

Essential Compounds in Skin Health

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Received: May 17, 2019; Published: October 21, 2019

Abstract

The link between nutrition and skin health or, rather, the effect of nutrition on the skin aging was an interesting field of research not only for scientists, but also a common area of interest for people over the years, from the earliest times to the present. Aging of the skin consists of two distinct processes from a clinical and biological point of view. The first is the intrinsic aging of the skin, which represents aging in chronological terms and it affects the skin in the same way in which all internal organs aged. The second is extrinsic aging of the skin as a result of external factors and the environment, especially chronic exposure to sun and light to ultra-violet (UV) radiation, but also smoking, pollution, sleep deprivation and inappropriate nutrition. But we can prevent skin aging from extrinsic causes. The best prevention strategy against harmful action of free radicals is a well-regulated lifestyle (calorie restriction, body care and exercise for the body), with low stress conditions and a balanced nutritional diet, especially rich in foods rich in antioxidants. Researchers have found phytonutrients to act as antioxidants, such as carotenoids, tocopherols and flavonoids, as well as vitamins (A, C, D and E), omega-3 fatty acids, some proteins and lactobacilli are considered agents capable of promoting the health and beauty of the skin. In this article will be presented, what we need to consume to prevent aging of the skin.

Keywords: Skin Health; Phytonutrient; Antioxidants; Carotenoids; Tocopherols and Flavonoids; Vitamins

The vitamins

L-ascorbic acid (vitamin C)

Vitamin C, also called L-ascorbic acid $C_6H_8O_6$, is water soluble, photosensitive and is the most important hydrophilic antioxidant. Vitamin C is not naturally synthesized by the human body, and therefore a proper diet of vitamin C essential for a healthy diet is required [1]. The richest natural sources are fruits and vegetables. High vitamin C foods include guavas, bell peppers, kiwifruit, strawberries, oranges, papayas, broccoli, tomatoes, kale, and snow peas. The current daily value (% DV) for vitamin C is 90 mg. L-ascorbic acid can be used orally and locally for its benefits on the skin [2]. Vitamin C is a cofactor that stabilizes the structure of collagen. It also plays a role in iron uptake and increases the bioavailability of selenium [3]. The most common skin manifestations that accompany vitamin C deficiency are attributed to collagen synthesis. It is manifested by keratosis of the hair follicles, mainly on the upper arms and the follicles become haemorrhagic [4]. In addition, deficiency of vitamin C causes scurvy, a disease with some symptoms, such as frailty, skin lesions, bleeding gums, easy bruising or appearance of slow wound healing. Ascorbic acid is used locally in various cosmetic products, for example for skin pigmentation, for anti-aging creams and for sunscreen formulations [5]. A long-term study observed the effects of a combination of ascorbic acid and D- α -tocopherol (vitamin E) on UVB-induced epidermal lesions [6]. The treatment was well-tolerated and could be used prophylactically against the dangerous effects of UV irradiation and skin cancer, according to the authors [7].

Tocopherols (vitamin E)

The vitamin E $C_{29}H_{50}O_2$ complex is a group of 8 compounds called tocopherols. Tocopherol is an antioxidant linked to the liposoluble membrane and, consequently, a free radical scavenger, especially strong reactive oxygen [1]. Tocopherol is like vitamin C, an endogenous, non-enzymatic, antioxidant, natural. High amounts of tocopherol are found in vegetables, vegetable oils such as wheat germ oil, sunflower oil, safflower oil and seeds, corn, soybean and some types of meat [8]. Vitamin E intake from natural sources works against collagen re-tilation and lipid peroxidation, both of which are responsible for aging skin. Topically applied vitamin E is used to reduce erythema, sunburn, skin damage caused by UVB and photo carcinogenesis in most published studies [9]. Vitamin E deficiency has been associated with a type of with dementia or seborrheic erythema, dryness and depigmentation of the skin in premature infants. There are many clinical trials that have tested the effects of tocopherol. Oral administration of vitamins C and E together with other photoprotective compounds dramatically increased photoprotective effects as they act synergistically [10].

