An Insider’s Look at Sunscreen Ingredients and Formulation

A clinical dermatologist and sunscreen formulator discusses sunscreen ingredient safety, strategies to improve topical UV protection, and the keys to successful patient education.

By Lawrence Samuels, MD, FAAD

Dr. Samuels developed Rx Systems PF® Facial Moisturizer with SPF 35 created as the ideal sunscreen for everyday use. The facial moisturizer with SPF 35 provides a broad spectrum UVB/UVA protection in a facial moisturizer appropriate for all skin types. It combines four sunscreen ingredients to expand the range of ultraviolet ray protection including transparent, micronized zinc oxide. Antioxidants are incorporated to enhance its photo-protective properties.

Lawrence Samuels, MD, FAAD is a board-certified dermatologist with 30 years experience. As a practicing physician, Dr. Samuels saw the need for skin and hair care products that were easy to use, affordable and effective. In 1996, after witnessing positive results with regular use of glycolic acid—based skin care products and medicated hair care products, Dr. Samuels developed the Rx Systems PF® line of skin care products—a complete line of pH-balanced, glycoic complex (glycolic acid and alpha lipoic acid) based products, vitamin C serum in a trademarked age bloc delivery system, retinols, enzymes and moisturizers for the face and body. Rx Systems PF products are now sold at selected retailers nationwide and online at www.rxsystemspf.com.

Dr. Samuels is Chief of Dermatology at St. Luke’s Hospital in St. Louis, MO.

Photoaging, characterized by rough skin texture, dilated pores, poor skin tone, skin laxity, blotchy skin color, brown spots, sallowness, telangiectasia (sometimes called broken blood vessels), fine lines and wrinkles, results from repeated ultraviolet exposure. As such, exposure to UVB/UVA radiation is the primary, preventable cause of aging. The ubiquitous nature of ultraviolet rays requires the use of sunscreen agents to block the damaging effects. Since UVB (280-320nm) and UVA (320-400nm) radiation contribute to photoaging, it is important to provide UV protection over a broad spectrum of ultraviolet radiation (280-400nm). (Table 1) To provide this type of protection, a sunscreen must contain a combination of organic (chemical sunscreen ingredients) and inorganic (physical sunscreen ingredients) filters. Combination sunscreens enhance the SPF of the final product.

It is important for all medical-affiliated personnel (physicians, nurse practitioners, chiropractors, physician assistants, nurses, estheticians, physician office staffs, and all those medical-associated specialists not listed) to understand the science and benefits of sunscreens in order to better educate their patients, clients, friends, and family about the importance of UV ray protection.

Types of Sunscreens and SPF

Chemical sunscreen ingredients act as an ultraviolet sponge to absorb the damaging UV rays. Physical sunscreen ingredients deflect or block damaging UV rays in a similar fashion to protective clothing. Current toxicology based on acute and chronic exposure to (UVB/UVA) broad spectrum sunscreens concluded that sunscreen ingredients or products pose no human health concern, despite any remarks to the contrary that appeared in a widely publicized Allure Magazine article and comments made by the

Bottom Line

It is important for all medical-affiliated personnel (physicians, nurse practitioners, chiropractors, physician assistants, nurses, estheticians, physician office staffs, and all those medical-associated specialists not listed) to understand the science and benefits of sunscreens in order to better educate their patients, clients, friends and family about the importance of UV ray protection.
Environmental Working Group. In addition, micronized, transparent zinc oxide is not absorbed into the skin, and there are no reports of skin allergies to zinc oxide.

Misleading remarks made in the media regarding the safety, efficacy, and benefits of sunscreen ingredients and the use of sunscreen could unfortunately lead people to stop or decrease their use of sunscreen agents.

SPF is an indication of a sunscreen’s effectiveness preventing sunburn related to the length of time in the sun, but it does not actually increase proportionately absorbing the damaging UV rays. An SPF of 35 blocks 97-98 percent of UVB rays, while a SPF of 15 blocks 93 percent of the rays, and an SPF of 2 screens 50 percent of UVB rays (Table 2). The take away for sun protection: an SPF of at least 15 should be used on a daily basis. The additional daily benefit of a sunscreen with an SPF greater than 35 may not be substantial, and patients may benefit more from attention to issues like broad-spectrum protection or formulation quality rather than simply looking for the highest available SPF rating.

