

# Vitamins and Healthy Skin

Zoe Diana Draelos, MD



The term *nutricosmetic* combines the words nutrition and cosmetic. Many of the new food introductions at the grocery store are nutricosmetics. For example, milk is enriched with vitamin D whereas yogurt is not. However, a new line of yogurt contains both vitamin D and inulin, a nonabsorbable fiber to aid elimination. A competing yogurt brand contains probiotic organisms, which are bacteria designed to recolonize the gut, resulting in improved elimination and better overall health from the inside out. Adding nutrients is an important marketing tactic because it allows existing foods to be made new with the addition of one ingredient. An existing food with decreasing sales can be reinvented in the marketplace with little upfront cost.

The following sections examine the use of vitamins, used both orally and topically, to improve the skin's health. While taking vitamins orally is far superior to taking vitamins topically, there are certain functions that topical vitamins perform in cosmeceuticals. Vitamins are frequently used as specialty ingredients in skin creams due to their excellent safety, low cost, and high consumer acceptance.

## Vitamin D

Vitamin D is important for healthy skin because it maintains the bony architecture under the skin. It is used both orally and topically. Vitamins A and D were used in some of the oldest marketed skin care preparations to aid in healing wounds. The topical application of vitamin D is largely used for its ability to function as a humectant, which increases the water-holding capacity of the skin.

Vitamin D is fat soluble and manufactured by the body when exposed to sunlight. The inhibition of manufacturing vitamin D by using sunscreen and avoiding the sun has been a controversial topic, with some individuals discontinuing sunscreen use and encouraging sun exposure

to prevent vitamin D deficiency.<sup>1</sup> Vitamin D deficiency, the cause of rickets in children, was virtually eliminated when milk was enriched with 400 IU vitamin D per quart in the 1930s. One cup of milk supplies 25% of the recommended daily allowance of vitamin D in adults; however, it is probable that the current recommended daily allowances are too low.<sup>2</sup> Two hundred IU are recommended daily from birth to age 50 years; 400 IU from age 51 to 70 years; and 600 IU from age 71 years and older.<sup>3</sup>

It is important to recognize that only milk is enriched with vitamin D. Cheese, yogurt, and ice cream are not required to include vitamin D; however, a new trend in some nutricosmetic yogurts, mentioned previously, is to add vitamin D. Only a few foods are rich in vitamin D, including fatty fish (eg, salmon, sardines in oil, mackerel) and fish oils (eg, cod liver oil).<sup>4</sup> Consuming too much vitamin D results in toxicity because the vitamin is stored in body fat. Toxicity presents as nausea, vomiting, poor appetite, constipation, weakness, and weight loss.

The importance of vitamin D is the preservation of the facial bones. Vitamin D is necessary to maintain calcium homeostasis, which promotes bone mineralization.<sup>5</sup> Proper mineralization of the facial bones is imperative. Bone loss with maturity commonly occurs in the gingival bones, especially in edentulous persons. This bone loss leads to wrinkling of the skin around the mouth and inward turning of the lips. To find deficiencies, dermatologists should consider obtaining 1,25-dihydroxy vitamin D on all female patients older than 50 years, especially if they are fair skinned, petite, and have a family history of osteoporosis.<sup>6</sup> Several vitamin D replacement protocols are available, depending on the degree of the deficiency. One commonly used replacement strategy is to take 50,000 IU of vitamin D weekly for one month followed by 50,000 IU monthly.

In addition, vitamin D is being studied for its ability to modulate the skin's immune response. It appears that vitamin D<sub>3</sub> may be a major factor in the regulation of cathelicidin expression, which may be abnormally processed to forms that induce cutaneous inflammation in rosacea.<sup>7</sup> Other researchers have linked vitamin D to the regulation of p53, a tumor suppressor protein important

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*Dr. Draelos is Consultant and Researcher, Dermatology Consulting Services, High Point, North Carolina.*

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*Correspondence: Zoe Diana Draelos, MD (zdraelos@northstate.net).*

in skin cancer.<sup>8</sup> This has led to a speculative relationship between vitamin D deficiency and melanoma.<sup>9</sup> It may be that oral vitamin D supplementation is worthwhile to prevent skin cancer, which is at one end of the cutaneous aging spectrum.<sup>10</sup>

### **Vitamin C**

Vitamin C, also known as ascorbic acid, is used both orally and topically for skin benefits. Topically, ascorbic acid is used in cosmeceuticals for hyperpigmentation. It interrupts melanogenesis by interacting with copper ions to reduce dopaquinone and blocks dihydrochinindol-2-carboxylic acid oxidation.<sup>11</sup> Orally, nutricosmetic formulations utilize vitamin C in the form of L-ascorbic acid, which functions as an antioxidant by scavenging and quenching free radicals and by regenerating vitamin E from its radical form.<sup>12,13</sup> It is well established that vitamin C is necessary for healing wounds because it is a cofactor for lysyl and prolyl hydroxylase, which stabilize the triple helical structure of collagen. Whether an individual takes oral or topical vitamin C supplements, its role in healing wounds is controversial.

