Daily Use of a Facial Broad Spectrum Sunscreen Over One-Year Significantly Improves Clinical Evaluation of Photoaging

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BACKGROUND Sunscreens are known to protect from sun damage; however, their effects on the reversal of photodamage have been minimally investigated.

OBJECTIVE The aim of the prospective study was to evaluate the efficacy of a facial sun protection factor (SPF) 30 formulation for the improvement of photodamage during a 1-year use.

METHODS Thirty-two subjects applied a broad spectrum photostable sunscreen (SPF 30) for 52 weeks to the entire face. Assessments were conducted through dermatologist evaluations and subjects' self-assessment at baseline and then at Weeks 12, 24, 36, and 52.

RESULTS Clinical evaluations showed that all photoaging parameters improved significantly from baseline as early as Week 12 and the amelioration continued until Week 52. Skin texture, clarity, and mottled and discrete pigmentation were the most improved parameters by the end of the study (40% to 52% improvement from baseline), with 100% of subjects showing improvement in skin clarity and texture.

CONCLUSION The daily use of a facial broad-spectrum photostable sunscreen may visibly reverse the signs of existing photodamage, in addition to preventing additional sun damage.

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Capsule Summary

- Sunscreens are well known to protect the skin from sun damage
- A broad-spectrum photostable sunscreen (sunburn protection factor (SPF) 30) applied for 52-week improved existing facial photodamage
- This information further underlines and expands the benefits of photostable sunscreens when used daily.

Repeated unprotected exposure to ultraviolet radiation (UVR) may lead to skin photodamage and skin cancer.[1–4] Both ultraviolet A (UVA) and ultraviolet B (UVB) are involved in these events. Ultraviolet B (280–320 nm) affects mostly the epidermis and is the primary cause of erythema. UVA (320–400 nm), instead, penetrates deeper into the dermis and is the main culprit in photoaging.[4]

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Photodamage is characterized histologically by degeneration of the connective tissue and abnormalities in keratinocytes and melanocytes. Clinically, it manifests primarily with wrinkles, dyspigmentations, texture changes, and, in more severe cases, skin cancer.[5] These visible signs of photoaging are cosmetically unappealing and can be psychologically distressing. The social need and quality of life demand for youthful skin appearance is fueling a multibillion dollar antiaging industry worldwide. Topical antiaging formulations range from prescription products with active ingredients such as tretinoin[6] to many cosmetic preparations.[7,8] Formulations containing sunscreens, however, play an essential role in the prevention of photodamage[9] and UV-induced skin cancers.[3,10] Sunscreen ingredients are now incorporated in many cosmetic formulations, especially facial products, where they may be adjuncts to active ingredients. Because both UVA and UVB produce damage to the skin, the sunscreens used should be broad spectrum and photostable to avoid quick degradation.[11]

Although many studies support the use of sunscreens to protect from the acute and chronic effects of UV exposure,[3,9,11,12] very little information is found on their effects in reversing photodamage. Early studies in mice by Kligman and colleagues[13,14] suggested that previously photodamaged skin could partially repair itself when UV radiation was removed or impeded by sunscreens. Incidental evidence of the effect of sunscreens in photoaging repair is also found in the control arm of many clinical investigations.[15,16]

The aim of this study was to assess the anti-photoaging benefits of using a daily broad spectrum, photostable sunscreen with SPF of 30 over a 52-week period.

Materials and Methods

The investigation was approved by an independent institutional review board, and it was conducted in accordance with the principles of the 1975 Declaration of Helsinki; written informed consent was obtained from all study subjects before enrollment. The study was performed in the northeastern part of the United States from September 2011 to September 2012.

Thirty-three women were enrolled in this 52-week, single-arm prospective study. The subjects were between the ages of 40 and 55 with Fitzpatrick skin Type I–III and in good general health. Subjects with mild to moderate photodamage were recruited for the study to assess the effect of daily use of sunscreen on photoaging. Main inclusion parameters were based on Griffith photonumeric scale for the cutaneous photodamage: overall facial photodamage score of 4 to 8, crow's feet coarse wrinkles score of 4 to 6, and mottled pigmentation score of 3 to 5 on a 1 to 9 scale.[17] Subjects were excluded if they had used topical antiaging or antiacne products within 30 days of study entry, or topical prescription retinoids within 90 days, or systemic retinoids within 6 months. The subjects were further instructed not to use antiaging products throughout the study.

