Received: 1 August 2020 | Revised: 17 October 2020 | Accepted: 30 November 2020

DOI: 10.1111/jocd.13879

ORIGINAL CONTRIBUTION

JCD Journal of Cosmetic Dermatology WILEY

Nature-based botanical facial oil oxidative stress protection

Zoe Diana Draelos MD[1] | Hemali Gunt PhD[2] | Stanley B. Levy MD[3]

[1]Dermatology Consulting Services, PLLC High Point, NC, USA

[2]Burt's Bees, Durham, NC, USA

[3]Chapel Hill Dermatology, Chapel Hill, NC, USA

Correspondence
Zoe Diana Draelos, 2444 North Main Street, High Point, NC 27262, USA.
Email: zdraelos@northstate.net

Funding information
Burt's Bees

Abstract

Introduction: UV-induced oxidative skin stress leads to cutaneous photoaging. The objective of these 2 studies was to evaluate a nature-based botanical facial oil for the ability to decrease UV-induced oxidative skin stress.

Methods: 22 females were enrolled in the UVA study, and 10 females were enrolled in the UVB study. Skin chemiluminescence induced by UVA exposure was measured at baseline and after 2 weeks of daily topical application of the nature-based facial oil was evaluated in study 1. In study 2, UVB-induced erythema was measured after 8 weeks of twice-daily topical application of the nature-based facial oil to a photoprotected site followed by skin biopsy to evaluate sunburn cell formation. In both studies, the treatment response was compared to the response on untreated skin.

Results: The nature-based facial oil significantly reduced skin chemiluminescence following UVA exposure, demonstrating antioxidant activity. The nature-based facial oil also significantly reduced erythema formation following UVB exposure and resulted in reduced sunburn cell formation in 66.67% of subjects.

Conclusion: Topical nature-based facial oil can reduce UV-induced oxidative cutaneous damage.

KEYWORDS

antioxidant, botanical, cosmeceutical, natural

1 | INTRODUCTION

Extrinsic aging is a complex process modulated through environmental exposure from solar UVA (320-400 nm) and UVB (280-320 nm) radiation.[1-5] UVA radiation penetrates skin more deeply and triggers the generation of hydroxyl and oxygen free radical intermediates, which can then react with macromolecules. The resultant damage has a major role in skin aging and wrinkling. The increase in reactive oxygen species also results in an increased chemiluminescence signal. UVB radiation does not penetrate as deeply, but is directly absorbed by DNA and protein in the skin.[6,7] Botanical antioxidants are often included in topical preparations to help diminish UV-induced damage, but their efficacy is not widely established.[8,9]

In vitro or ex vivo methods are often used to assess antioxidant activity, but these might not be representative of in-use conditions. Topical antioxidants can inhibit the transient increase in skin chemiluminescence and sunburn cell formation that occur in vivo following UVA and UVB exposure, respectively. For this reason, two separate in vivo studies were conducted to assess the nature-based facial oil's ability to mitigate the effects of UVA and UVB challenge.

2 | METHODS

2.1 | UVA Study

The study was conducted at an independent research facility following ICH GCP guidelines. 22 healthy females aged 18-60 years with Fitzpatrick skin type I or II, based on measurement of the individual typological angle (ITA) by colorimetry to determine skin

pigmentation, signed informed consent and were enrolled in the UVA study. Subjects were prohibited from applying cosmetic products to their backs, sunbathing, or swimming during their participation. After acclimation of 30 minutes, baseline readings of induced chemiluminescence of human skin (ICL-S) were taken from three designated areas on subjects' backs using a proprietary apparatus.[10,11] The ICL-S at each site was measured for 120 seconds following 120 seconds of controlled UVA irradiation (350 nm, ~1 J/cm^2).

Sites were randomized for treatment with the nature-based facial oil and an antioxidant standard, both dosed at 2 mg/cm^2. The third site remained the untreated control. The treatments were applied by site personnel on weekdays and by subjects (or a partner) on weekends. Final ITA and ICL-S measurements were made after two weeks of daily use, at least 20 hours after the last treatment application.

2.2 | UVB Study

The UVB clinical study was conducted at an independent research facility (Dermatology Consulting Services, PLLC, High Point, NC) following ICH GCP guidelines. Ten healthy nonpregnant adult females age 30-70 years with Fitzpatrick skin type I were enrolled who signed an IRB-approved informed consent (Allendale Institutional Review Board, Old Lyme, CT). Subjects agreed to avoid sun exposure and swimming. Subjects self-applied a quarter-sized amount of the nature-based facial oil (Table 1) to one randomly assigned photoprotected upper outer buttock and nothing to the contralateral photoprotected upper outer buttock twice daily for 8 weeks. 8 weeks was required to build a stratum corneum reservoir of the antioxidant formulation. They maintained a daily compliance diary, and test article containers were weighed to monitor compliance.

Subjects returned to the research center after 4 weeks for a compliance check, and after 8 weeks for irradiation of both upper outer buttocks with 2MED of solar simulated radiation (150W xenon arc bulb, Solar Light, Philadelphia). Twenty-four hours later, dermaspectrophotometer (DSP) erythema readings were made, digital images were captured, and a 3 mm punch biopsy was taken from each site. Biopsy specimens were sent to a dermatopathology laboratory for H&E staining and apoptotic (sunburn) cell counting (Garron Solomon, MD, Tripoint Diagnostics, PLLC, Morrisville, NC).