Theoretically, the value of vitamin C oral supplementation is to maintain the body's reservoir of 1500 mg, which rapidly depletes when the body is exposed to UV light. Some researchers believe that natural dietary sources of vitamin C (eg, vegetables and citrus fruits) are the best way to restore body reserves. Others feel that the poorly ripened fruits sold in grocery stores are vitamin C deficient. These researchers feel that synthetic vitamin supplementation is important; however, vitamin C can function as an oxidant in the presence of iron. Oral vitamin C is necessary to prevent scurvy, a disease with many skin manifestations that include skin fragility, gingivitis, and corkscrew hairs.<sup>14</sup> In addition, vitamin C may also promote fibroblast proliferation, migration, and replication-associated base excision repair of potentially mutagenic DNA lesions.<sup>15</sup> These activities are necessary to maintain youthful-appearing skin.

Even though much of the media supports the use of topical vitamin C, little has been published in peer-reviewed dermatology literature. Some investigators have demonstrated enhanced cutaneous vitamin C levels following topical application of L-ascorbic acid 10%; however, this work was performed on a porcine model.<sup>16</sup> Other human studies have demonstrated a decrease in the minimum erythema dose and less erythema following UVB exposure in subjects treated with topical L-ascorbic acid 10%; however, the sample size was limited.<sup>17</sup> Vitamin C has also been purported to produce lightening of skin dyspigmentation in the form of magnesium

L-ascorbyl-2-phosphate, but no well-controlled studies exist.<sup>18</sup> The challenge remains for researchers to embark on large-scale, double-blinded, placebo-controlled studies to demonstrate the value of topical vitamin C.

### **Vitamin E**

Vitamin E is the most popular topical vitamin in cosmeceuticals and is a common nutricosmetic. Similar to vitamin C, vitamin E is a naturally occurring, endogenous antioxidant. Even though the concentration of vitamin E in the epidermis is extremely small at 1.0 nmol/g,<sup>19</sup> it is the most important lipid-soluble, membrane-bound antioxidant in the body.<sup>20</sup> Vitamins C and E work synergistically because vitamin E can regenerate its antioxidant capabilities in the presence of vitamin C.<sup>21</sup> The form of vitamin E with the most biologic activity is  $\alpha$ -tocopherol, which functions to terminate lipid radical chain reactions. It stabilizes membranes against damage by phospholipase A<sub>2</sub>, free fatty acids, and lysophospholipids.<sup>22</sup> Vitamin E may also protect membrane proteins containing selenium or sulfur.

Vitamin E levels in the body are maintained through the intake of vegetables, oils, seeds, corn, soy, whole wheat flour, margarine, nuts, and some meat and dairy products.<sup>23</sup> Vitamin E levels must be maintained by continuous consumption or lipid peroxidation and collagen cross-linking will occur. This becomes accelerated with aging skin.<sup>24</sup> Taking vitamin E orally has also been linked to immunoglobulin E levels and the clinical manifestations of atopy.<sup>25</sup>

The value of topical application of vitamin E awaits further study. A review of the literature demonstrated that  $\alpha$ -tocopherol could inhibit UVB-induced edema and erythema, conferring a sun protection factor of 3 after multiple applications.<sup>26</sup> This may be due to its ability to marginally absorb light and function as a free radical-quenching, lipid-soluble antioxidant.<sup>27</sup> However, consuming vitamin E orally was shown to confer no photoprotective effects.<sup>28</sup> Topical vitamin E may also function as a penetration enhancer for other active ingredients by intercalating within the lipid bilayer region of the stratum corneum and altering membrane characteristics.<sup>29</sup>

### **Vitamin A**

Of all the topical carotenoids, vitamin A (retinol) is the most important because it is necessary for vision and possesses a well-characterized skin receptor.<sup>30</sup> The amount of vitamin A in an oral supplement is measured in retinol activity equivalents (RAE). Many supplements contain  $\beta$ -carotene, which can be split to yield 2 active units of vitamin A. Vitamin A is fat soluble with the

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recommended daily allowance of 700 RAE for women and 900 RAE for men. Foods that are high in vitamin A include sweet potatoes, kale, carrots, mango, turnip greens, spinach, and papaya. Low-fat milk, skim milk, margarine, and cereal are commonly enriched with vitamin A.

