

Tinted Sunscreens: Consumer Preferences Based on Light, Medium, and Dark Skin Tones

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PRACTICE POINTS

- Visible light has been shown to increase tyrosinase activity and induce immediate erythema in light-skinned individuals and long-lasting pigmentation in dark-skinned individuals.
- The formulation of sunscreens with iron oxides and pigmentary titanium dioxide are a safe and effective way to protect against high-energy visible light, especially when combined with zinc oxide.
- Physicians should be aware of sunscreen characteristics that patients like and dislike to tailor recommendations that are appropriate for each individual to enhance adherence.
- Cosmetic elegance and tone compatibility are the most important criteria for individuals seeking tinted sunscreens.

Visible light (VL) has been shown to increase tyrosinase activity and induce immediate erythema in light-skinned individuals and long-lasting pigmentation in dark-skinned individuals. Tinted sunscreens (TSs) formulated with iron oxides (IOs) and/or pigmentary titanium dioxide (PTD) provide functional and cosmetic benefits and are a safe, effective, and convenient way to protect against both UV and high-energy VL. We conducted an analysis of over-the-counter TSs with the objective of investigating the factors that influence consumer preference when choosing TS depending on underlying skin tone. Descriptive data for each product were collected from an online supplier that provides reviewer information. The top 10 most helpful reviews were analyzed and coded by a consensus qualitative coding scheme, which included positive and negative descriptors in 5 major categories. Most products provided only one color shade, and tone incompatibility was the most commonly cited negative feature, with the vast majority of these comments being from consumers of dark skin tones. Top recommended products

corresponded with increased shade options, indicating the dearth of shade diversity in products to be a potential area of improvement in tinted sunscreen options.

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Sunscreen formulations typically protect from UV radiation (290–400 nm), as this is a well-established cause of photodamage, photoaging, and skin cancer.¹ However, sunlight also consists of visible (400–700 nm) and infrared (>700 nm) radiation.² In fact, UV radiation only comprises 5% to 7% of the solar radiation that reaches the surface of the earth, while visible and infrared lights comprise 44% and 53%, respectively.³ Visible light (VL) is the only portion of the solar spectrum visible to the human eye; it penetrates the skin to a depth range of 90 to 750 μm compared to 1.5 to 90 μm for UV radiation.⁴ Visible light also may come from artificial sources such as light bulbs and digital screens. The rapidly increasing use of smartphones, tablets, laptops, and other digital screens that emit high levels of short-wavelength VL has increased concerns about the safety of these devices. Although blue light exposure from screens is small compared with the amount of exposure from the sun, there is concern about the long-term effects of excessive screen time. Recent studies have demonstrated that exposure to light emitted from electronic devices, even for as little as 1 hour, may cause reactive oxygen species generation, apoptosis, collagen degradation, and necrosis of skin cells.⁵ Visible light increases tyrosinase activity and induces immediate erythema in light-skinned individuals and long-lasting pigmentation in dark-skinned individuals.^{4,6}

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Sunscreens consist of chemical and mineral active ingredients that contain UV filters designed to absorb, scatter, and reflect UV photons with wavelengths up to 380 nm. Historically, traditional options do not protect against the effects induced by VL, as these sunscreens use nanosized particles that help to reduce the white appearance and result in transparency of the product.⁷ To block VL, the topical agent must be visible. Tinted sunscreens (TSs) are products that combine UV and VL filters. They give a colored base coverage that is achieved by incorporating a blend of black, red, and yellow iron oxides (IOs) and/or pigmentary titanium dioxide (PTD)(ie, titanium dioxide [TD] that is not nanosized). Because TSs offer an instant glow and protect the skin from both sun and artificial light, they have become increasingly popular and have been incorporated into makeup and skin care products to facilitate daily convenient use.

The purpose of this analysis was to study current available options and product factors that may influence consumer preference when choosing a TS based on the reviewer characteristics.

