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 ORIGINAL ARTICLE

Iron Oxides in Tinted Sunscreen for Hyperpigmentation: A Product Analysis and Literature Review

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ABSTRACT

Background: Hyperpigmentation disproportionately affects skin of color, often exacerbated by visible light (VL) exposure. Photoprotection in these populations remains underused due to the cosmetic incompatibility of sunscreens and the lack of targeted education. Iron oxides have emerged as essential VL blockers in tinted sunscreens for hyperpigmentation management.

Objectives: To evaluate the role of iron oxide in tinted sunscreens for hyperpigmentation and assess commercial sunscreen product labeling regarding iron oxide content.

Methods: A literature review was conducted using PubMed and Google Scholar to assess clinical studies on iron oxide for hyperpigmentation. A product analysis of 37 tinted sunscreens was also performed, including ingredient review and direct manufacturer contact regarding iron oxide content.

Results: Literature supports that iron oxide-containing sunscreens improve VL-induced pigmentation outcomes. Most products (97.3%) did not list iron oxide as an active ingredient, and only 9.6% of responding brands disclosed iron oxide percentages when contacted, with disclosed concentrations ranging from <1.4% to 10.4%. Although 6 brands (19.3%) claimed their product protects against VL, only one brand publicly detailed any specific corresponding testing performed.

Conclusion: Iron oxides enhance VL protection in sunscreens for skin prone to hyperpigmentation. Standardized reporting of iron oxide content and/or measurement of VL protection is essential to guide evidence-based photoprotection.

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INTRODUCTION

Hyperpigmentation and pigmentary disorders are prevalent dermatological concerns that can significantly impact quality of life, particularly in skin of color, as variations in pigmentation are often more noticeable.[1-3] Treatment options typically fall into several categories, including photoprotection, topical and systemic therapies, chemical peels, and laser or light-based procedures. Many of these are not covered by insurance, leading patients to spend significant financial resources and time to treat their hyperpigmentation. Although numerous treatments are available for hyperpigmentation, managing this condition remains a challenge for dermatologists due to variable outcomes, and single-therapy treatment is not reliably effective.[2-4]

Sun exposure significantly contributes to hyperpigmentation, with contributions from both ultraviolet (UV) and visible light (VL) – especially high-energy visible light (HEV) in the blue range of approximately 400 nm to 490 nm, making photoprotection essential for treatment. However, healthcare providers overall recommend sunscreens more frequently to white patients than to those with richly pigmented skin.[4] Lower sunscreen usage among skin of color, particularly vulnerable to pigmentary disorders, suggests the need for focused education and counseling.[3,4] Furthermore, a majority of sunscreen formulations are cosmetically incompatible with darker skin types, leaving a white cast or ashy discoloration, which lowers patients' desire to use these products, and thus decreases photoprotection.[5] Addressing this issue necessitates not only comprehensive education but also ensuring access to resources and photoprotection products designed to meet the specific needs of patients of color.

Recent studies highlight that iron oxide in tinted sunscreens provides substantial protection against persistent and worsening VL-induced hyperpigmentation in patients of color.[6] However, most tinted sunscreen products do not specify the

percentage of iron oxide or list it as an active ingredient. Iron oxides are pigments and are classified into 3 types: red iron oxide (Fe_2O_3), yellow iron oxide ($Fe(OH)_3$/FeOOH), and black iron oxide (Fe_3O_4). Each type has different peak wavelengths and varying abilities to attenuate visible light.[7-9] The type(s) and proportion of iron oxides are generally not reported, as this is often considered proprietary information. There is no standardized equivalent to SPF for VL attenuation. Few companies or studies report metrics such as the percentage of VL blocked. Tinted sunscreens, especially zinc-based with iron oxides, can have HEV protection; zinc alone provides some attenuation in the 400-450 nm range of HEV and works synergistically with iron oxide.[7] Gaining a deeper understanding of iron oxides and VL protection can empower dermatologists to recommend more effective products for skin of color and manage this dermatological concern.

This literature review aims to examine the role of iron oxide in mitigating hyperpigmentation. Tinted sunscreens identified as compatible with skin of color were also analyzed to determine whether iron oxides were reported among their listed ingredients. This study seeks to highlight the importance of iron oxide in tinted sunscreens and advocates for the consideration of standardization of reporting or measurement of VL protection to promote informed consumer choices and outcomes.

MATERIALS AND METHODS

Literature Review

A comprehensive search of Google Scholar and PubMed related to iron oxides and hyperpigmentation was performed. Search terms and keywords included: "iron oxides", "ferrous oxide", "ferric oxide", "sunscreen," "hyperpigmentation," "tinted sunscreen, "mineral sunscreen," "visible light," "ultraviolet," "melasma," and "skin of color." Publications were considered eligible if they were published in English and included original clinical research, clinical trials, systematic reviews, meta-analyses, or expert consensus guidelines. Studies were included based on their relevance to the clinical utility and efficacy of iron oxides in sunscreens for the management of hyperpigmentation.