Formulations

All women applied the same formulations daily to the entire face for 52 weeks; the test formulation was applied in the morning. To standardize the study a simple moisturizer, without any antiaging actives, was given to the subjects to apply in the evening. The test formulation was a broad spectrum, photostable sunscreen with SPF 30. The composition of active ingredients in the SPF formulation was Avobenzone (3%), Homosalate (12%), Octisalate (5%), Octocrylene (1.7%), and Oxybenzone (3%). No antiaging active was present in the sunscreen formulation. The use of the study formulation was monitored, by weighing the product to insure adherence to the daily use of the formulation across the 1 year study.

Subjects were advised to avoid excessive sun exposure during the study and were provided with a recreational sunscreen for use under settings, such as swimming or playing outdoors where sun exposure was unavoidable.

Evaluations

Determination of benefits was based on clinical and self-assessment evaluations. Safety was assessed by the incidence and severity of skin irritation and any other adverse effects as determined by the investigator.

Study visits were scheduled at baseline, 12, 24, 36, and 52 weeks and included on-site dermatologist evaluation of the face for efficacy and irritation parameters, self-assessment grading, and standardized clinical photography. Dermatologist grading was conducted by a single physician (J.J.L.) using a 1 (none) to 9 (most severe) scale and evaluated the following signs of photodamage: overall photodamage, overall skin tone, crow's feet fine lines, mottled pigmentation, discrete pigmentation, evenness of skin tone, clarity, and texture.

Analysis of data at Week 52 was considered primary. Analysis of data at weeks 12, 24, and 36 was considered secondary. We used a paired *t*-test to determine whether there was a change from pretreatment to posttreatment. Changes were considered significant at the 0.05 level.

Imaging

The system we used for skin imaging consisted of a digital SLR camera (Canon Digital Rebel XTI) equipped with a Canon 35 f2.0 lens and a flash light (Bron Elektronik, Broncolor Picolite 1600 W, model 12-5003; Allschwil, Switzerland). Both the camera and the light were enhanced with linear polarizing laminated films (model NT38-493; Edmund Optics, Barrington, NJ), mounted on rotating filter wheel which are all controlled by a computer, which takes measurements within seconds of each other.

Results

A total of 33 subjects were enrolled in the prospective study; 32 subjects completed the study, and 1 subject withdrew for personal reasons.

Data analysis from dermatologist assessment showed that all photodamage parameters significantly improved from baseline ($p \leq .05$), beginning at Week 12 and continuing until the end of the study (Figures 1, 2, and 3). Furthermore, the percent and net change improvement in clinically relevant photodamage endpoints increased throughout the study (Figure 1 A, B). Skin surface and pigmentation attributes (texture, clarity, mottled, and discrete pigmentation) improved the most (40%–52% improvement from baseline at Week 52) (Figure 1 A, B) with most of the subjects showing at least a 2-grade improvement (Table 1), which is highly clinically relevant. All other photoaging signs (crow's feet fine lines, skin tone evenness, overall skin tone, and overall photodamage) improved 18%-34% ($p \leq .05$) by week 52 (Figure 1 A, B). Each parameter improved in at least 78% of subjects (texture and clarity improved in 100% of women) by the end of the study (Figure 4).

According to self-assessment results, skin dullness and crow's feet fine lines were perceived to be the most improved signs (42% and 49%, respectively, by Week 52). About half of the women noticed amelioration in skin dullness, roughness, crow's feet fine lines, redness, and tone evenness by the end of the study (Table 2). The improvement of these parameters was statistically significant ($p \leq .05$). In addition, most of the subjects felt that the test product helped the skin look firmer and improved skin tone and texture (Table 3).

The test formulation was well tolerated and no adverse events were reported by any subject during the study.