Methods

The keyword *sunscreen* was searched in the broader category of *skin care* products on an online supplier of sunscreens (www.sephora.com). This supplier was chosen because, unlike other sources, specific reviewer characteristics regarding underlying skin tone also were available. The search produced 161 results. For the purpose of this analysis, only facial TSs containing IO and/or PTD were included. Each sunscreen was checked by the authors, and 58 sunscreens that met the inclusion criteria were identified and further reviewed. Descriptive data, including formulation, sun protection factor (SPF), ingredient type (chemical or physical), pigments used, shades available, additional benefits, price range, rating, and user reviews, were gathered. The authors extracted these data from the product information on the website, manufacturer claims, ratings, and reviewer comments on each of the listed sunscreens.

For each product, the content of the top 10 most helpful positive and negative reviews as voted by consumers (1160 total reviews, consisting of 1 or more comments) was analyzed. Two authors (H.D.L.G. and P.V.) coded consumer-reported comments for positive and negative descriptors into the categories of cosmetic elegance, performance, skin compatibility and tolerance, tone compatibility, and affordability. Cosmetic elegance was defined as any feature associated with skin sensation (eg, greasy), color (eg, white cast), scent, ability to blend, and overall appearance of the product on the skin. Product performance included SPF, effectiveness in preventing sunburn, coverage, and finish claims (ie, matte, glow, invisible). Skin compatibility and tolerance were represented in the reviewers' comments and reflected how the product performed in association with underlying dermatologic conditions, skin type, and if there were any side effects such as irritation or allergic

reactions. Tone compatibility referred to TS color similarity with users' skin and shades available for individual products. Affordability reflected consumers' perceptions of the product price. Comments may be included in multiple categories (eg, a product was noted to blend well on the skin but did not provide enough coverage). Of entries, 10% (116/1160 reviews) were coded by first author (H.D.L.G.) to ensure internal validity. Reviewer characteristics were consistently available and were used to determine the top 5 recommended products for light-, medium-, and dark-skinned individuals based on the number of 5-star ratings in each group. Porcelain, fair, and light were considered light skin tones. Medium, tan, and olive were considered medium skin tones. Deep, dark, and ebony were considered dark skin tones.

Results

Sunscreen Characteristics—Among the 161 screened products, 58 met the inclusion criteria. Four types of formulations were included: lotion, cream, liquid, and powder. Twenty-nine (50%) were creams, followed by lotions (19%), liquids (28%), and powders (3%). More than 79% (46/58) of products had a reported SPF of 30 or higher. Sunscreens with an active physical ingredient—the minerals TD and/or zinc oxide (ZO)—were most common (33/58 [57%]), followed by the chemical sunscreens avobenzone, octinoxate, oxybenzone, homosalate, octisalate, and/or octocrylene active ingredients (14/58 [24%]), and a combination of chemical and physical sunscreens (11/58 [19%]). Nearly all products (55/58 [95%]) contained pigmentary IO (red, CI 77491; yellow, CI 77492; black, CI 77499). Notably, only 38% (22/58) of products had more than 1 shade. All products had additional claims associated with being hydrating, having antiaging effects, smoothing texture, minimizing the appearance of pores, softening lines, and/or promoting even skin tone. Traditional physical sunscreens (those containing TD and/or ZO) were more expensive than chemical sunscreens, with a median price of \$30. The median review rating was 4.5 of 5 stars, with a median of 2300 customer reviews per product. Findings are summarized in Table 1.

Positive Features of Sunscreens—Based on an analysis of total reviews (N=1160), cosmetic elegance was the most cited positive feature associated with TS products (31%), followed by product performance (10%). Skin compatibility and tolerance (7%), tone compatibility (7%), and affordability (7%) were cited less commonly as positive features. When negative features were cited, consumers mostly noted tone incompatibility (16%) and cosmetic elegance concerns (14%). Product performance (13%) was comparatively cited as a negative feature (Table 1). Exemplary positive comments categorized in cosmetic elegance included the subthemes of rubs in well and natural glow. Exemplary negative comments in cosmetic elegance and tone compatibility categories included the subthemes patchy/dry finish and color mismatch. Table 1 illustrates these findings.

