Vitamin C

Collagen, Cancer, and the Common Cold

Vitamin C or ascorbic acid has become popular for its ability to enhance the functioning of the immune system and fight the common cold, but most of us do not realize that vitamin C is an essential biological molecule: a deficiency of vitamin C causes scurvy, a fatal disease that killed hundreds of thousands of sailors before it was understood. Ascorbic acid is remarkably similar in structure and weight to glucose (the simple sugar that is converted to energy in our body), and most animals can synthesize vitamin C from glucose. We, unfortunately, lack the enzyme necessary for the conversion of glucose to ascorbic acid and must rely on dietary sources such as citrus fruits or dark green, leafy vegetables to obtain sufficient quantities of vitamin C. Though scientists do not yet agree on how much vitamin C we need, all agree that ascorbic acid is a key vitamin for overall health and in particular for the health of the skin.

The History of Vitamin C

Although Vitamin C was first used to treat scurvy in the 1700's, it was not actually identified and isolated until much later. Scurvy was a common disease among sailors who were deprived of fresh fruits and vegetables for long periods of time during their voyages. In 1753, the British physician James Lind published the *Treatise of Scurvy* explaining that citrus fruits could cure scurvy and that adequate regular intake of citrus fruits would probably prevent the disease. Initially few believed that such a deadly disease could be cured so easily but eventually his advice was heeded and sailors were given rations of citrus fruits. In the twentieth century, Dr. Albert Szent-Gyögyi isolated vitamin C, the molecule responsible for curing scurvy, from red pepper and proposed the name ascorbic acid, indicating its antiscorbutic effect. His work identifying and isolating ascorbic acid earned him the Nobel Prize in 1937 (Packer and Colman, 79-81).

Toward the end of the twentieth century, Dr. Linus Pauling, a two-time Nobel Prize winner, made vitamin C famous. In his book *Vitamin C and the Common Cold,* Dr. Pauling asserted that high doses of vitamin C could prevent the common cold. A later book provided anecdotal evidence for vitamin C as a cancer treatment. Dr. Pauling advocated taking extremely high doses of vitamin C to prevent and treat the common cold, treat cancer, and maintain overall good health. His highly controversial books and theories generated discussion and brought vitamin C to the attention of the public (Packer and Colman, 82-85).

Since the discovery of vitamin C, thousands of exciting studies have been performed to understand the role of vitamin C in the body and demonstrate the multiple health benefits of ascorbic acid. Studies show that vitamin C strengthens immune function, protects against cataracts, protects against cancer by shielding DNA from free radical damage, and with vitamin E protects against oxidation of lipoproteins thereby reducing the risk of heart disease (Packer and Colman, 77-91). Vitamin C has also been shown to stimulate collagen growth, protect against UV-induced photodamage, and modify the inflammatory response (Colven and Pinnell, 1996; Catani et al., 2005).

Antioxidant Protection

In the body, vitamin C is one of the most important and most prevalent water-soluble antioxidants. As a water-soluble antioxidant, vitamin C exists inside the cells and in the extracellular matrix (the space between the cells) (Catani et al., 2005). This is especially important for the skin. Collagen and elastin, two structural proteins present in the extracellular matrix, give our skin tone, elasticity and firmness and are vulnerable to free radical damage. When collagen and elastin are damaged or begin to break down, skin loses its tone and firmness and fine lines and wrinkles appear. Because ascorbic acid is present in the extracellular matrix, it can scavenge free radicals that may harm these important structural proteins, thus preserving youthful skin tone and discouraging the formation of lines and wrinkles.

Vitamin C also indirectly protects the cell membranes and lipid-based structures of the skin. Vitamin E, the predominant lipid-soluble antioxidant, forms the first line of defense in the cell membranes. To inactivate a free radical, vitamin E or any other antioxidant must absorb the extra electron from the free radical. In doing so, the vitamin E molecule becomes inactivated. However, vitamin C can recycle vitamin E: vitamin C accepts the extra electron from the vitamin E molecule, restoring the antioxidant power to vitamin E (Packer, Weber, and Rimbach, 2001). Sufficient concentrations of vitamin C are crucial to protect all structures of the cell, both to inactivate free radicals inside the cell and between the cells and, by recycling vitamin E, to protect the lipid-soluble structures as well.

