Żyga Justyna. Oral collagen supplements intake on improving skin structure and function. Journal of Education, Health and Sport. 2022;12(7):434-440. eISSN 2391-8306. DOI http://dx.doi.org/10.12775/JEHS.2022.12.07.043
https://apcz.umk.pl/JEHS/article/view/JEHS.2022.12.07.043
https://zenodo.org/record/6819324

The journal has had 40 points in Ministry of Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of December 21, 2021. No. The journal has had 40 points in Ministry of Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of December 21, 2021. No. 32343.
Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical Culture Sciences (Field of Medical sciences and health sciences); Health Sciences (Field of Medical Sciences and Health Sciences).

Punkty Ministerialne z 2019 - aktualny rok 40 punktów. Załącznik do komunikatu Ministra Edukacji i Nauki z dnia 21 grudnia 2021 r. Lp. 32343. Posiada Unikatowy Identyfikator Czasopisma: 201159.
Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).

Received: 22.06.2022. Revised: 22.06.2022. Accepted: 11.07.2022.

Oral collagen supplements intake on improving skin structure and function

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Abstract

Introduction: Young and healthy skin is a beauty standard that generates the necessity of acceptance. Collagen supplements have recently grown in popularity and become a trendy product advertised as a remedy for various skin problems. As it turns out, numerous scientific studies have shown the benefits of hydrolyzed collagen supplementation in improving the signs of skin ageing. There are various animal sources of collagen, but marine fish collagen has the best safety profile, biocompatibility and bioavailability and remains the most frequent product used in scientific trials. Among newest randomised-control trials five were researched for this study to evaluate the efficacy of collagen supplementation and its influence of skin appearance with both objective and subjective assessment.

State of knowledge: hydrolysed collagen supplementation demonstrated a significant reduction in wrinkles, improvement in skin texture, firmness and appearance. Moreover, studies show significant enhancement of the water content in the stratum corneum and epidermis. Reduction of transepidermal water loss and increased level of natural moisturising factor was observed.

Conclusions: hydrolysed collagen supplements can delay and improve the signs of skin ageing by decreasing facial wrinkles and improving skin hydration and elasticity. Supplement intake is effective and safe - analysed studies have not reported any major adverse effects.

Since reviewed trials lasted for no longer than 12 weeks, further studies are needed to evaluate the long-term use of hydrolysed collagen peptides.

Keywords: collagen; aesthetics; collagen supplements; dermatology; age-related skin changes

Role of collagen in human body

Collagen is the main structural protein in connective tissues such as the skin, tendons, cartilage and bones of the human body and almost all animals. It constitutes 25–30% of all proteins in the body and its main function is related to contributing mechanical properties of tissues such as the tensile strength in skin and the resistance to traction in ligaments. Twenty-eight collagen types have been identified and characterised at the molecular level. Collagens interact with cells through several receptors, and their roles in the regulation of cell growth, differentiation, and migration through the binding of their receptors is well documented. In association with hyaluronic acid, reticulin, and elastin, collagen forms a support network for fibroblasts, keratinocytes, melanocytes, and specialised cells of the skin immune system [1].

The current understanding of collagen's digestion has changed over the past years. As opposed to previous beliefs that collagen is broken down to and absorbed as single amino acids, collagen hydrolysates are digested into dipeptides or tripeptides by protease enzymes. Epithelial cells absorb these across the intestinal membrane in a two-step mechanism. First, the transporter PEPT1 absorbs peptides to epithelial cells via the membrane of the intestine. Second, the peptides cross to the bloodstream, then are distributed to skin and other tissues [2].

Changes in the skin connected with ageing

In recent years, collagen supplements have recently grown in popularity and become a trendy treatment in the world of skin health. They are widely advertised as a remedy for improvement of skin hydration and elasticity, a potential treatment method against the ageing process, wrinkle reduction and skin-rejuvenation.

The skin acts as a primary barrier protecting the body from the external environment and preventing water loss. In particular, the stratum corneum is fundamental for the skin barrier function. Besides multiple layers of flattened corneocytes, it contains a complex mixture of low-molecular-weight, water-soluble compounds termed natural moisturising factors. Moreover, stratum corneum is rich in intercellular lipids of which ceramides constitute the most important barrier preventing transepidermal water loss. The ingestion of collagen peptides induces ceramide synthesis and is expected to increase skin moisture by natural moisturising factor levels in the stratum corneum [3].

