Eat Your Sunscreen: How the Food We Consume Can Protect Our Skin from the Sun's Harmful Rays

By Howard Murad, M.D. and Jeff Murad

Ultraviolet radiation from the sun, in countless laboratory and clinical studies, has been implicated to cause inflammation of the skin, oxidative stress and free-radical damage, among other problems. While topical sun-protecting products have been useful to assist in reducing sun damage, their protection alone is not adequate to prevent damage from ultraviolet light impingement. In view of this, new skin protecting and cell-fortifying methods are needed to promote healthy skin and offer the highest available photoprotection without toxicity considerations. With this in mind, a considerable number of researchers have turned to the study of ingredients found in many of the foods we eat. These are being used both topically (on the surface of the skin) and systemically (internally ingested). This article is designed to share a summary of the sun protection effects of selected foods. These foods- that naturally feature key elements proven to enhance the skin's protection from ultraviolet rays- literally enable us to "Eat our Sunscreen."

Damage from the Sun

As noted above, exposure to ultraviolet light initiates many cell-deteriorating processes such as inflammation and oxidative stress. The result of these processes is compromised cellular integrity, since exposed cell membranes weaken as a result and allow vital, hydrating intracellular water (ICW) to evacuate from the cells. As inflammation accumulates, collagen and elastin breakdown is also initiated. Aging and cell damage cause cutaneous layers to flatten, encourage dermal structures to thin, and blood vessels to leak. The result of these processes is a diversion of nutrients from the damaged cells they would otherwise reach [1]. Clinical experiments have shown a clear relationship between nutrients, the lack thereof, and cutaneous cell functions [2-7]. Specifically, normal cell processes such as repair and replication slow. Replication errors and tumor formation may arise as skin healing is impaired [8]. Additionally, cutaneous diseases and conditions can further complicate matters when the concommitant UV-stimulated inflammation cascade and damage continue unabated [9].

In general, the human body requires a vast array of nutrients to supply its cells with adequate energy for the purposes of cellular rejuvenation and turnover. The majority of the nutrients needed to best benefit day-to-day function come from the diet and include proteins, carbohydrates and lipids. In addition to these life-sustaining dietary categories, the body also needs vitamins, minerals, and essential fatty acids for optimum cellular functions.

Nutrition recommendations in the past have treated botanical dietary components as secondary foods [10]. However, with advances in nutrition science, a renewed interest has been generated in organic food products, increased LOHAS participation, the proliferation of natural products and greening trends. An abundance of research has concentrated on sustainable botanical ingredients as components in neutraceuticals and cosmeceuticals [8,11,12]. Ethnobotanists, who collect information on culturally known, indigenous remedies, have also stimulated a body of research on plants, vegetables and fruit ingredients and their possible uses within topical or supplement products. What has been gleaned from scientific literature is that certain phytochemicals from these plant-based foods may offer important photoprotective capabilities, among other benefits, and may preserve cutaneous barrier function and cellular immunity [8,11,13-18].

Topical and Internal Protection

A challenge with regard to topical sun protection is user application. Topical products, in order to provide their full sun protection capabilities, must be applied correctly by end-users. Most people only apply between 25% to 50% of what is recommended [19]. A secondary challenge is ingredients. A formulation's delivery system must protect ingredients from degradation, while distributing them readily and appropriately for optimum function. High-tech formulations have addressed these challenges, however, research is ongoing [20].

Systemic or endogenous sun protection is not without challenges either as there are efficacy, toxicity and availability issues [21]. However, endogenous sun protection has the advantage of protecting the entire body's surface and may be considered more convenient and desirable. Actual SPF provided systemically may also be lower depending on metabolism, age, total health, among other factors [22].

A plausible solution to these challenges may be to pair external with internal regimens to offer sun protection both from topical cosmetics and dietary sources including supplements. A combination of external and internal methods can offer more sun protection than when used singularly.