Carotenoids (vitamin A, β -carotene, astaxanthin, retinol)

Carotenoids are derivatives of vitamin A $C_{20}H_{30}O$, like β -carotene, astaxanthin $C_{40}H_{52}O_4$, lycopene and retinol, which are very effective antioxidants and have photoprotective properties [11]. β -carotene is the most prominent member of the group of carotenoids, natural dyes found in the human diet [12]. Compared to other carotenoids, the primary role of β -carotene is its activity as provitamin A. In addition, β -carotene may also act as a lipid-cleansing agent, as demonstrated *in vitro* [13]. Examples of fruits and vegetables containing β -carotene: Carrots, pumpkin, sweet potatoes, mango and papaya. β -carotene is an endogenous photoprotector and its effectiveness in preventing the formation of UV-induced erythema has been demonstrated in various studies. In healthy volunteers, oral administration of β -carotene for 12 weeks can lead to a reduction in UV-induced erythema [14]. Similar effects have been reported in volunteers who received a diet rich in lycopene. Astaxanthin is found in microalgae, yeast, salmon, trout, krill, shrimp, crayfish and crustaceans. The UV protective effects of algae extract containing 14% astaxanthin compared to synthetic astaxanthin were tested [15]. As a result, Astaxanthin has a photoprotective effect and provides protection against cellular changes caused by UVA rays. Lycopene is a bright red carotenoid pigment and a phytochemical compound found in tomatoes and other red fruits and vegetables, such as red carrots, watermelons and papaya (but not strawberries or cherries). Although lycopene is chemically carotene, it does not have vitamin A activity [16]. β -carotene and lycopene are usually dominant carotenoids in human blood and tissues and are known to modulate skin properties when ingested as supplements or as products food [17]. Although they cannot be compared to sun protection, there is evidence that they protect the skin against sunburn (solar erythema) by increasing basal defense against UV-mediated damage [18]. Retinol is important for the human body; Although the human body cannot synthesize it. Retinol is essential for the growth, differentiation and protection of epithelial tissues and plays a role in reproduction [19]. Retinol intake must come from food. Natural retinol is found in the liver, milk, egg yolk, cheese and fatty fish, etc. Natural and synthetic vitamin A (retinol) has similar biological activities. There are different products with retinol, such as cosmetics and food supplements [20].

Vitamin D or cholecalciferol

In humans, vitamin D $C_{27}H_{44}O$ acts as a prohormone and the human body can synthesize it alone by exposure to the sun. Skin is the primary site for UV-B-mediated vitamin D3 synthesis and synthesis of 1,25-dihydroxy vitamin D3 [21]. Smaller amounts of vitamin D2 and D3 are derived from the consumption of food based on animal products such as fatty fish or egg yolk. Some products such as milk and cereals can be enriched with vitamin D. Vitamin D excess (from dietary supplements less frequently) is stored in body fat and can have toxic effects [22]. Toxicity is manifested by: nausea, vomiting, low appetite, weakness, weight loss and constipation. Skin is one of the key tissues of the human body's endocrine system [23]. Besides its role in calcium homeostasis (maintenance of balance) and bone integrity, 1,25-dihydroxy vitamin D3 [1,25 (OH) 2D3] is also essential for many physiological functions including immune response, inflammatory cytokine release and growth regulation; and differentiation of normal and malignant tissues from the breast, lung and colon. 1,25 (OH) 2 D3 protects human skin cells from UV-induced cell death and apoptosis [24]. With increasing age, the skin's ability to produce vitamin D3 decreases and, consequently, the vitamin's protective effect is low [25]. Therefore, vitamin D and calcium supplementation are of

particular importance among the elderly. An association between skin aging and levels of 25 (OH) D3, another vitamin D precursor, is suggested. Many other studies that tested oral treatment with vitamin D have demonstrated skin cancer prevention that is related to anti-aging effects [26].

Polyphenols

Polyphenols, are a structural class of chemicals that are naturally presence in plants, have attracted the anti-aging research community over the last decade, mainly because of their antioxidant properties [11]. Studies show their role in preventing various diseases associated with oxidative stress, such as cancer and cardiovascular and neurodegenerative diseases [27]. Polyphenols are found in fruit and herbal derivatives, such as fruit juices, teas and coffee [28]. Vegetables, cereals, chocolate and dried legumes are also sources of total polyphenol intake. Several thousand molecules having a polyphenolic structure have been identified in plants that are generally involved in the defense against UV radiation or aggression by pathogens. Depending on the chemical structure, polyphenols can be divided into several different functional groups, such as phenolic acids, flavonoids, stilbels and lignans. Flavonoids are also divided into flavones, isoflavones and flavanones, [29]. each with a slightly different chemical structure. It has been reported that the polyphenolic content of foods can be reduced by the methods of preparing the food [30]. For example, onions, which are a major source of phenolic and flavonoid acids, and tomatoes lose between 75% and 80% of their initial content when boiled over 15 minutes, 65% when cooked in a microwave and 30 % when potatoes are fried [31]. Laboratory studies on various polyphenols, such as green tea polyphenols, grape seed proanthocyanidins, resveratrol, silimarine and genistein, performed on animals on UV-induced skin inflammation, oxidative stress and DNA lesions, suggested that these polyphenols combined with sun protection, increase the ability to protect the skin from the adverse effects of ultraviolet radiation, including the risk of skin cancer [32].