TABLE 1. Tinted Sunscreen Characteristics and Descriptors of the Top 10 Most Helpful Positive and Negative Comments as Voted by Consumers

Sunscreen characteristics	No. (%)	Sunscreen characteristics	No. (%)
Formulation (N=58)		Price, US \$	
Lotion	11 (19)	<20	2 (3)
Cream	29 (50)	21–40	30 (52)
Liquid	16 (28)	41–60	13 (22)
Powder	2 (3)	61–80	7 (12)
SPF (N=58)		>100	6 (10)
<30	12 (21)	Rating^b (N=58)	
30	21 (36)	5	1 (1)
>30	25 (43)	4	35 (60)
Active ingredient type^a (N=58)		3	21 (36)
Chemical	14 (24)	2	1 (1)
Physical	33 (57)	1	0 (0)
Mixed	11 (19)	Cosmetic elegance (n=522)^c	
Pigments used (N=58)		Positive comments	356 (69)
Iron oxides (CI 77491, CI 77492, CI 77499)	29 (50)	Negative comments	166 (31)
Pigmentary titanium dioxide (CI 77891)	3 (5)	Performance (n=260)^c	
Mixed	26 (45)	Positive comments	112 (43)
Different shades available (N=58)		Negative comments	148 (57)
Yes	22 (38)	Skin compatibility and tolerance (n=148)^c	
No	36 (62)	Positive comments	80 (54)
Additional benefits (N=58)		Negative comments	68 (46)
Yes	58 (100)	Tone compatibility (n=265)^c	
No	0 (0)	Positive comments	76 (29)
		Negative comments	189 (71)
		Affordability (n=117)^c	
		Positive comments	52 (44)
		Negative comments	65 (56)

Abbreviation: SPF, sun protection factor.

^aMain active ingredients in chemical sunscreens included avobenzone, octinoxate, oxybenzone, homosalate, octisalate, and octocrylene. Main active ingredients in physical sunscreens included the minerals titanium dioxide and zinc oxide.

^bConsumers rated products from 1 to 5 on an online sunscreen supplier's website (www.sephora.com), which automatically produces a mean rating for each product.

^cTotal number of comments within designated category.

Product Recommendations—The top 5 recommendations of the best TS for each skin tone are listed in Table 2. The mean price of the recommended products was \$42 for 1 to 1.9 oz. Laura Mercier Tinted Moisturizer Oil Free Natural Skin Perfector broad spectrum SPF 20 (Laura Mercier) was the top product for all 3 groups. Similarly, of 58 products available, the same 5 products—Laura Mercier Tinted Moisturizer Oil Free Natural Skin Perfector broad spectrum SPF 20, IT Cosmetics CC+ Cream with SPF 50 (IT Cosmetics, LLC), Tarte Amazonian Clay BB Tinted Moisturizer Broad Spectrum SPF 20 (Tarte Cosmetics), NARS Pure Radiant Tinted Moisturizer Broad Spectrum SPF 30 (NARS Cosmetics), and Laura Mercier Tinted Moisturizer Natural Skin Perfector broad spectrum SPF 30—were considered the best among consumers of all skin tones, with the addition of 2 different products (bareMinerals Original Liquid Mineral Foundation Broad Spectrum SPF 20 [bareMinerals] and ILIA Super Serum Skin Tint SPF 40 Foundation [ILIA Beauty]) in the dark skin group. Notably, these products were the only ones on Sephora’s website that offered up to 30 (22 on average) different shades.