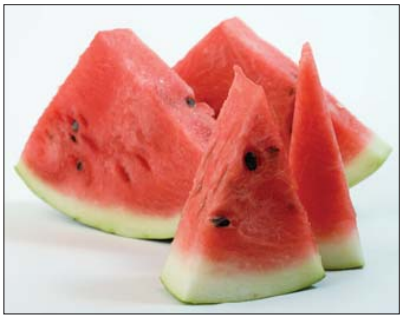
In short, to apply sunscreen topically is important, but to do that in conjunction with digesting particular foods that can boost the level of protection, or "eating your

sunscreen," is the best known way to protect one's skin from the sun's rays overall. Listed below are a number of natural elements that can be found in edible plants. These elements contain the natural tools our bodies can use to enhance sun-protection. Let's take a look at each element, explore scientifically how it can help protect us from the sun, and reveal in which foods it can be found.

Carotenoids

Colorful fruits and vegetables such as tomatoes, sweet potatoes, carrots, watermelon and canteloupe provide the most

carotenoids. In human studies, carotenoids are known to be useful as systemic sun protectants because of their antioxidant properties. Major carotenoids include β-carotene, α-carotene, lutein, zeaxanthin and lycopene. Digestible supplements with high doses of β-carotene protect against UV-induced skin abnormalities [23]. However, β-carotene supplements have met with controversy because they are known to increase the risk of lung cancer in smokers [24]. In an effort to capture β-carotene's sun protection capabilities without the toxicity, researchers have experimented successfully



with the other carotenoids and combinations thereof, to produce results equivalent to those produced by β-carotene supplements. During this quest, researchers found that lycopene, of all carotenoids, has the most, and safest, cell-quenching action [25].

While colorful, fresh and raw fruits and vegetables may offer the highest levels of carotenoids, in the case of lycopene, which is only found in significant amounts in a few foods (tomato, watermelon, pink grapefruit), it may be preferable to consume a processed product as lycopene is more bioavailable in this form [26]. For example, a German study examined the sun-protecting benefits of lycopene from store-bought tomato paste. Subjects ingested 40g of tomato paste daily. After 10 weeks, subjects experienced much less surface redness than the control group, indicating a 40% protection against UV-induced skin abnormalities [27].

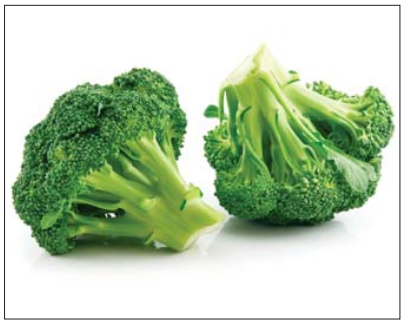
Interestingly, when supplements rich in carotenoids are taken, skin levels of carotenoids increase in all areas of the body, however, higher levels of carotenoids are found on the forehead, back and palms of the hands [28], which may offer slightly more photoprotection in these areas.

Of all edible plants, goji berries have been indicated to contain the highest levels of carotenoids including β-carotene. Used for centuries in Tibet and Mongolia as a longevity and strength-building food, goji berries are attributed to both long life and a good quality of life. The berries are said to boost the immune system response and healing [29]. According to new research, goji ber-

ry's indigenous uses and health benefits are valid [30]. Because of the berries' high levels of carotenoids, including β-carotene, it can be presumed that they offer photoprotective action on skin.

Isothiocyanates

Isothiocyanates are sulfur-containing phytochemicals that can be found in vegetables such as broccoli, cabbage, brussels sprouts, watercress, turnips, cauliflower, and radishes. Known for their anti-carcinogenic properties, isothiocyanates inhibit cancer cell proliferation and induce attacks on cancer cells. Recent experiments on



broccoli sprout extract show that it has significant sun protection capabilities as well [31,32]. Unlike sunscreens, the extract does not absorb UV light and prevent its entry into the skin. Rather, the extract's sulforaphane, which occurs naturally in vegetables containing isothiocyanates, works inside cells by boosting the production of a network of protective enzymes that defend cells against many aspects of UV damage. Consequently, the effects are long lasting; the protection lasts for several days, even after the extract is no longer present on or in the skin. The study on broccoli sprout extract showed reductions of UV-induced erythema between 8 to 78%, with a mean of 37.7%. The differences in protection level may have been due to genetic factors, lifestyle or diet. Regardless, because traditional sunscreens only last for hours at most, this study's findings are significant and require more examination as it seems the cells can only benefit from intake of these natural sun protection elements.