Ubiquinol (coenzyme Q10)

Coenzyme Q10 (CoQ10) $C_{59}H_{90}O_4$ is a vitamin-like endogenous substance (synthesized by the body) [33], that is mainly stored in the fatty tissues of the body [34]. Good food sources of CoQ10 include: cold water fish, like tuna, salmon, mackerel, and sardines, vegetable oils, meats. It is present in eukaryotic cells, primarily in mitochondria, and plays an important role in the electron transport chain in aerobic cellular respiration, generating energy. Ubiquinol is also known as a powerful antioxidant compound. CoQ10 sources of nutrition include fatty fish (such as salmon and tuna), organs (such as liver) and whole grains [35]. The amount of CoQ10 required by the human body can be obtained through a balanced diet, however, in CoQ10 pharmacies is available as dietary supplements. As the liposoluble substance is better absorbed when taken with high fat meals. CoQ10 is also added to various cosmetics [25].

Pre- and probiotics

The term probiotic is defined as “living microorganisms which, when consumed in adequate quantities, confer an effect on the health of the host” [25]. The most commonly used probiotics in humans and animals are naturally occurring enterococci, lactobacilli and bifidobacteria in the intestinal tract. A prebiotic is a non-viable food component that provides a benefit to the host’s health associated with microbiota modulation. Oligofructose and other oligosaccharides are prebiotics that have a significant effect on the intestinal flora population, stimulating bifidobacterial populations. Currently, finding alternatives to antibiotics for skin treatment is widespread among researchers [36]. It has been found that, similar to intestinal microflora, skin microbiology plays a beneficial role in skin health. Certain probiotics (*Lactobacillus johnsonii* NCC 533) can help maintain skin homeostasis by modulating the immune system of the skin [37].

Essential fatty acids (vitamin F)

Essential fatty acids or Vitamin F (Linoleic Acid) are polyunsaturated fatty acids derived from linolenic $C_{18}H_{32}O_2$, linolenic $C_{18}H_{30}O_2$ and oleic acids $C_{18}H_{34}O_2$. Essential fatty acids cannot be synthesized by the human body and foods rich in these compounds should be consumed. Essential fatty acids are present in many natural sources such as fish and crustaceans, linseed, hemp oil, soybean oil, canola oil, chia seeds, pumpkin seeds, sunflower seeds, leaf vegetables, nuts, sesame seeds, avocados, salmon and white tuna [38]. There are also fish oil supplements rich in omega 3 fatty acids. They are essential for the synthesis of tissue lipids, play an important role in regulating

cholesterol levels and are prostaglandin precursors. Larger amounts of linoleic acid have been associated with a lower probability of senile skin dryness and cutaneous atrophy (symptoms of skin aging), reduction of UV-induced inflammation, inhibition of wrinkle formation caused by chronic UV exposure and increased collagen synthesis [39].

Other categories of phytonutrients

As I mentioned, there are several categories and subcategories of phytonutrients, and many of them have not yet been discovered or researched to find out exactly what benefits the body can bring. But there are already certain categories of phytonutrients whose properties are known and even used in the pharmacological industry [28]. These include the following:

- Resveratrol $C_{14}H_{12}O_3$ has a role in preventing cancer and is found in dark fruits such as black grapes. It also reduces inflammation and prevents the development of inflammatory diseases [30].
- Lycopene $C_{40}H_{56}$ is recommended for the prevention of cardiovascular diseases and skin diseases. It is found in large quantities in tomatoes. The consumption of lycopene, which also gives the red color, is also associated with the reduction of prostate cancer [31].
- Phytoestrogens plant-derived xenoestrogen (estrogen) but not synthesized within the endocrine system, are especially found in soybeans, walnuts or flaxseeds. Phytoestrogens are plant-derived dietary compounds with structural similarity to 17- β -oestradiol (E2), the primary female sex hormone. Phytoestrogens are plant-derived dietary compounds, found in a wide variety of foods, especially in soy.