UV Protection

As an antioxidant, vitamin C protects skin from UV-induced free radical damage. UV light, endogenous biochemical reactions, smoking, ozone, and other environmental agents produce free radicals. These free radicals have the potential to harm cell structures, important proteins, and DNA. The cumulative damage caused by free radical attack has been implicated in skin cancer, inflammation, and photoaging (the visible signs of skin aging such as lines, wrinkles, and a loss of skin firmness and tone as well as age spots). Fortunately, antioxidants, and Vitamin C in particular, have been shown to have a protective effect against UV-induced DNA damage and photoaging (Colven and Pinnell, 1996).

In one topical study, researchers clearly demonstrated the photoprotective effects of vitamin E: topical application of vitamin C for four days prior to UV irradiation protected skin cells from sunburn and decreased the molecular indicators of UV-induced photodamage. After showing that topical application of vitamin C protects skin cells, the researchers demonstrated that topical application of the combination of vitamin C and vitamin E confers even stronger protection on cells (Lin et al., 2003). Another study demonstrated that oral supplementation of vitamins E and C also protected against UV-induced skin damage (Placzek et al., 2005), presumably by increasing the concentration of vitamins C and E in skin cells. Increasing the concentration of vitamin C in the skin, whether by topical application or dietary supplementation will help protect your skin from free radical damage.

Anti-Cancer Properties

DNA mutation or damage, often caused by free radicals, is one of the first steps of carcinogenesis. In order to protect against cancer, the body needs to first prevent DNA mutations. The body uses antioxidants to defend itself against free radical damage, and researchers are investigating the ability of antioxidants to protect against certain types of cancer. To determine the extent of DNA damage caused by UV light, scientists measure specific molecular markers. In the study mentioned previously by Lin et al., topical application of vitamins C and E was shown to decrease these markers: vitamins C and E diminished the DNA damage caused by UV irradiation (Lin at al., 2003).

However, even with ample concentrations of antioxidants in the body and skin, DNA damage and mutations still occur. Fortunately, the body has mechanisms to repair the DNA or induce the death of

a damaged cell thereby preventing the unhealthy cell from becoming tumorogenic. Recent research suggests that vitamin C also participates in the pathway that induces cell death (Catani et al., 2005). By protecting against DNA mutations and by helping to induce death of an unhealthy cell, vitamin C exhibits strong anti-cancer properties.

Collagen Synthesis

In addition to its role as an antioxidant, vitamin C has another extremely important function in the skin: vitamin C is necessary for the production of mature collagen. As mentioned previously, the structural proteins collagen and elastin give our skin tone, elasticity and firmness. As we age, collagen synthesis declines, and skin loses its tone and firmness and fine lines and wrinkles appear. However, in 1994 researchers demonstrated that vitamin C actually stimulates collagen growth in both newborn and elderly skin cells. Researchers cultivated fibroblasts donated by elderly volunteers and newborns. When researchers added vitamin C to the culture, both the newborn fibroblasts, and the elderly fibroblasts were stimulated to produce collagen and the elderly fibroblasts produced collagen at the same rate as the younger skin cells (Phillips, Combs, and Pinnell, 1994; Colven and Pinnell, 1996). Vitamin C stimulates collagen synthesis and helps restore a more youthful skin tone and firmness.