Skin ageing can be characterised by a progressive process of drying, changes on the skin microrelief, loss of firmness and elasticity that results in wrinkles and sagging. Therefore, aged skin shows reduced cell turnover, hyperkeratinization, abnormal elastic tissue production and degradation of collagen fibres. Collagen fibres give the skin its tensile strength, whereas elastin fibres contribute to elasticity and resilience. Dermal collagen bundles are well-organised in young adults, however in ageing skin they lose their extensible configuration, instead becoming fragmented, disorganised and less soluble. Collagen synthesis decreases resulting in a shift in the balance between synthesis and degradation. Among women population, reduced estrogen levels in post-menopausal period contributes to wrinkling, dryness, atrophy, laxity, poor wound healing, and vulvar atrophy. Loss of collagen appears to

be more closely related to post-menopausal age than chronologic age.

Estrogen therapy may prevent collagen loss and can stimulate synthesis of collagen in those that have lower initial collagen levels. There is also a relationship between estrogen deprivation and degenerative changes of dermal elastic tissue. Although there are numerous defence mechanisms to protect the skin from damage, the efficacy of these decreases over time, resulting in the clinical features associated with ageing and the development of skin cancers. In this context, the use of hydrolyzed collagen supplements is indicated to improve aged skin conditions [4].

Interest among society in collagen supplementation

Although there is currently limited data available in the literature and much regarding its possible effects on the skin has yet to be fully clarified and understood, the popularity of oral collagen supplements continues to rise. A survey of American consumers aged between 18 and 44 years identified Google as a trusted and frequented source for obtaining cosmetic information [5].

Google Trends engine (www.google.com/trends) provides checking popularity of any request. Interest over time is a value that Google defines as the number relative to the highest point for a given region or time. Peak popularity is represented by a value of 100, while any other number is in proportion to that. When there is not enough data available for a set time point or location, a value of 0 is assigned. The popularity of terms including “collagen”, “collagen supplements” from January 2016 to July 2022 increased significantly worldwide - from level of around 25 in the beginning of 2016 to 100 nowadays.

Dermocosmetics containing collagen vs oral supplementation

Topical products containing collagen are claimed to possess anti-aging properties and popularised for the past several years. Given the high molecular weight of intact collagen fibrils, topical application of this large protein and its result in any skin penetration and action is questionable. There have been fewer studies assessing the effect of topical collagen on the ageing process when compared with researches conducted for oral supplements. However, those infrequent investigations prove that participants who were applying a product containing collagen on face performed better results compared to the control group. Studies showed anti-wrinkling effects, substantial increase in the dermal density and elasticity of the skin. Even a retrospective study on 480 patients with wrinkles, lax skin, scarring and stretch marks after percutaneous administration of collagen demonstrated significant improvement with considerable increase in collagen and elastin deposition and thickening of stratum spinosum in histologic examination [6]. Although topical dermocosmetic formulation with di- and tripeptides can improve skin hydration and elasticity, oral supplementation showed more noticeable results for oral supplementation [7]. Future epidemiological studies with large sample sizes and thorough follow-up measures would be required to comprehensively understand the potential effects of these two types of collagen on the ageing process.

Effects of oral hydrolysed collagen supplementation in randomised controlled trials (RCT)

The aim of discussed studies was to evaluate effects of hydrolysed collagen supplementation on various skin parameters - elasticity, hydration, wrinkling and appearance. Assess was obtained with professional dermatological tools and visual scale. All participants received hydrolysed collagen derived from marine fish. Description of trials was summarised in a table (Table 1).

Sangsuwan & Asawanonda investigated the effects of collagen supplement on skin elasticity in sun-exposed and sun-protected areas. The study demonstrated significant improvement of skin elasticity in sun-exposed areas after 4 weeks ingestion of collagen hydrolysate compared to placebo. The improvement of 36 participants' skin elasticity remained 4 weeks after discontinuation of the agent. Skin elasticity was measured by Cutometer dual MPA 580. The collagen hydrolysate used in this study was derived from fish scale and skin [8].

Clinical trial of 70 women receiving 1000mg of collagen hydrolysate per day obtained from the sutchi catfish's skin was conducted by Kim et al. The study results demonstrated that oral intake of collagen peptides efficiently improved the health of photoaged skin, by significantly improving its hydration as early as after 6 weeks of intake, and skin wrinkling and elasticity after 12 weeks of intake. Parameters of skin hydration, wrinkling, and elasticity were assessed with a Corneometer CM 825 [9].

Another study showed important clinical benefits for the skin with a lower dosage (500 mg per day) of oral supplementation with hydrolyzed fish cartilage. The supplementation improved the morphological and structural characteristics of the dermis by improving the collagen morphology. In addition, the study participants also perceived the results obtained by the high-resolution image analysis with an improvement in the evaluated skin parameters. In the clinical evaluation, the participants also experienced a reduction in wrinkles, improvement in skin texture, firmness and appearance as well as a moisturising effect. Skin relief was evaluated using the Visioscan, 20 MHz ultrasound, microscope and high-resolution digital camera [10].

