collagen as a key nutraceutical ingredient in maintaining the health, integrity, and aesthetic quality of skin appendages.

## Conclusions

Collagen is a key structural protein responsible for maintaining elasticity, firmness, and proper function of the skin and its appendages. With age, endogenous collagen synthesis declines, leading to decreased skin resilience, wrinkle formation, and deterioration in the condition of hair and nails. Regular collagen supplementation-particularly hydrolyzed forms at 2.5-10 g per day for at least 8-12 weeks-has demonstrated benefits in improving hydration, elasticity, and skin density, while strengthening hair and nail structure. Marine collagen appears to be the most bioavailable and safe, and its efficacy increases when combined with vitamin C, zinc, copper, manganese, and silicon, which serve as cofactors in endogenous collagen synthesis. The mechanism of action involves not only

provision of amino acids required for fiber rebuilding, but also stimulation of fibroblasts to enhance production of native collagen and other extracellular matrix components. Numerous clinical studies support the effectiveness and safety of collagen supplementation; however, further clinical observations across age groups, environmental exposures, and collagen sources are warranted to fully elucidate mechanisms and optimize use.

### **Author's contribution:**

Conceptualization, supervision and project administration- DPB

Methodology- WK,DPB

Software, validation, formal analysis, investigation, resources- WK,DPB

Writing original draft preparation- WK,DPB,TS,AK

Writing review editing and visualization- AK,TS

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### **References:**

1. Jadach B, Mielcarek Z, Osmałek T. Use of Collagen in Cosmetic Products. *Molecular Biology*. 2024;46(3):2043–2070. doi:10.3390/cimb46030132
2. Jurkowska S. Kolagen – przyjaciel, który nie pyta o wiek! Opole: Twórz Teraz; 2019.
3. Arseni L, Lombardi A, Orioli D. From Structure to Phenotype: Impact of Collagen Alterations on Human Health. *Molecular Sciences*. 2018;3–12. doi:10.3390/ijms19051407
4. Górská M, Ziaja M, Drab K. Wpływ suplementacji kolagenu na jakość skóry, włosów i paznokci. *Pol J Cosmetol*. 2023;187–191.
5. Morąg M, Burza A. Budowa, właściwości i funkcje kolagenu oraz elastyny w skórze. *Journal of Health Study and Medicine*. 2017;1–19.

6. Daneault A, Prawitt J, Soulé VF, Coxam V, Wittrant Y. Biological effect of hydrolyzed collagen on bone metabolism. *Crit Rev Food Sci Nutr.* 2017;57(9):1922–1937. doi:10.1080/10408398.2015.1038377
7. Reilly DM, Lozano J. Skin collagen through the life stages: importance for skin health and beauty. *Plast Aesthet Res.* 2021:2–18. doi:10.20517/2347-9264.2020.153
8. Nielsen MJ, Karsdal MA, Leeming DJ, Langholm LL, Manon-Jensen T, Siebuhr A, et al. The good and bad collagen of fibrosis – their role in signaling and organ function. 2017:1–14.
9. Jafari H, Lista A, Siekapen MM, Ghaffari-Bohlouli P, Nie L, Alimoradi H, Szawandi A. Fish collagen: extraction, characterization, and applications for biomaterials engineering. *Polymers.* 2020:1–37. doi:10.3390/polym12102230
10. Burns EK, Perez-Sanchez A, Katta R. Risks of skin, hair, and nail supplements. *Dermatol Pract Concept.* 2020:1–7. doi:10.5826/dpc.1004a89
11. Kaziród K, Hunek A, Zapła M, Wiśniewska-Skomra J, Chmielarz K, Tylutka K, Hapon A. Collagen supplementation – does it bring real benefits? *Quality in Sport.* 2023:88–107. doi:10.12775/QS.2023.13.01.008
12. Janda K, Kasprzak M, Wolska J. Witamina C – budowa, właściwości, funkcje i występowanie. *Pomeranian Journal of Life Sciences.* 2015:419–425.
13. Gauza-Włodarczyk M, Kubisz L, Włodarczyk D. Amino acid composition in determination of collagen origin and assessment of physical factors effects. *Int J Biol Macromol.* 2017:987–991. doi:10.1016/j.ijbiomac.2017.07.013
14. Dziędziński M, Goryńska-Goldmann E, Kobus-Cisowska J, Szczepaniak O, Marciniak G. Problem nadkonsumpcji suplementów diety przez Polaków. *Intercathedra.* 2019:2–9. doi:10.17306/J.INTERCATHEDRA.2019.00080
15. Matysek-Nawrocka M, Bernat M, Dyczewski B, Chmiel A. Popularność diety wśród dorosłych Polaków. 2016:145–151.
16. Holwerda AM, van Loon LJC. The impact of collagen protein ingestion on musculoskeletal connective tissue remodeling: a narrative review. *Nutr Rev.* 2022:1497–1514. doi:10.1093/nutrit/nuab083
17. Gref R, Deloménie C, Maksimenko A, et al. Vitamin C–squalene bioconjugate promotes epidermal thickening and collagen production in human skin. *Sci Rep.* 2020. doi:10.1038/s41598-020-727041
18. Asserin J, Lati E, Shioya B, Prawitt J. The effect of oral collagen peptide supplementation on skin moisture and the dermal collagen network. *J Cosmet Dermatol.* 2015:291–301. doi:10.1111/jocd.12174
19. Dewi D, Arimuko A, Norawati L. Exploring the impact of hydrolyzed collagen oral supplementation on skin rejuvenation: a systematic review and meta-analysis. *Cureus.* 2023;15(12). doi:10.7759/cureus.50231
20. Evans M, Lewis ED, Zakaria N, Pelipyagina T, Guthrie N. A randomized, triple-blind, placebo-controlled, parallel study to evaluate the efficacy of a freshwater marine collagen on skin wrinkles and elasticity. *J Cosmet Dermatol.* 2021:825–834. doi:10.1111/jocd.13676
21. Campos LD, Santos Jr, Pimentel JD. Collagen supplementation in skin and orthopedic diseases: a review of the literature. *Heliyon.* 2023:1–10. doi:10.1016/j.heliyon.2023.e14961
22. Bolke L, Schlippe G, Gerß J, Voss W. A collagen supplement improves skin hydration, elasticity, roughness, and density. *Nutrients.* 2019:7–11. doi:10.3390/nu11102494