Topical Application of Vitamin C

In order for vitamin C to be able to protect and nourish the skin, there must be sufficient levels of vitamin C in the skin. Although studies have shown that dietary supplementation of vitamin C does confer protection on the skin (Placzek et al., 2005), researchers believe that topical application is more effective at increasing skin levels of ascorbic acid than dietary supplementation and that higher skin levels of ascorbic acid can be reached with topical application than by dietary supplementation (Colven and Pinnell, 1996). Dietary supplements of ascorbic acid are distributed to all cells of the body; topical application delivers vitamin C directly to the skin cells. To enjoy the maximum benefis of vitamin C, use topical formulations that contain therapeutic concentrations of vitamin C.

Treating Photodamaged Skin with Topical Vitamin C

The many demonstrated skin benefits of vitamin C has led researchers to study topical vitamin C as a treatment for photodamaged skin. Various studies use a double-blind split face design; patients apply vitamin C enriched product to one side of the face and a product that does not contain vitamin C to the other side of the face. Usually dermatologists evaluate the skin changes and patients are asked to give their opinion about the products they have been using.

A study using photographic assessment and patient questionnaires evaluated the effects of topical vitamin C on damaged skin. Nineteen patients applied a vitamin C serum daily for three months to one side of the face and a placebo serum to the other half of the face. Wrinkles, tactile roughness, skin tone and pigmentation were evaluated after twelve weeks by both the patients and by photographic assessment. Both clinical evaluation and patient feedback demonstrated improvement in wrinkling, skin tone, tactile roughness and overall assessment of the skin on the side of the face treated with vitamin C (Traikovich, 1999).

A similar half-face study used a vitamin C gel and evaluated wrinkles, pigmentation, inflammation, and hydration after 12 weeks of treatment. Researchers also biopsied the skin to evaluate the collagen levels in the skin. At the end of the three-month study, wrinkling improved and biopsies showed an increase in collagen on the side of the face treated with the vitamin C gel. Additionally, none of showed any signs of inflammation (Fitzpatrick and Rostan, 2002).

A third double-blind study tested the effects of vitamin C on volunteers with photoaged skin on the low neck and arms. Patients applied a vitamin C crème to one side and a placebo crème to the other side everyday for six months. At the end of the six months both clinical assessment and volunteer evaluation showed overall improvement as well as improvement in small wrinkles, smoothness, firmness, and dryness on the vitamin C treated side. Skin analysis demonstrated a decrease in deep furrows as well as an increase in the density of skin microrelief (Humbert et al., 2003).

These studies clearly demonstrate that topical vitamin C effectively treats photodamaged skin and improves the overall appearance of skin. All three studies report that treatment with topical vitamin C increases collagen in skin, improves skin tone, decreases wrinkles, and improves the tactile roughness of skin.

Different Kinds of Vitamin C

Now you are excited about vitamin C, but when you look at the label of a cosmetic formulation, you do not find ascorbic acid. Because ascorbic acid is a water-soluble antioxidant, it is very unstable in cosmetic formulations and rarely used. It reacts with water and air and other components of the formulation. Instead of ascorbic acid, you will usually find ascorbyl palmitate or ascorbyl phosphate or another form of vitamin C to ensure that the vitamin C in your crème or serum remains stable. Cosmetic companies use these slightly modified forms of vitamin C to deliver vitamin C to your skin. Ascorbyl palmitate, also called C-Ester, is a stable, non-acidic form of vitamin C. Ester-C® is another unique form of vitamin C. This patented ascorbate complex contains vitamin C, minerals, and bioactive metabolites to enhance the penetration and bioavailability of vitamin C. Studies demonstrate the Ester-C® readily penetrates skin and is non-irritating.

Vitamin C For Your Skin

For skin, vitamin C offers multiple benefits. As an antioxidant, vitamin C protects the water-soluble structures from free radical damage and aids in protecting the lipid-soluble cell membranes by recycling vitamin E. Additionally, vitamin C stimulates collagen growth to maintain and improve skin tone, firmness, flexibility, and elasticity. It modulates the inflammatory response and is known for evening out pigmentation. For your overall health, make sure you consume enough vitamin C daily. For the health of your skin, choose skin care products that contain vitamin C!

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