Comment

Tone Compatibility—Tinted sunscreens were created to extend the range of photoprotection into the VL spectrum. The goal of TSs is to incorporate pigments that blend in with the natural skin tone, produce a glow, and have an aesthetically pleasing appearance. To accommodate a variety of skin colors, different shades can be obtained by mixing different amounts of yellow, red, and black IO with or without PTD. The pigments and reflective compounds provide color, opacity, and a natural coverage. Our qualitative analysis provides

information on the lack of diversity among shades available for TS, especially for darker skin tones. Of the 58 products evaluated, 62% (32/58) only had 1 shade. In our cohort, tone compatibility was the most commonly cited negative feature. Of note, 89% of these comments were from consumers with dark skin tones, and there was a disproportional number of reviews by darker-skinned individuals compared to users with light and medium skin tones. This is of particular importance, as TSs have been shown to protect against dermatoses that disproportionately affect individuals with skin of color. When comparing sunscreen formulations containing IO with regular mineral sunscreens, Dumbuya et al³ found that IO-containing formulations significantly protected against VL-induced pigmentation compared with untreated skin or mineral sunscreen with SPF 50 or higher in individuals with Fitzpatrick skin type IV ($P < .001$). Similarly, Bernstein et al⁸ found that exposing patients with Fitzpatrick skin types III and IV to blue-violet light resulted in marked hyperpigmentation that lasted up to 3 months. Visible light elicits immediate and persistent pigment darkening in individuals with Fitzpatrick skin phototype III and above via the photo-oxidation of pre-existing melanin and de novo melanogenesis.⁹ Tinted sunscreens formulated with IO have been shown to aid in the treatment of melasma and prevent hyperpigmentation in individuals with Fitzpatrick skin types IV to VI.¹⁰ Patients with darker skin tones with dermatoses aggravated or induced by VL, such as melasma and postinflammatory hyperpigmentation, may seek photoprotection provided by TS but find the lack of matching shades unappealing. The dearth of shade diversity that matches all skin tones can lead to inequities and disproportionately affect those with darker skin.

TABLE 2. Top 5 Products as Rated by Reviewers With Light, Medium, and Dark Skin Tones

Rank	Light skin tone	Medium skin tone	Dark skin tone
1	Laura Mercier Tinted Moisturizer Oil Free Natural Skin Perfector broad spectrum SPF 20 (Laura Mercier)	Laura Mercier Tinted Moisturizer Oil Free Natural Skin Perfector broad spectrum SPF 20	Laura Mercier Tinted Moisturizer Oil Free Natural Skin Perfector broad spectrum SPF 20
2	IT Cosmetics CC+ Cream with SPF 50+ (IT Cosmetics, LLC)	Laura Mercier Tinted Moisturizer Natural Skin Perfector broad spectrum SPF 30	NARS Pure Radiant Tinted Moisturizer Broad Spectrum SPF 30 (NARS Cosmetics)
3	Tarte Amazonian Clay BB Tinted Moisturizer Broad Spectrum SPF 20 Sunscreen (Tarte Inc)	IT Cosmetics CC+ Cream with SPF 50+	Laura Mercier Tinted Moisturizer Natural Skin Perfector broad spectrum SPF 30
4	NARS Pure Radiant Tinted Moisturizer Broad Spectrum SPF 30	NARS Pure Radiant Tinted Moisturizer Broad Spectrum SPF 30	bareMinerals Original Liquid Mineral Foundation Broad Spectrum SPF 20 (bareMinerals)
5	Laura Mercier Tinted Moisturizer Natural Skin Perfector broad spectrum SPF 30	Tarte Amazonian Clay BB Tinted Moisturizer Broad Spectrum SPF 20 Sunscreen	ILIA Super Serum Skin Tint SPF 40 Foundation (ILIA Beauty)

Abbreviation: SPF, sun protection factor.