Antioxidants

Antioxidants are plentiful in many botanical ingredients and are known for fortifying cell membranes and preserving intracellular components from UV-induced cell damage and subsequent intracellular water loss. Additionally, there is growing evidence that a combination of antioxidants used with sunscreens boosts photoprotection [33]. Some antioxidants are more effective than others at neutralizing different free radicals in cells and in certain parts of the body. In addition some are better when used together [34]. For example, water-soluble vitamin C, removes free radicals from the cell structures composed primarily of water and from areas containing body fluids. Fat-soluble β-carotene and vitamin E are active in the lipid or fatty parts of the cell membrane and in fat tissue. Moreover, some antioxidants work not only as free-radical scavengers but also as anti-aging catalysts [33].

A preliminary study was conducted to assess the sun protection factor (SPF) offered by a sunscreen before and after supplementation with an oral antioxidant formula [35]. Ten subjects took twice-daily ingestion of an oral antioxidant formula containing vitamins A, C, E and other antioxidants, plus various herbs and minerals. After 7 days of treatment with the oral antioxidant, the average SPF of the test sunscreen product increased from 17.98 to 19.84. This study is one of many that point to the potential benefits of oral antioxidants in providing added photo-protection as offered by sunscreens.

Foods rich in multiple kinds of antioxidants include pomegranate, goji berries,

walnuts, blueberries, blackberries, artichoke, and most kinds of beans.

Some specific antioxidants have been documented to have more sun protection qualities than others. Vitamin C, Coenzyme Q10, and Alpha Lipoic Acid are three examples of antioxidants that have repeatedly proven to be strong sun protectors.

With regard to skin health, vitamin C is perhaps one of the most documented and significant antioxidant. Found in citrus fruits, mangos, strawberries, cauliflower, broccoli and potatoes, vitamin C is capable of protecting the skin against ultraviolet light exposure, when applied topically [36].

Coenzyme Q10 is a fat-soluble antioxidant that is necessary for the production of energy in all cells of the body. The majority of studies on CoQ10 have been on its oral use. Found primarily in meat products, botanical sources include spinach, broccoli, peanuts, wheat germ and whole grains. While CoQ10 occurs in the cells of all plants and animals, dietary sources do not often provide adequate levels of this nutrient; as a result, supplements may be useful.

Alpha lipoic acid is another important antioxidant to get through diet or supplements. Sources of alpha lipoic acid include spinach, broccoli and brewer's yeast. Alpha lipoic acid is integrally involved with cellular functions as it is known to boost cellular energy, enhance immunity and muscle strength, and improve brain function. While it was not recognized as an antioxidant until 1989, it is now known to boost the entire antioxidant defense network, increasing the actions of vitamins E and C, glutathione and CoQ10 [35]. Because of its small size, it readily crosses cell membranes and through the nuclear membrane, so its antioxidant action can occur not only in the bloodstream, but also in the cell membrane and intracellularly. Topical alpha lipoic acid at 3% has also been shown to diminish UV-induced skin abnormalities, which demonstrates its photoprotective and anti-inflammatory properties [37].

Polyphenols

A growing area of study is polyphenols, which are a group of phytochemicals, characterized by the presence of more than one phenol unit or building block per molecule. Polyphenols are found in fruits, herbs and vegetables. In the diet, our major dietary source of polyphenols is beverages such as juices, teas and wines. Interest in polyphenols has grown because of their positive and preventive effects on cardiovascular disease, cancer, stroke and inflammation [38]. Specifically, flavonoids regulate nitric oxide, a free radical that regulates blood flow, and protects against blood clots and oxidation of LDL cholesterol. Systemically, flavonoids have shown to lower blood pressure [35].

Polyphenols, along with other dietary agents, including vitamin C, vitamin E and carotenoids, protect the body's tissues against oxidative stress and protect the immune system [35,38]. The strongest polyphenol is ellagic acid, with high levels found in raspberries, strawberries and pomegranates. Other polyphenol food sources include nuts, whole-grain cereals, brightly colored fruits, vegetables, berries, soybeans, tea (especially green tea), red grapes, red wine, onions, and citrus fruits.