Ninety percent of the body's vitamin A reserve is found in the liver, with 1% found in the plasma. The liver's vitamin A level in a well-nourished adult is approximately 100  $\mu\text{g/g}$ .<sup>31</sup> Adequate vitamin A levels are not only necessary for vision, but also for the prevention of chemical carcinogenesis in the epithelial tissues of the bronchi, trachea, stomach, uterus, and skin.<sup>32</sup> Outside of the retina, 9-*cis*-retinoic acid and didehydroretinoic acid are more important because they trigger gene expression by binding to nuclear retinoid receptors.<sup>33</sup> The mean concentrations of carotene, retinol, and dehydroretinol found in the skin on the backs of healthy participants were 13  $\mu\text{g/g}$ , 0.4  $\mu\text{g/g}$ , and 0.4  $\mu\text{g/g}$  of protein, respectively, with no difference found with variations in sex and age.<sup>34</sup>

Theoretically, it is possible to interconvert the retinoids from one form to another. For example, retinyl palmitate and retinyl propionate, chemically known as *retinyl esters*, can become biologically active following cutaneous enzymatic cleavage of the ester bond, subsequently converting to retinol. Retinol is the naturally occurring vitamin A form found in red, yellow, and orange fruits and vegetables. It is the pigment responsible for vision, but is also highly unstable. Retinol can be oxidized to retinaldehyde and then oxidized to retinoic acid, also known as prescription tretinoin. It is this cutaneous conversion of retinol to retinoic acid that is responsible for the biologic activity of some of the new, stabilized, over-the-counter vitamin A preparations designed to improve the appearance of benign photodamaged skin.<sup>35</sup> Unfortunately, only small amounts of retinyl palmitate and retinol can be converted by the skin, accounting for the increased efficacy seen with prescription preparations containing retinoic acid.

The topical benefits of retinol have been documented by well-controlled studies.<sup>36</sup> It is commonly felt among dermatologists that retinol is beneficial for improving the appearance of aged skin.<sup>36,37</sup>

### Essential Fatty Acids

Essential fatty acids are sometimes referred to as vitamin F in nutricosmetic and cosmeceutical literature. Essential fatty acids cannot be synthesized by the body and must be consumed in the diet. They are long-chain, polyunsaturated fatty acids derived from linolenic, linoleic, and oleic acids. The 2 families of essential fatty acids are omega-3, derived from linolenic acid, and omega-6, derived from

linoleic acid. The numbers indicate the position of the first double bond from the terminal methyl group on the molecule.<sup>38</sup>

The principal omega-3 fatty acid is  $\alpha$ -linolenic acid, which is converted to eicosapentaenoic acid and then into docosahexaenoic acid. Omega-3 fatty acids are used in the formation of cell walls, and deficiency leads to decreased mental abilities, poor vision, diminished immune function, increased triglycerides, increased low-density lipoprotein cholesterol, hypertension, and skin disease resembling eczema. The highest concentration of omega-3 fatty acids are found in flaxseed oil. Other sources include canola oil, hempseed oil, walnuts, sesame seeds, avocados, salmon, and albacore tuna.<sup>39</sup>

The principal omega-6 fatty acid is linoleic acid, which is converted into  $\gamma$ -linolenic acid and combines with eicosapentaenoic acid to form eicosanoids. The foods previously listed are also high in omega-6 fatty acids, with the addition of borage oil and evening primrose oil. Both are popular topical agents. Borage oil and evening primrose oil are used in homeopathic preparations for inflamed dry skin, based on the skin disease observed in essential fatty acid-deficient patients.<sup>40</sup>

### Summary

Vitamins are used for nutraceutical and cosmeceutical purposes. Double-blind, placebo-controlled studies are difficult to perform, thus validating the benefits of vitamins becomes challenging. This article has reviewed some of the more commonly used vitamins and their published benefits. Readers will need to make their own judgments as to the utility of topical and oral vitamin supplements. This is a particularly difficult task when one recognizes that the recommended daily allowances listed on all foods were determined by consensus rather than research.

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