The major groups of phytoestrogens present in our diet are isoflavones, prenylflavonoids, coumestans and lignans (Figure 1). The main isoflavones are genistein, daidzein, glycitein, formononetin and biochanin A, which are mainly found in soy, soy-based food and legumes usually in their conjugated forms like genistin, daidzin, puerarin, glycitin, ononin and sissotrin. In countries in Asia where fermented soy products are part of the traditional diet, isoflavone intake levels may amount to about 15 - 50 mg isoflavones per day. Improves menopausal symptoms in women, improves memory and concentration. They have positive effects on lipid metabolism, they have antidepressant, antiviral and antibacterial properties [32-34].

- Phytosterols are found in sesame, pumpkin, safflower, soy and in most vegetable oils, are plant sterols and stanols, similar to cholesterol [35,36]. They reduce cholesterol levels in the blood and block the action of hormones in the development of cancerous tumors [37]. In addition, it helps reduce the number of triglycerides and strengthen the immune system [38].
- Lutein $C_{40}H_{56}O_2$ is a natural carotenoid that the body turns into antioxidant [39-41]. It is very important for the health of the retina and, implicitly, for the maintenance of visual acuity [42]. Its main function is to protect the eye from the harmful effects of ultraviolet light [43].
- Saponins regulate cholesterol, blood sugar and blood pressure [44,45]. They are used in the pharmacology industry to synthesize cortisone [46-48]. Saponins are a group of chemical substances found in particular abundance in different plant species and help eliminate bronchial secretions and relieve muscle spasms [49-52]. Saponins are natural organic compounds formed of an aglycone unit linked to one or more glucide chains. They are in eggplant, asparagus, soy, beans, peas, peppers and quinoa [53].
- Terpenes are a large and diverse group of organic compounds, produced by a different plant species, in the case of food, these are flavoring substances, such as limonene for lemons or eugenol for garlic. They are found in carrots and spinach and are important to protect the health of the bone system, as well as to protect vision [54].

These are the most common phytonutrients, and these substances have different roles in maintaining skin and eye health, preventing and treating infections, removing toxins from the body, and fighting against germs, infections and parasites [3].

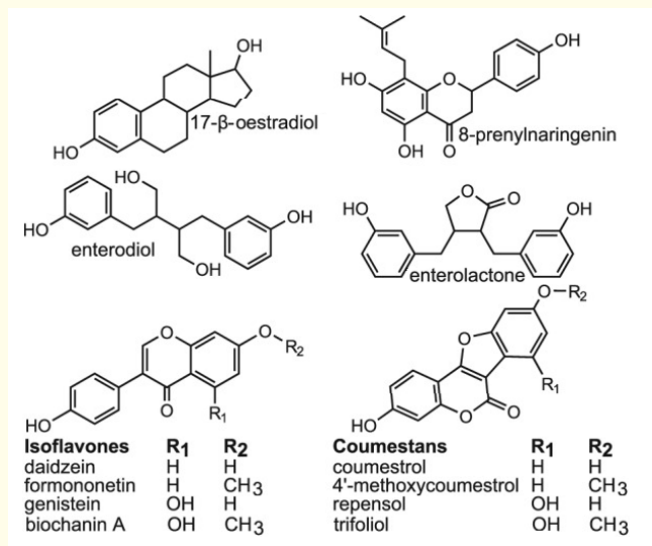


Figure 1: Chemical structures of the most common phytoestrogens.

Conclusion and Recommendations

It is estimated that only 2% of the existing plant species in the world have been researched for some scientific purposes, so many phytonutrients are still undeveloped along with the benefits they bring to health. However, certain phytonutrients have been identified in foods that have been classified as beneficial to treat various health problems. Garlic has antibacterial properties, hot pepper prevents the action of carcinogens, the pumpkin contains phytosterols, chamomile contains flavonoids and soy contains isoflavones. The best way to consume phytonutrients is by adding as many fruits and vegetables as possible to the daily diet as well as by using herbs and herbs. Therefore, a balanced, diversified and low-food diet offers the body the amount of phytonutrient it needs to prevent the emergence of various health problems.

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Volume 14 Issue 11 November 2019

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