Pomegranate is a key beneficial sun-protecting source of polyphenols. Ethnobotanists describe the use of pomegranate in traditional medicines in many countries, as anti-inflammatory and antibacterial. In ancient times, the Greeks and Egyptians used pomegranate to heal many ailments. Writings about the pomegranate date back as far as 1550 BC in the Papyrus Ebers of Egypt, pharmaceutical documents recording a collection of 800 prescriptions. As mentioned

earlier in this article, pomegranates are also widely used for their antioxidant action. Pomegranate has also been studied for its tyrosinase-inhibiting action and subsequent skin-lightening properties[39]. One study on topical and systemic pomegranate showed boosted SPF levels in human test subjects[35,40]. Eight subjects took a daily pomegranate antioxidant orally for 7 days and experienced a 14.4 to 22.7% increase in SPF factor. This was in addition to the inclusion of topical pomegranate extract, which increased the SPF by between 22.7 and 28.8%.

Like pomegranate, grapes, for thousands of years, have been heralded for their health benefits from the Egyptians to the Greeks to Europeans. In the last few decades, interest in the "French Paradox" fueled new research on grapes. In the process of this study, researchers found that grape seed extract contains vitamin E, flavonoids, linoleic acid, and compounds called procyanidins[41]. The most promising research on grape seed is in the realm of anti-carcinogenesis. Researchers have shown that grape seed extract displays cytotoxicity toward human breast, lung, and gastric and enocarcinoma cells while promoting growth of normal gastric mucosal cells. In addition to these qualities, grape seed extract is used for conditions related to the heart and blood vessels, such as atherosclerosis (hardening of the arteries), high blood pressure, high cholesterol, and poor circulation, making it useful in the treatment of complications related to diabetes, such as nerve and eye damage; vision problems, such as macular degeneration; and post-injury or post-surgery edema and wound healing[42]. Grape seed extract proanthocyanidins have been shown to be 50 times more effective than vitamin E and 20 times more effective than vitamin C as antioxidants[43]. Several authors contend that proanthocyanidins inhibit enzymes integral to the breakdown of the skin[44-46]. These studies indicate that grape seed extract may improve skin elasticity as well as protect against UV damage.

Polyphenols are not limited to foods we eat, either – as green and black teas have proven to have similar benefits. Green tea comes from leaves and leaf buds of plants cultivated principally in Asian countries. Green tea contains epigallocatechin-3-gallate or EGCG, a powerful polyphenol antioxidant that has been shown in studies to offer preventive effects against photocarcinogenesis and phototoxicity[47-50]. In particular, topical application of EGCG before UV exposure markedly decreases UV-induced production of hydrogen peroxide and nitric oxide in both epidermis and dermis in a time-dependent manner. EGCG pretreatment also inhibits UV-induced infiltration of inflammatory elements of the skin. Black tea, like green tea, offers photoprotective action on skin when applied topically and in studies has proven effective in absorbing UV rays in the UVB and C spectrum, but does not counteract the effect of UVA rays well[51].

Another effective polyphenol we can eat is rosmarinic acid, which is found in many herbs including lemon balm, rosemary, oregano, sage, thyme and peppermint. In vitro tests show that this acid possesses strong antioxidant potential. In addition, researchers conclude that concentrated rosmarinic acid extracts from rosemary leaves could protect against UV-induced oxidative stress when used in oral preparations and supplements[52].

Consumed in large amounts in Indian cooking, curcumin is a polyphenol that comes from turmeric, is a member of the ginger family that has been shown to offer a wide range of potential therapeutic and protective uses with Alzheimer's disease, cancer and psoriasis, as such, clinical trials are currently underway to determine curcumin's various effects in vivo[54]. The antioxidant spice component has been reported to exhibit anti-inflammatory properties and prevent UV irradiation-induced skin changes[8,55]. Because only very small amounts of curcumin is absorbed through foods that are consumed, especially in Western diets, supplementation may be of benefit.