Product Analysis

Tinted sunscreen product analysis was performed as an epidemiologic assessment of commercially available products. A list was compiled from a Google search with terms including "tinted SPF," "tinted sunscreen," "sunscreen for skin of color," "sunscreen for darker skin tones," "sunscreens for hyperpigmentation," and "sunscreens that don't leave a cast." These included products recommended by prominent beauty/health sources including *Cosmopolitan, Oprah Daily, InStyle, Women's Health Mag, Vogue*, CNN, and dermatologist-recommended products from blog posts and social media from August 2024 to June 2025, and a 2020 article from the *International Journal of Women's Dermatology*.[10] Non-tinted sunscreens were excluded from review, and only products marketed or labeled as "tinted" were included. Consumer reviews of the tinted sunscreens identified from the above sources were searched for comments on skin of color, no white cast, or other favorable characteristics prior to selection. Ingredient lists were analyzed to determine if iron oxides or information about visible light protection testing were reported. In addition, companies were contacted through email or online submission form listed on their websites, or through local representatives, to inquire about the percentage of iron oxides. Descriptive statistics were performed in Excel.

RESULTS

Literature Review

While UV filters such as zinc oxide and titanium dioxide effectively protect against UVA and UVB radiation, their ability to shield the skin from VL remains limited. In contrast, iron oxide pigments provide an additional layer of protection against VL, which has been especially implicated in the exacerbation of hyperpigmentation disorders.[2,3]

Iron oxide pigments have emerged as a valuable addition to sunscreen formulations due to their unique ability to attenuate VL. A comparative study evaluated 2 sunscreen formulations containing 4.87% and 27.25% iron oxide against a mineral SPF 50+ sunscreen composed solely of zinc oxide and titanium dioxide in individuals with Fitzpatrick skin phototypes greater than type III.[3] The results indicated that the iron oxide-containing formulations were significantly more effective in improving pigmentation, underscoring the clinical benefit of incorporating VL blockers in sunscreens for patients with hyperpigmentation. Further supporting the photoprotective role of iron oxides, another study in 2021 examined formulations containing red, yellow, and black iron oxides along with patented skincare ingredients.[7] Using diffuse transmittance spectroscopy, these formulations demonstrated 71.9% to 85.6% attenuation or blockage of HEV in the 415 nm to 465 nm range (blue light).[7] The findings suggest that iron oxides, particularly when combined with zinc oxide, enhance blue light protection and may offer a promising defense against HEV exposure.

The clinical relevance of this enhanced protection is further illustrated in a study conducted in 2014, which assessed the efficacy of HEV protective sunscreen in the treatment of melasma. In this 8-week trial, 61 participants undergoing treatment with hydroquinone were randomized to receive either a UV-only sunscreen or a UV + HEV sunscreen containing iron oxides.[11,12] The UV + HEV group exhibited a significantly greater reduction in Melasma Area and Severity Index (MASI) scores (75% vs. 60%; $P<0.001$), along with improvements in skin lightness and melanin content.[11,12] These findings reinforce the therapeutic value of iron oxide-containing sunscreens in managing pigmentary disorders.

Recent studies have focused on improving our understanding of how efficacy varies across different formulations. A 2023 study evaluated the protective effects of 4 different sunscreen formulations against skin changes induced by VL and UVA1 in 12 participants with Fitzpatrick skin types III to IV.[13] The sunscreens were applied to specific areas on the participants' backs, which were then exposed to VL + UVA1. Erythema and pigmentation were subsequently measured using investigator global assessment, colorimetry, and diffuse reflectance spectroscopy. Formulations containing 1% and 4% iron oxides demonstrated significantly better protection than those lacking iron oxides.[13] Notably, the formulation containing 1% iron oxides, along with titanium dioxide and antioxidants, provided the most consistent and effective defense against both erythema and pigmentation, outperforming even the product with a higher concentration of iron oxides.[13] These findings suggest that photoprotective efficacy may depend not only on the concentration of iron oxides, but also on the proportions of different iron oxides, as well as combined effects of additional active ingredients. Further studies are needed to clarify the relationship between iron oxide concentration, proportions, and clinical protection.