Performance—Tinted sunscreen formulations containing IO have been proven effective in protecting against high-energy VL, especially when combined synergistically with ZO.¹¹ Kaye et al¹² found that TSs containing IO and the inorganic filters TD or ZO reduced transmittance of VL more effectively than nontinted sunscreens containing TD or ZO alone or products containing organic filters. The decreased VL transmittance in the former is due to synergistic effects of the VL-scattering properties of the TD and the VL absorption properties of the IO. Similarly, Sayre et al¹³ demonstrated that IO was superior to TD and ZO in attenuating the transmission of VL. Bernstein et al¹⁴ found that darker shades containing higher percentages of IO increased the attenuation of VL to 98% compared with lighter shades attenuating 93%. This correlates with the results of prior studies highlighting the potential of TSs in protecting individuals with skin of color.³ In our cohort, comments regarding product performance and protection were mostly positive, claiming that consistent use reduced hyperpigmentation on the skin surface, giving the appearance of a more even skin tone.

Tolerability—Iron oxides are minerals known to be safe, gentle, and nontoxic on the surface of the skin.¹⁵ Two case reports of contact dermatitis due to IO have been reported.^{16,17} Within our cohort, only a few of the comments (6%) described negative product tolerance or compatibility with their skin type. However, it is more likely that these incompatibilities were due to other ingredients in the product or the individuals' underlying dermatologic conditions.

Cosmetic Elegance—Most of the sunscreens available on the market today contain micronized forms of TD and ZO particles because they have better cosmetic acceptability.¹⁸ However, their reduced size compromises the protection provided against VL whereby the addition of IO is of vital importance. According to the RealSelf Sun Safety Report, only 11% of Americans wear sunscreen daily, and 46% never wear sunscreen.¹⁹ The most common reasons consumers reported for not wearing sunscreen included not liking how it looks on the skin, forgetting to apply it, and/or believing that application is inconvenient and time-consuming. Currently, TSs have been incorporated into daily-life products such as makeup, moisturizers, and serums, making application for users easy and convenient, decreasing the necessity of using multiple products, and offering the opportunity to choose from different presentations to make decisions for convenience and/or diverse occasions. Products containing IO blend in with the natural skin tone and have an aesthetically pleasing cosmetic appearance. In our cohort, comments regarding cosmetic elegance were highly valued and were present in multiple reviews (45%), with 69% being positive.

Affordability—In our cohort, product price was not predominantly mentioned in consumers' reviews. However, negative comments regarding affordability were slightly higher than the positive (56% vs 44%). Notably, the mean

price of our top recommendations was \$42. Higher price was associated with products with a wider range of shades available. Prior studies have found similar results demonstrating that websites with recommendations on sunscreens for patients with skin of color compared with sunscreens for white or fair skin were more likely to recommend more expensive products (median, \$14/oz vs \$11.3/oz) despite the lower SPF level.²⁰ According to Schneider,²¹ daily use of the cheapest sunscreen on the head/neck region recommended for white/pale skin (\$2/oz) would lead to an annual cost of \$61 compared to \$182 for darker skin (\$6/oz). This showcases the considerable variation in sunscreen prices for both populations that could potentiate disparities and vulnerability in the latter group.

Conclusion

Tinted sunscreens provide both functional and cosmetic benefits and are a safe, effective, and convenient way to protect against high-energy VL. This study suggests that patients with skin of color encounter difficulties in finding matching shades in TS products. These difficulties may stem from the lack of knowledge regarding dark complexions and undertones and the lack of representation of black and brown skin that has persisted in dermatology research journals and textbooks for decades.²² Our study provides important insights to help dermatologists improve their familiarity with the brands and characteristics of TSs geared to patients with all skin tones, including skin of color. Limitations include single-retailer information and inclusion of both highly and poorly rated comments with subjective data, limiting generalizability. The limited selection of shades for darker skin poses a roadblock to proper treatment and prevention. These data represent an area for improvement within the beauty industry and the dermatologic field to deliver culturally sensitive care by being knowledgeable about darker skin tones and TS formulations tailored to people with skin of color.

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