Genistein is a polyphenol in the isoflavone family that can be effectively isolated from fermented soybeans, has low toxicity and is highly antioxidant[56]. Whether topically applied or eaten, it has been postulated that genistein prevents and quashes skin carcinogenesis, by blocking DNA adduct formation and inhibiting oxidative and inflammatory events in vivo[57,58]. Laboratory tests on topical genistein have confirmed its photoprotective capabilities against UV-induced events such as inflammation, skin hypersensitivity, and cellular complications[21]. Interestingly, isoflavones happen to also have weak estrogen-like effects and may help protect skin as estrogen is known to preserve skin[59,60]. In skin care products and supplements for aging or menopausal women, the use of genistein as an ingredient may prove to be useful in counteracting decreasing estrogen levels as well as assisting with photoaging.

One promising plant is the milkweed, native to North America and traditionally used for its silky floss. New research indicates that the plant's oil, when extracted and modified with a biodegradable, natural additive for stability, offers UV-absorbing characteristics[53]. According to the study, the oil, when used topically, is unlikely to be toxic because very small amounts are needed for UV protective effects. The oil has been shown to offer protection up to approximately 370 nm and down to the shorter wavelength regions. Furthermore, it was found that the intensity of protection could be modulated to target a particular wavelength region. Studies are ongoing to develop the technology further for possible inclusion in cosmetic industry products.

Beta-glucan

Beta-glucan is an element found in natural food sources such as bran, wheat germ, baker's yeast, mushrooms, oats and barley. Like polyphenols, beta-glucan is believed to offer cardiovascular benefits, however, unlike polyphenols, which scavenge bad or damaged skin cells, beta-glucan works differently as a biological response modifier. Interestingly, both polyphenols and beta glucan are indicated to increase immunity. Beta-glucan's immune-stimulating capabilities have been used in the treatment of many diseases [37,61]. Additionally, its cell-stimulating action make it useful on skin irritation and wound healing [37,62,63]. Topically applied, beta-glucan has been shown to penetrate epidermal layers where it presumably mobilizes growth factors, which encourage fibroblasts to produce collagen [64]. With regard to photoprotection, beta-glucan has demonstrated an ability to maintain glutathione levels in cells after UV exposure [64,65]. With no phototoxic effects, beta-glucan offers photoprotective action on skin and a unique ability to repair and forestall UV-induced oxidative stress.

Essential Fatty Acids

Also known for cardiovascular benefits, essential fatty acids (EFAs) are a family of substances that not only attract water to dehydrated cells and connective tissue all throughout the body, but also prevent future water loss by repairing cell walls, preserving or improving intra-cellular water. They include omega-6, omega-3 and omega-9 fatty acids and can be found in "fatty" cold-water fish (omega-3s) and some plant-based sources such as papaya, broccoli and kale.

EFAs enhance the immune system as they strengthen the skin's barrier function [35,66]. They are anti-bacterial, anti-viral and anti-fungal and exhibit anti-inflammatory action, which can be attributed to their ability to decrease the formation of pro-inflammatory cellular elements [67]. One study demonstrates that eicosapentaenoic acid, an omega-3 fatty acid, inhibits UV-induced skin damage, making it a potential ingredient for the prevention and treatment of skin aging [68]. While research indicates topical EFAs to offer little direct UV-absorbing powers, it is assumed that their photoprotection comes indirectly from their cell and cell membrane repairing capabilities.

Ingredients containing EFAs abound in current cosmetic formulations. In addition to their EFA content, the botanical sources of EFAs may have other components that offer synergistic antioxidant or anti-inflammatory characteristics when used internally or externally. Such is the case with the durian fruit [69]. Durian is a native fruit to Asia that offers omega-3 EFAs and antioxidants that moderate the induction of inflammatory mediators, decreasing free-radical tissue damage; and inhibit collagen and elastin breakdown [70,71].

Açaí berries also contain EFAs and, like durian, contain other synergistic components that may combat UV-induced cell damage. Native to the rainforests of the Amazon, the berries contain a blend of omega-3 fatty acids, phytosterols, antioxidants and amino acids.

Studies on durian and açai and photoprotection, if they exist at all, are limited. However, because the fruits' phytochemical components are known to offer protection, it can be assumed that durian and açai berries may produce positive results.