23. Tomaszewicz V, Klawe JJ, Chrzanowska M. Ocena stanu skóry po suplementacji kolagenem w odniesieniu do wyników pomiaru aparaturowego wilgotności naskórka. *Pol J Cosmetol.* 2015:223–248.
24. Sangsuwan W, Asawanonda P. Four-weeks daily intake of oral collagen hydrolysate results in improved skin elasticity, especially in sun-exposed areas. *J Dermatolog Treat.* 2021;32(8):991–996. doi:10.1080/09546634.2020.1725412
25. Roseane B de M, Weimer P, Rossi C. Effects of hydrolyzed collagen supplementation on skin aging: a systematic review and meta-analysis. *Int J Dermatol.* 2021:1–13. doi:10.1111/ijd.15518
26. Schwartz SR, Hammon KA, Gafner A, Dahl A, Guttman N, Fong M, Schauss AG. Novel hydrolyzed chicken sternal cartilage extract improves facial epidermis and connective tissue in healthy adult females. *Altern Ther Health Med.* 2019:12–21.
27. Dzikowska J, Wójcik M. The effect of oral administration of collagen bioactive peptides on hair thickness. *Nutrafoods.* 2020:58–64.
28. Reilly DM, Kynaston L, Naseem S, Proudman E, Laceby D. A clinical trial shows improvement in skin collagen, hydration, elasticity, wrinkles, scalp and hair condition following 12-week oral intake of hydrolysed collagen. *Nutrients.* 2024:1–12. doi:10.1155/2024/8752787
29. Hwang SB, Park HJ, Lee BH. Hair-growth-promoting effects of fish collagen peptide. *Int J Mol Sci.* 2022;23. doi:10.3390/ijms231911904
30. Hexsel D, Zague V, Schunck M, Siega C, Camozzato FO, Oesser S. Oral supplementation with specific bioactive collagen peptides improves nail growth and reduces symptoms of brittle nails. *J Cosmet Dermatol.* 2017:520–526. doi:10.1111/jocd.12393
31. Sparavigna A, Tenconi B, La Penna L. Efficacy and tolerability of a biomineral formulation for treatment of onychoschizia: a randomized trial. *Clin Cosmet Investig Dermatol.* 2019;12:355–362. doi:10.2147/CCID.S187305
32. Vleminckx S, Virgilio N, Asserin J, et al. Influence of collagen peptide supplementation on visible signs of skin and nail health and aging in an East Asian population. *J Cosmet Dermatol.* 2024:1–9. doi:10.3389/fnut.2024.1416643