Discussion

This study supports the photoaging benefits and skin tolerability of a SPF 30 photostable, broad-spectrum sunscreen. All photoaging parameters assessed by the dermatologist were significantly improved from baseline as early as Week 12, with clinically relevant improvements in skin surface and tone parameters (texture, clarity, tone evenness, and discrete and mottled pigmentation) improving the most. Crow's feet fine lines also significantly improved, albeit less than the other parameters. Because a significant improvement in clinical parameters was measured, we wanted to see if subjects observed any improvements in their skin appearance during the study. However, the inclusion of self-evaluations was not to directly correlate with the dermatologist grading, indeed evaluations from a trained dermatologist will produce more reproducible and significant results as compared with 30 panelists who grade themselves with different perception. But it is noteworthy that subject self-assessment reports showed similar trends as

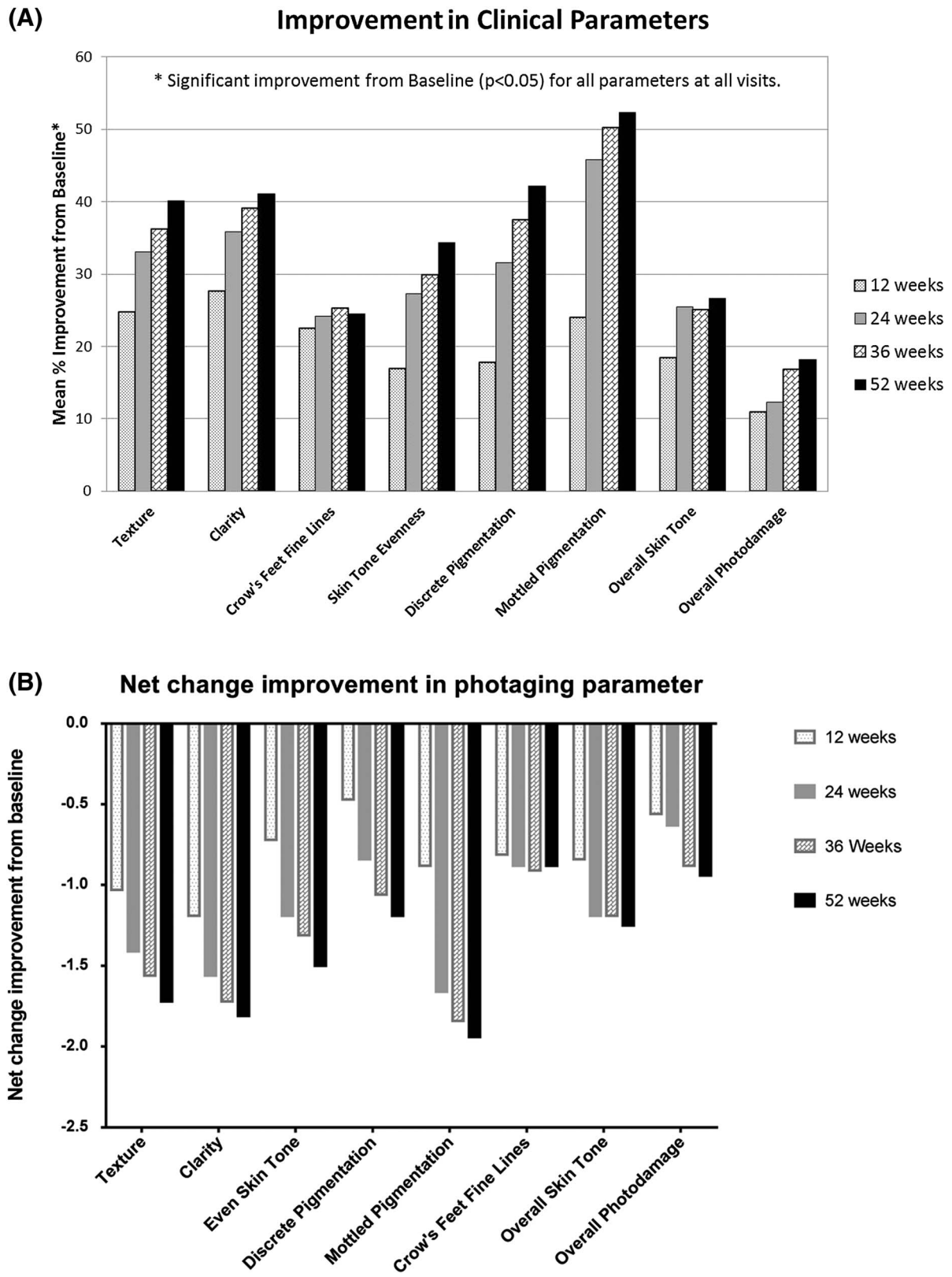

Figure 1. (A) All photoaging parameters evaluated by the dermatologist were significantly improved from baseline at all timepoints. The greatest improvement was seen in mottled pigmentation. (B) Net change in photoaging parameters from baseline evaluated by the dermatologist were significantly improved from baseline at all timepoints. The greatest improvement was seen in mottled pigmentation.