A study conducted in 2024 investigated the current counseling practices of dermatology practitioners (board-certified dermatologists, residents, fellows, nurse practitioners, and physician assistants) regarding VL protection to their patients.[14] Of the 974 respondents, the majority (91.68%) reported actively counseling patients on VL protection, especially for hyperpigmentation (70.92%). However, only 10.34% of those who provided such counseling specifically recommended sunscreens with ingredients addressing VL protection – such as iron oxides and antioxidants – for melanin-rich skin; while almost half (48.89%) recommended such sunscreens for management of melasma or post-inflammatory hyperpigmentation. Of the 8.32% who reported not counseling their patients on VL protection, the primary reasons were an absence of standardized guidelines (50.62%), difficulties in recommending appropriately tinted sunscreens (27.16%), and limited availability of sunscreen options (23.46%).[14] This study further emphasizes the clinical importance of iron oxide visibility and standardized reporting of VL protection for tinted sunscreens to guide clinical practices.

Most recently, a 2025 study was conducted to evaluate the benefits of incorporating iron oxides into sunscreen formulations for patients with photodamage and melasma.[15] This 12-week study compared the effects of SPF 50 sunscreen alone vs SPF 50 with iron oxides in healthy women with Fitzpatrick skin types III to VI.[15] Colorimetric measurements were performed, and clinical evaluations revealed that both sunscreen formulations improved overall skin quality. However, the addition of iron oxides led to early improvement over baseline in skin texture and appearance in both photodamage and melasma subgroups.[15] The benefits were most pronounced in the melasma subgroup, where 36% of participants using SPF 50 with iron oxides showed superior improvement in skin radiance compared with 0% in the SPF 50 only group.[15] These clinical findings highlight the importance of VL protection and support the integration of iron oxide formulations into daily photoprotection routines to address indoor and outdoor light exposure.

Product Analysis

Thirty-seven tinted sunscreens were identified from a total of 31 brands, some brands having multiple products. 100% of brands did not report the percentage of iron oxides publicly, and 97.3% did not report iron oxide as an active ingredient on publicly available product information online. Six brands (19.3%) included a claim that the product prevents against VL, blue light, or HEV light; however, only one brand (3.2%) noted and described any specific corresponding testing performed.[16] Of the 24 brands that responded when contacted (77.4% response rate), only 3 brands (9.6%) disclosed the percentage of iron oxide, which ranged from <1.4% to 10.4%. The remaining 90.3% declined to provide this information, citing proprietary formulation details or internal policy.

DISCUSSION

Collectively, these studies highlight the growing importance of iron oxide pigments in modern sunscreen development. Their inclusion not only enhances protection against VL but also offers therapeutic and preventive benefits for individuals prone to hyperpigmentation. However, further research is warranted to elucidate the optimal concentration and formulation strategies that maximize clinical efficacy across diverse skin types and pigmentary conditions. One limitation to our understanding of VL blockers in melanin-rich skin is our lack of universal terminology to describe and categorize skin pigmentation.[17-20]

While current evidence supports the role of iron oxides in reducing hyperpigmentation, sunscreen products queried do not publicly disclose the percentage of iron oxide used, limiting patients' ability to make informed decisions. Given that iron oxide contributes to protection against VL, a known trigger for hyperpigmentation, there is a strong rationale for listing it as an active ingredient in tinted sunscreens. Transparency around iron oxide concentrations would not only benefit patients and providers but could also encourage standardization across the industry.

Disclosing the percentage and/or ratios of iron oxides is unlikely to compromise proprietary formulations, as the majority of the sunscreens' composition would remain undisclosed. Although there is a lack of data identifying the exact concentration of iron oxide needed for clinical effectiveness, existing studies consistently support its benefit in pigmentary disorders. Future research should aim to determine optimal dosing thresholds, while manufacturers should be encouraged to report iron oxide content to support evidence-based skincare.

Safety and Tolerability

Topical use of iron oxides in sunscreens is generally safe and well-tolerated, with no reports of adverse events identified in the reviewed literature. Very rarely, allergic contact dermatitis to topical iron oxide used in cosmetics has been reported; only 2 reports were identified in a literature search specifically for adverse effects, and both involved a reaction to mascara.[21-22]

CONCLUSION

Given the current lack of sufficient reporting of VL attenuating ingredients, patients with hyperpigmentation should look for a sunscreen with zinc oxide and iron oxides, even if the details of iron oxides are not reported. Iron oxides are not UV filters, so they are not recognized by the FDA as a photoprotective active ingredient. However, if a product claims to protect against visible light, iron oxides should be considered as an active ingredient for this purpose – ideally with the percentage(s) listed – and visible light protection testing should be reported. We encourage the cosmeceutical industry to consider increased and eventually standardized reporting of iron oxides and tested VL protection to best help patients with hyperpigmentation choose optimal photoprotection.

DISCLOSURES

All authors have no conflicts of interest to declare.

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