Navigate the Alphabet Soup of Topical Antioxidant Vitamins

From inhibiting degenerative processes to promoting healthy function, antioxidants benefit cutaneous health. But where do topical formulations fit in?

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Among the various ingredients commonly added to topical cosmeceutical formulations, vitamins are among the most popular. Scientific consensus supports the role of vitamins in various functions necessary for cutaneous health. It’s less clear when and how well the skin processes and utilizes certain topically-applied vitamins and whether they are photoprotective. I’ll review current evidence related to topically applied vitamins B, C, and E and discuss the implications below.

Vitamin C

Probably the vitamin additive with the greatest marketing cache is vitamin C. The active form of vitamin C, L-ascorbic acid is a necessary co-factor for several enzymes involved in collagen synthesis and cross-linking. It regenerates vitamin E, which inhibits lipid peroxidation. Additionally, antioxidant L-ascorbic acid neutralizes reactive oxygen molecules produced by exposure to UV radiation.

The human body does not naturally synthesize vitamin C, and only about eight percent of systemically absorbed vitamin C reaches cutaneous tissues. Therefore, the use of topical preparations seems logical to deliver active L-ascorbic acid directly to the skin. Multiple applications of L-ascorbic acid 10% to porcine skin increased vitamin C levels in the skin by four- to 40-fold.

Interestingly, while vitamin C is depleted in cells following UV exposure—reportedly up to a two-thirds loss—vitamin C demonstrates photoprotective qualities. Both animal models and studies in normal human volunteers support the photoprotective action of vitamin C. Application of topical vitamin C or E was shown to minimize low level, chronic UVB damage to murine skin. In porcine skin, sites pretreated with vitamin C had significantly fewer sunburned cells after UV exposure. Compared to vehicle, L-ascorbic acid 10% reduced erythema following UVB radiation and produced a significant change in the minimal erythema dose (MED) in pretreated human skin. A combination of vitamins C and E taken orally for eight days caused a significant increase in the MED compared to placebo.

Three months of daily application of a unique topical formulation of L-ascorbic acid that included zinc and tyrosine (Cellex-C high-potency serum, Cellex-C International) produced significant improvement of wrinkles/ rhytids, roughness, color and overall features of photodamaged skin, compared to vehicle, as determined by subjective and objective measures. The added ingredients help stabilize ascorbic acid and allow for greater skin penetration with topical application. Zinc is involved in collagen remodeling.

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while tyrosine functions in cell turnover and may help transport ascorbic acid into the skin.

Moy et al found that retinyl palmitate in combination with glycolic acid produced greater improvements in signs of photodamage (ranging from 56 to 89 percent) than did L-ascorbic acid. Nonetheless, vitamin C improved measured parameters by 12 to 56 percent. No statistical analysis was reported. A double-blind half-face study looking at a vitamin C complex containing 10% water-soluble ascorbic acid and 7% lipid-soluble tetrahexyldecyl ascorbate in an anhydrous polysilicone gel base did show decreased photoaging scores of the cheeks and peri-oral areas, but in the peri-orbital area improvement was not different from the vehicle alone.

Though many products incorporate vitamin C, most formulations, especially lower-end ones, include derivatives and esters that do not penetrate the skin as readily as L-ascorbic acid nor are efficiently converted to the only active form of vitamin C, L-ascorbic acid. L-ascorbic acid is unstable. In order to provide benefit, formulations containing L-ascorbic acid would have to include proper stabilizers and come in appropriate packaging. At this time, the therapeutic effects of vitamin C products are not clearly established, and the clinical role for vitamin C preparations is not defined.

**Vitamin E**

Lipid-soluble vitamin E decreases free radical production by protecting cell membranes from peroxidation. With age, production of both protein kinase C (PKC) and collagenase increases, leading to increased collagen degradation. Alpha-tocopherol, the biologically active form of vitamin E, inhibits PKC activation and collagenase increases, leading to increased collagen degradation.10 With topical administration of vitamin E has not been shown to prevent UV-induced skin damage in humans,13 alpha-tocopherol did confer a photoprotective effect in human tissue cultures.14

### Vitamin B

Water-soluble vitamins found naturally in vegetables and whole grains comprise the B-vitamins. Niacinamide (nicotinamide) has been formulated into some cosmetics and skin-care products, including moisturizers, shampoos, and conditioners. Studies suggest that niacinamide may have an exfoliative effect and may aid in prevention of photocarcinogenesis.16 When incubated with human keratinocytes, it increases ceramide synthesis, which naturally decreases with aging. The end result is improved barrier function and decreased transepidermal water loss (TEWL). Unlike L-ascorbic acid, vitamin B boosts stability and compatibility, making it a popular additive.

**Patient Recommendations**

Since it is shown to decrease TEWL and improve barrier function, is highly stable, and is generally inexpensive as an ingredient, nicotinamide-containing products may warrant a trial by patients. The dearth of evidence on vitamin E, on the other hand, makes it tough to provide a recommendation to patients regarding its use. Vitamin C shows promise both in photoprotection and improvement of the signs of photodamage, but it is not clear that the growing laboratory evidence currently translates to practical benefit. It’s worth noting that a number of well-known products formulated with vitamin C have gained the praise and trust of both patients and dermatologists. Dermatologists may feel comfortable supporting patients’ trials of these products based on their positive records, even if their benefit cannot be conclusively linked to vitamin C. No patient should abandon proven physical and chemical sunscreen ingredients in favor of vitamins for photoprotection.