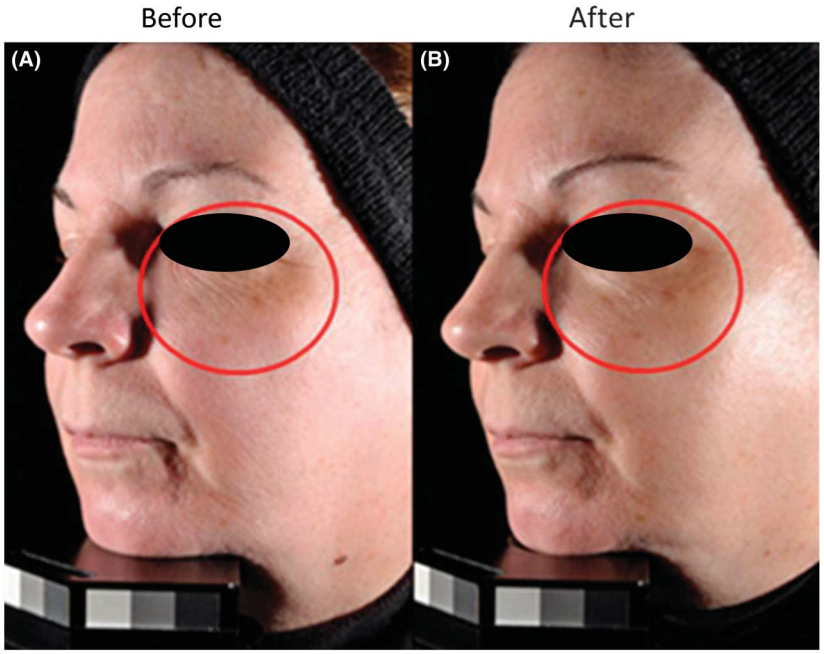

Figure 2. Parallel polarized photography, where linear polarizers are placed parallel to each other to enhance skin texture and wrinkles. (A) Before; (B) after 52 weeks of sunscreen use, the face showed significant smoothing of texture and significant decrease of crow's feet fine lines.

demonstrated by the dermatologist. Subjects noticed that the formulation was efficacious for the improvement of multiple photoaging signs, which were comparable to clinical grading endpoints; "Roughness" (texture), "Skin dullness" (clarity/skin tone), "skin discoloration" (mottled pigmentation), "Crows feet fine lines" (crows feet fine lines).

Indirect reports of photodamage improvement by sunscreens can be found in the control arm of various antiaging studies, where a sunscreen is added as a daily regimen.[15,16] In the study by Maddin and colleagues[15], 800 photodamaged patients applied either 0.1% topical isotretinoin or its vehicle to face and arms/hands for 36 weeks. In addition, all subjects used a SPF 15 sunscreen every morning. Although isotretinoin was significantly better than control in improving all photodamage parameters at all skin sites, the results showed also improvement in the control arm, especially for texture, fine wrinkles, and overall photodamage. No information is given on the significance of these changes from baseline. Another large (505 subjects) double-blind, vehicle-controlled, 24-week trial evaluated the efficacy of tazarotene 0.1% cream in photodamage.[16] In addition to their assigned treatments; all subjects applied a SPF 15 sunscreen daily. The study demonstrated a clear superiority of tazarotene over vehicle for the improvement of photodamage. However, vehicle-treated subjects also showed improvement in several photoaging parameters compared with baseline. The authors did not mention if these differences were statistically significant, but they commented that the improvements were likely due to the UV protection from the daily use of sunscreens and to the moisturizing effect of the emollient.[16]

The improvements in signs of photoaging using sunscreens were also recently suggested in a large long-term, controlled study conducted in Australia.[18] Participants were randomly assigned to 4 groups: daily versus discretionary use of sunscreen, with addition of oral beta-carotene or placebo. Photoaging changes were measured using skin surface microtopography (silicone replicas) on the back of the left hand, at the beginning, and at the end of the study (604 participants had good replica samples at both visits). The authors found that oral supplementation with beta-carotene did not change skin aging progression, whereas the daily use of a broad spectrum SPF 15 + sunscreen for 4.5 years significantly retarded the progression of skin aging compared with the control