A randomised, placebo-controlled, double-blind trial was conducted in 99 healthy Japanese women receiving 1 or 5 g of collagen peptides or placebo once daily for 12 weeks. Before and after treatment skin elasticity, thickness and level of natural moisturising factor were evaluated. Oral ingestion of collagen peptides increased the water content in the stratum corneum and epidermis. Furthermore, transepidermal water loss decreased and the level of natural moisturising factor was increased. However, the results have not demonstrated improvement of skin elasticity and thickness in both doses 1g ang 5g of collagen peptides. Fish collagen peptides were used for examination. Skin parameters measurement was conducted with professional tools. Water content of skin layers was measured using a Corneometer. Measurement of transepidermal water loss was performed with Tewameter. Measurements of natural moisturising factor level in the stratum corneum were collected from the skin surface by tape stripping with adhesive sampling discs [11].

The objective of a randomised, triple-blind trial performed by Evans et al. was to evaluate the safety and efficacy of a hydrolyzed marine collagen on aspects of skin health and quality in women. Participants supplemented with hydrolysed marine collagen powder for 12 weeks

showed significant improvements on self-reported elasticity, hydration, radiance, firmness, and wrinkle scores compared to placebo group.
The study demonstrated that hydrolysed fish collagen is safe and well tolerated in a healthy female population, based on electrolyte level as well as blood, liver and kidney markers. The skin wrinkle analysis was performed using the 6th Generation VISIA skin analysis system, skin elasticity was assessed using the Cutometer dual MPA 580. Skin quality was self-assessed by using a Visual Analogue Scale [12].

Table 1: Description of the included studies

RCT	Number of participants	Duration	Dose	Improved parameters	Unchanged parameters
Sangsuwan & Asawanonda	36	4 weeks	5g	elasticity	
Kim et al.	70	12 weeks	1g	wrinkles, elasticity, hydration	
Maia Campos et al.	46	90 days	0,5g	wrinkles, skin texture, firmness, appearance, moisturising	
Miyanaga et al.	99	12 weeks	1g/5g	moisturising, transepidermal water loss, water content in the stratum corneum	elasticity, thickness
Evans et al.	45	12 weeks	10g	elasticity, hydration, radiance, firmness, and wrinkle	

The results obtained in above trials corroborate older studies in the scientific literature that report the benefits of oral supplementation of hydrolyzed collagen in improving the characteristics of skin parameters - most of them reported improved skin hydration and elasticity, increased dermal density, and reduced facial wrinkles. Similar to above, collagen preparations used in studies had different percentages of additional compositions such as vitamins, minerals, antioxidants, coenzyme Q10, hyaluronic acid and chondroitin sulphate. The positive outcomes of supplementation were solely attributed to collagen and the effect of addons was not comparatively evaluated. Thus, the beneficial effects achieved may have occurred owing to the synergism of these substances with collagen [13].

Oral supplementation of hydrolysed collagen in wound healing

Since collagen remains the main structure protein of the human body, its role in wound treatment cannot go unmentioned. Wound repair is a complex process that is generally categorised into four phases which occur in a temporal sequence but are overlapping: hemostasis, inflammation, proliferation and remodelling. Those steps are responsive to the

extracellular matrix, collagen and its compounds.

There are few reports about wound dressings containing collagen blended with polymers (such as polyethylene oxide, hyaluronic acid, elastin and silk fibroin, alginate, chitosan etc.) and incorporated other additives such as insulin, antibiotics or gold nanoparticles. Despite the positive in vitro effects, there is still no understanding of all the benefits that collagen plays in the wound healing process, due to the lack of compilation of the results obtained in animal studies [14]. Except for collagen membranes, oral supplementation of hydrolysed collagen as a potential support in wound healing was investigated in a randomised-control trial. 31 men with 20-30% total body area burned were randomly assigned to receive either a collagen-based supplement (1000kcal) or an isocaloric placebo, for 4 weeks. Results showed that a hydrolyzed collagen-based supplement significantly improved wound healing and circulating prealbumin, and clinically reduced hospital stay [15].

Summary

Based on discussed trials hydrolysed collagen supplementation has several beneficial effects on skin. Supplement intake is effective as it delays the signs of skin ageing by decreasing facial wrinkles, improving skin hydration and elasticity. Besides esthetic effects, hydrolysed collagen peptides strengthen the skin barrier function and can speed up wound healing. It is a safe method since analysed studies have not reported any major adverse effects. Although many researches give promising outcomes in skin condition improvement, reviewed trials lasted for no longer than 12 weeks, therefore further studies are needed to evaluate its efficiency, long-term outcome and additional factors influencing collagen's action.

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