The SPF only relates to a sunscreen’s ability to block UVB rays. Unfortunately, at the present time there is no measure to indicate the effectiveness of a sunscreen’s ability to block UVA rays. It is well known that chemical sunscreen ingredients that block UVA rays are somewhat unstable when exposed to UV rays and oxygen (air). This is further complicated by the fact that we do not have the ability to measure the stability or effectiveness of chemical sunscreens that block UVA rays.

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PATIENT EDUCATION TIP:

Most physicians would agree that the use of sunscreen has attributed to a decrease in the incidence of photodamage and pre-cancerous skin lesions. In fact, the American Academy of Dermatology recommends that, regardless of skin type, a broad spectrum sunscreen with an SPF of at least 15 should be used all year-round. Patients must understand that sunscreen shouldn’t be reserved for use only on sunny days. Even on a cloudy day, up to 70 percent of the sun’s ultraviolet rays can pass through the clouds. Additionally, sand reflects 25 percent of the sun’s rays, and snow reflects 80 percent of the sun’s rays.

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PATIENT EDUCATION TIP:

Combination sunscreens with adequate SPF, containing micronized zinc oxide or titanium dioxide, and used with daily application increase a sunscreen’s ability to neutralize UV rays.
Editors Spotlight

Sunscreens can actually cause negative cutaneous effects due to the incorporation of irritating or allergenic ingredients. Some of these negative effects include, but are not limited to, dryness of the skin, allergic dermatitis, irritant dermatitis, acne, cancer, skin aging, and photosensitivity. With some brands of sunscreen, even mere inhalation of the product can cause reactions in some patients. It is important to find the right sunscreen for each person and to ensure that these symptoms do not occur with the brand they are using. Sunscreen should not be applied to children under six months of age, who are best not exposed to direct sun, anyway.

There are no published human studies on the cancer-causing potential of retinyl palmitate, a prime focus of the EWG. There are, however, observations from decades of clinical practice that do not support the notion that retinyl palmitate in sunscreen causes or promotes skin cancer.

Most chemical sunscreens contain UVA and UVB blockers in concentrations that range from two to six percent. There are claims that UV rays cause some sunscreen ingredients, such as benzophenone (and similar compounds), to break down, creating damaging free radicals. Many sunscreens also contain triethanolamine, a compound that is suggested to cause the formation of cancer-causing nitrosamines in products by combining with nitrite used as a preservative and often not disclosed on product labels.

Another claim is that sunscreen chemicals have estrogen-like effects. Concerns brought about by earlier scientific studies have led authorities in the EU to regulate that any sunscreen product containing a more than five percent dose of oxybenzone should be labeled accordingly. Benzophenone (benzophenone-3), homosalate, and octy-methoxycinnamate (octinoxate) are troubling, because they have shown estrogenic activity in lab tests.

Oxybenzone is a derivative of benzophenone, and it is linked to allergies, hormone disruption, and cell damage. However, most studies looked at very high doses of these drugs. According to reports, the Centers for Disease Control (CDC) says that 97 percent of Americans are “contaminated” with this widely-used sunscreen ingredient. The study in question did find evidence of the chemical in nearly 97 percent of analyzed urine samples, though the source of exposure was not assessed by the investigators.

Parabens (butyl-, ethyl-, methyl-, and propyl-) are com-

### Table 1. The Light Spectrum

<table>
<thead>
<tr>
<th>Spectrum</th>
<th>Description</th>
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<tr>
<td>Vacuum UV</td>
<td>Ultraviolet Light</td>
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<tr>
<td>X Rays</td>
<td>Ultraviolet Light</td>
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Recommend an SPF of at least 15 be used on a daily basis. The additional daily benefit of a sunscreen with an SPF greater than 35 may not be substantial, and patients may benefit more from attention to issues like broad-spectrum protection or formulation quality rather than simply looking for the highest available SPF rating.

http://modernaesthetics.com/tv.asp?f=how-sunscreens-work
mono in sunscreens, so avoiding them may prove difficult. They are preservatives that have estrogenic qualities. They have also been found to accumulate in the breast tissue of women with breast cancer. However studies fail to show a direct connection between topically applied parabens and human disease or interference with endocrine function. While on the surface of the skin, the chemicals Padimate-O and Parsol 1789 (Avobenzone) appear to prevent UV damage, but when absorbed into the skin, it has been suggested that they can actually damage DNA. There is evidence that the sun’s light may cause these chemicals to become reactive and cause free-radical damage when they’re absorbed.

In general, zinc oxide and titanium dioxide are good sunscreen choices as they scatter or reflect the sun’s rays rather than absorbing them. However, traditional formulations are not absorbed into the skin (thus the white streaks on the skin), so there is less risk of organic substance building up in the body. Some of the studies suggesting negative effects of sunscreen chemicals included excessive doses and systemic exposures, but overall, there is no good evidence to suggest that topical use of sunscreens is toxic to humans.