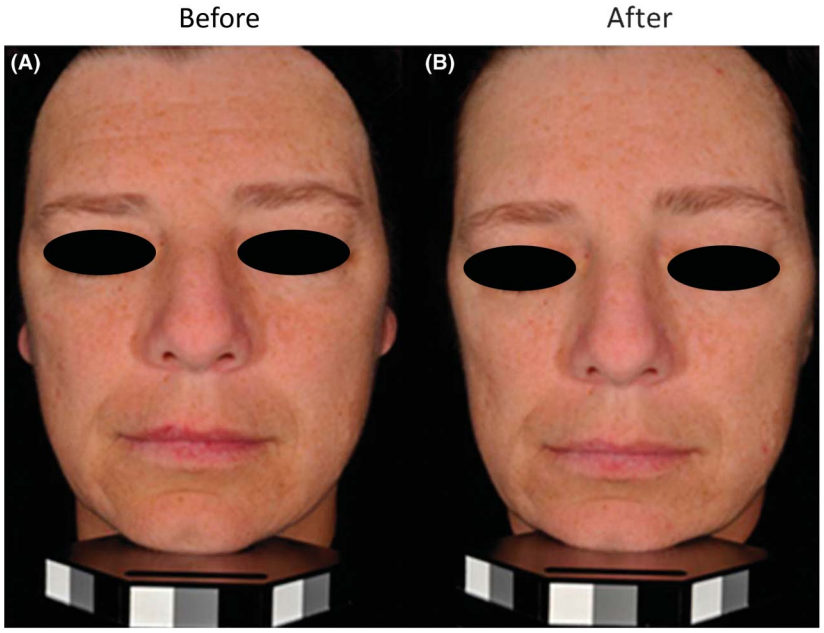

Figure 3. Cross polarized photography, where linear polarizers are placed perpendicular to each other to enhance subsurface details (pigmentation and red color details). (A) Before; (B) after 52 weeks of sunscreen use, the face showed significant decrease in overall skin tone and localized pigmentation.

group.[18] The study, however, did not mention improvement of photodamage. The methodology used in their investigation was significantly different from ours. In our study, a dermatologist conducted clinical grading for surface and pigmentation parameters, a method that can better evaluate the appearance of photodamage; in addition, we targeted the face, which is the most photoexposed body site.

The sunscreen in our formulation was broad spectrum (UVA and UVB), a recognized feature for photoprotection as demonstrated by Seité and colleagues[12] In a 6-week clinical study, the daily use of a broad-spectrum sunscreen significantly prevented the deposit of lysozyme (early indication of solar elastosis) and reduction of Type I procollagen compared with the control site receiving only solar-simulated radiation (SSR).[12]

TABLE 1. Week 52: Percentage of Subjects With Clinical Improvement From Baseline

Clinical Parameters	*+1 Grade Improvement*	*+2 Grades Improvement*
Texture	100	62.5
Clarity	100	65.6
Even skin tone	90.6	56.3
Discrete pigmentation	90.6	28.1
Mottled pigmentation	87.5	68.8
Crow's feet fine lines	78.1	9.4
Overall skin tone	87.5	37.5
Overall photodamage	84.4	9.4

Among all the parameters improved in our study, amelioration in skin texture (roughness) could be, in part, attributable to the placebo properties of the sunscreen formulation, which is often observed in the placebo or vehicle arm of many antiaging studies.[19,20] In contrast, the sunscreen likely played a more significant role in preventing additional photodamage during the yearlong study, thus allowing the skin's repair process to reverse the accumulated photodamage. As already discussed, many clinical studies have demonstrated the benefits of sunscreens in photoaging prevention; few, however, have reported their effects on the repair of chronic sun damage. We suggest that the topographical improvements, such as of crow's feet fine lines (especially deeper ones), and skin tone improvements are attributed to the sunscreen effect over the 12 months. Crow's feet, and wrinkles in general, are the clinical expression of dermal connective tissue alterations in photoaging.[21] Pioneer studies by Kligman and colleagues[14] reported the formation of