More Discoveries on the Horizon

It seems the more we study our healthy food sources, the more we can discover and analyze the properties of the various ingredients they contain and discover which of them, or their combination, can help us protect our skin against the sun. Not surprisingly this approach is anticipated to produce a wealth of new evidence and information that has, and will be constantly being unlocked. With every area of research, the studies are ongoing and may offer more information on already- used ingredients or new ones. In the case of compounds that reduce the effects of UV-induced damage, the list of potential ingredients currently under review, or still to be examined, is exhaustive. Many new discoveries show promise but require more study. An interesting example is Chinese Black Ash Bark – featured in an early study indicating that it seems to reduce the effect of UV-induced damage [72]. Another is glycyrrhetinic acid, which is found in the licorice root, and, in preliminary studies has been found to offer protection from UVB radiation damage [73].

Many of the ingredients discussed in this article have made their way into cosmetic industry products to benefit and protect the end user. However, even if these ingredients are not introduced to the cosmetic industry in new products, scientific study can offer consumers' ideas on foods that, if incorporated into an existing nutritional plan, offer some photoprotective benefits. Yet another example is Tamarind, which is frequently used in Asian cuisine and contains oligosaccharins which have been shown to provide an SPF of only 1. However, it has been demonstrated to increase protection from the UV-induced loss of cells following UV exposure [74].

An Inclusive Health Approach

As anyone who has experienced a "sunburn" can attest, inflammation of the skin due to prolonged UV exposure may not only have a painful topical component, but also can have an internal component and even an undesirable emotional aspect. The reality is, preventing damage from the sun's harmful rays is obviously more complex than the simple application of sunscreen. As outlined in this article, the food and supplements we consume can have a dramatically positive effect in terms of protecting our skin, but there more we can do on a holistic level. In fact, to be most successful in caring for our skin, a comprehensive method, possibly multidisciplinary, is required to achieve optimal hydration of the cells and prepare the body for extreme weather conditions of any kind. The authors call this comprehensive

method an **"Inclusive Health"** approach. It includes a formulaic, three-pillar protocol, which we apply to every one of our patients. Generally, this approach is effective since it breaks down the treatment strategy into the three categories: topical, internal, and emotional, and helps create a roadmap to the treatment goal.

Through a series of standard checks and evaluations, an inclusive program is initiated targeting each patient's specific needs. Gathering data from the treatment of more than 50,000 patients in Dr, Murad's Inclusive Health practice, dramatic benefits have been seen for patients when this three-step approach is taken and these benefits are not limited to just protecting skin from the sun. The benefits observed go far beyond the skin and the approach serves as a method of providing a complete strategy toward reducing existing inflammation- while opening the door to the added benefit of placing a patient on the track toward total wellness[75].

In short, by merging thinking on cellular health and sun protection with treatments that work topically, internally and emotionally, we have found that we can produce the best results possible for long-term skin protection.

Scientific study has brought us to where we are today and the growing demanding and knowledgeable consumer-push has encouraged the industry to honor their requests for better and longer-lasting results. Today's inclusive health care environment aims at being noninvasive, but is ever more thorough at removing underlying problems. So by all means, eat your sunscreen, and be willing to explore a more comprehensive, Inclusive Health lifestyle, and the result can be, not only protection from the sun, but an observable increase in overall health- and beauty that lasts.

Conclusion

The foods discussed within this review offer many UV-protection benefits, whether eaten, used as supplementation, or used as part of a topically delivered product. These foods have a multiplicity of significant characteristics which should make any cosmetic and personal care formulator become interested. These characteristics include, but are not limited to: an ability to strengthen cell membranes; to decrease accumulated cellular damage and to help maintain (or increase) intra-cellular water. They also are capable of decreasing inflammation, retarding tissue degradation; and increasing immunity. These foods are, and must become of increasing interest to the cosmetic industry in its search for skin beauty and wellness. Based on scientific literature and laboratory studies presented, routine use of these ingredients – as food or otherwise – may provide a higher level of photoprotection than topical sunscreen alone can possibly offer. Furthermore, these ingredients, if used with in, or in combination with topical sunscreens as supplements, and in the context of an overarching Inclusive Health approach, may enhance overall cellular health, and thus total body health.

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