**A ROLE FOR ANTIOXIDANTS**

The photoprotective capability of antioxidants does not lie in their ability to reflect or absorb UV rays. Rather, they prevent the damage created by UV-generated free radicals. Antioxidants neutralize free radicals by donating one of their own electrons, ending the destructive cascade. The antioxidants themselves don’t become free radicals, because they are stable in either form due to their chemical behavior. They act as scavengers to prevent cell damage. Antioxidants that give up their electrons are not harmful because they have the ability to accommodate the change in electrons without becoming reactive.

New methods to protect skin from photodamage are necessary, as sunscreens are under-used and have incomplete spectral protection. Skin naturally uses antioxidants to protect itself from photo damage. Vitamin C, Vitamin E, alpha lipoic acid, retinol, selenium, zinc, silymarin, soy, soflavones, and tea polyphenols may supplement sunscreen protection and provide additional photodamage repair when sunscreens fail. Non-enzymatic antioxidants include glutathione and ascorbic acid in the water phase and Vitamin E and ubiquinol in the lipid phase. A few antioxidants are Vitamin A, Vitamin C, Vitamin E, alpha lipoic acid and minerals (selenium). Antioxidants are manufactured in the body and can also be applied to the skin or extracted from ingested food. In other words, it creates an increase in photo-protection when used in conjunction with Rx Systems PF’s Facial Moisturizer SPF 35 with transparent zinc oxide.

**ADDITIONAL STEPS**

Patients must be counseled that there are other things that can be done in addition to wearing an effective sunscreen to protect against UVA/UVB rays. Particularly if they are reluctant to wear sunscreens or are simply non-compliant, patients should be encouraged to wear protective clothing, find shade, avoid tanning beds, and get Vitamin D safely. These are all effective tools with which dermatologists are familiar but bar repeating to patients. The sunscreen benefit of clothing is related to the thickness, type of fiber, weave, stretch, color and other factors. In fact, nylon stockings have a SPF of only 2-3. Patients often inquire about window glass and sunglasses. UVB rays are blocked by glass, but UVA rays (the longer wavelength UV rays) pass through window glass and sunglasses and can damage the skin and eyes.

<table>
<thead>
<tr>
<th>TABLE 2. SPF VALUES AND UVB BLOCKING</th>
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<tr>
<td>SPF rating (measures UVB)</td>
</tr>
<tr>
<td>2</td>
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<td>10</td>
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Photochemical reactions occur in the skin when UV rays are absorbed by the:
1. DNA of the cell acts as a chromophore to absorb UV rays.
2. Oxidation reactions can damage nucleic acids, proteins and lipids. Oxidative damage is cumulative. UVB (280-320nm) damage causes cyclopentamidine dimers, especially thymine dimers (body has nucleotide excision repair of damage if not too excessive).
3. Cells attempt to repair oxidative damage with enzymes including catalase, glutathione reductase, and glutathione peroxidase, which collectively destroy hydrogen peroxide and lipid hydro peroxides. In addition, superoxide dismutase destroys superoxide.

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Well-formulated, Safe Sunscreens Are Worthwhile

All the news is not bad. There have been advances. Inorganic sunscreens, micronized zinc oxide and titanium dioxide provide broad spectrum protection with no concerns about toxicity. Organic sunscreens, despite some troubling and frequently over-emphasized theoretical concerns, have not been shown to induce cancers or harm patients when used as directed. The incorporation of antioxidants into sunscreens provides added protection against the harmful effects of UV exposure and may provide reparative effects if/when sunscreens fail. Emphasis on inorganic sunscreens and synergistic antioxidants may avoid concerns associated with organic sunscreens and may be particularly useful for the patient with concerns about specific sunscreen ingredients. As a sunscreen formulator, I have reviewed the evidence and determined that an optimal sunscreen formulation must contain a combination of broad-spectrum sunscreen ingredients, antioxidants, and skin conditioning agents to enhance the SPF of the final product, especially with everyday use.

6. Schacht C, Knamer H, Jary H, Wuttke W. Effects of estradiol, benzophenone-2 and benzophenone-3 on the expression pattern of the estrogen receptor (ER) alpha and beta, the estrogen receptor-related receptor 1 (ERR1) and the aryl hydrocarbon receptor (AhR) in adult ovariectomized rats. Toxicology. 2004 Dec 1;205(1-2):123-30.