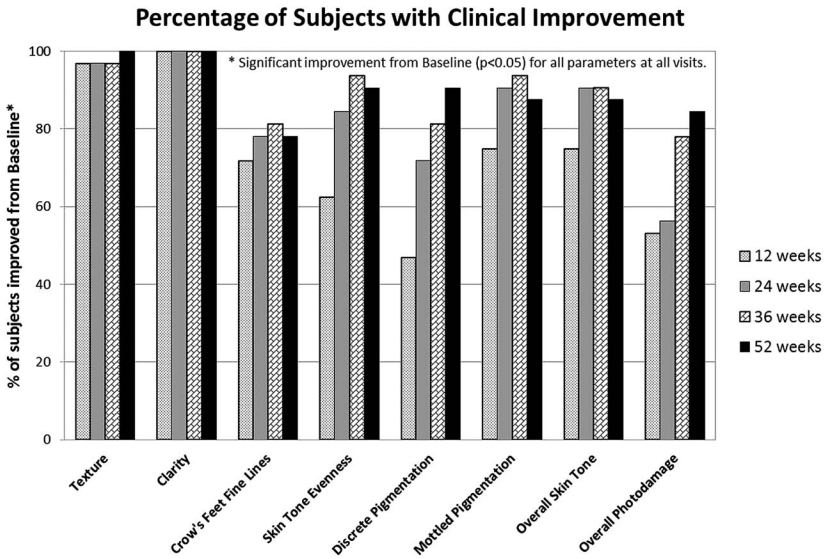

Figure 4. Almost all clinical parameters were improved in over 60% of the population as early as Week 12. By the end of the study, 100% of subjects showed texture and clarity improvement. All other parameters were improved in approximately 80% of subjects or more by Week 52.

a subepidermal repair zone with sunscreen use. They irradiated hairless albino mice with UVA and UVB for several months. After photodamage was established, some of the mice received a SPF 15 sunscreen before irradiation. Skin sites protected by the sunscreen showed reversal of some of the existing dermal damage, with deposition of new collagen in the upper dermis and repair of solar elastosis. These results were in line with previous findings from the same group.[13] In UV-irradiated hairless mice, Kligman and colleagues[13] observed prevention of dermal damage in mice protected by sunscreens; moreover, in the group of irradiated but unprotected mice, the discontinuation of UVR led to new collagen formation in the upper dermis (repair). In a subsequent human study, the use of sunscreens for 24 months significantly reduced the worsening of solar elastosis compared with vehicle.[9]

An important result in our study was the significant amelioration in tone and pigmentation parameters; this is remarkable given that the final evaluations were conducted at the end of the summer, a period when the skin tends to have uneven tone and pronounced mottled pigmentation. This improvement is most likely due to the presence of a sunscreen that is broad spectrum and photostable. Photostability is a critical feature to seek in a sunscreen, because it prevents the quick loss of efficacy with sun exposure.[11] Not all commercial sunscreens contain

TABLE 2. Week 52: Percentage of Subjects With Self-Assessed Improvement From Baseline

Self-Assessed Parameters	*% of Subjects with Improvement*
Skin dullness	56.3
Crow's feet fine lines	53.1
Skin discoloration	46.9
Age spots	43.8
Feeling of roughness	56.3
Skin redness	46.9
Overall appearance of redness	56.3
Overall tone evenness	50.0
Overall aged appearance	37.5

TABLE 3. Week 52: Global Assessment

Self-Assessed Agreement	*Agree and Completely Agree (%)*
Visibly reduces wrinkles	68.8
Improves tone and texture	75.0
Helps skin look firmer	68.8
Product was effective moisturizer	84.4
Overall satisfaction with product	75.0

photostable ingredients, therefore, these results may not be extended to other SPF 30 moisturizers. Our sunscreen was similar to the one evaluated in a recent study by Cole and colleagues.[22] Using SSR, they demonstrated that the sunscreen (SPF 55) protected against UV-induced cellular and molecular damage, such as increase in p53 and matrix metalloproteinase-9 (keratinocyte). In this study, the daily use of a photostable, UVA/UVB broad spectrum SPF 30 sunscreen for 1 year significantly improved photoaging, it can be speculated that including higher SPF (>30) product in daily regime can provide even greater protection and greater improvements in photoaging.

Overall, our results suggest that the daily use of a photostable, broad spectrum sunscreen not only prevents additional photoaging, but may improve some of the signs of accumulated photodamaged. These conclusions are in accordance with the literature.[14–16] Future investigations should compare the benefits of daily sunscreen versus discretionary use.

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