TABLE 1 Ingredient listing for nature-based facial oil

Rosa canina seed extract, *Simmondsia chinensis* (jojoba) seed oil, *Borago officinalis*, *Oenothera biennis* (evening primrose) seed extract, *Corylus avellana* (hazel) seed oil, *Triticum vulgare* (wheat) germ oil, Tocopherol, Fragrance, *Helianthus annuus* (sunflower) seed oil, Retinyl palmitate, Glycine soja (soybean) oil, Ascorbyl palmitate, β-Carotene, Canola oil, *Rosmarinus officinalis* (rosemary) leaf extract.

Ingredients are listed in order of decreasing concentration in the formula.

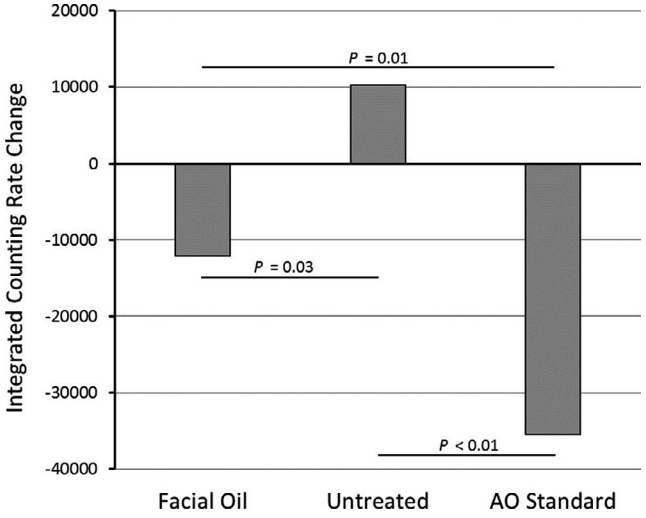

FIGURE 1 Difference in ICR Pre- and Post-UVA Exposure. Pretreatment with nature-based facial oil and antioxidant standard significantly reduced ICR compared to untreated skin

2.3 | Statistical analysis

Baseline and endpoint ITA values were compared by a paired t test to assess skin color change over the course of the UVA study. The ICL-S is maximal following UVA irradiation and exhibits a rapid decay. The integrated counting rate (ICR) between the time of the decay curve maximum (t = 0 seconds) and measurement end (t = 120 seconds) was calculated for each spectrum as previously described. ANOVA was used to assess the change from baseline ICR values between treatment groups. A paired t test was used to analyze DSP erythema values, and summary statistics were calculated for sunburn cell counts. A two-sided significance level of $\alpha = 0.05$ was used for all statistical tests.

3 | RESULTS

3.1 | Subject accountability

All enrolled subjects completed the studies without adverse events. There was a technical issue with the ICL-S measurement made on the facial oil-treated site for one subject in the UVA study, and the sunburn response for one subject in the UVB study was considered inadequate for erythema measurement. This data not included in the analysis.

3.2 | Effect of nature-based facial oil following UVA irradiation (ICL-S study)

All subjects enrolled in the study possessed minimally pigmented skin, that is, an ITA value greater than or equal to the minimum target value of 41. ITA values showed no significant change over the

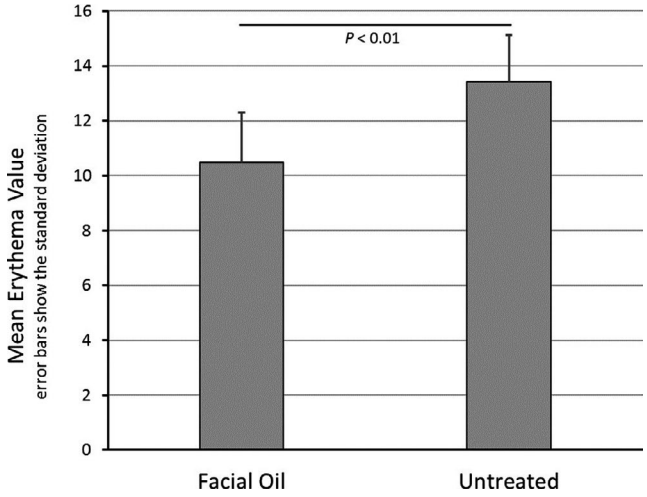

FIGURE 2 DSP Erythema Values on Treated and Untreated Buttock Skin. Pretreatment with the nature-based facial oil significantly reduced UVB-induced erythema compared to untreated skin

course of the study ($P = .90$) and therefore did not influence ICL-S measurements.

The ICR values measured on subject back treatment areas were not significantly different at baseline ($P > .57$). Measured ICR changes for the three treatments are summarized in Figure 1. Pretreating skin with the nature-based facial oil for two weeks prior to UVA challenge reduced the ICR value from baseline, indicating skin antioxidant activity. The ICR reduction for the oil was significantly greater than the change measured on untreated skin ($P = .03$). As expected, pretreatment with the antioxidant control produced the greatest reduction in ICR.

3.3 | Effect of nature-based facial oil following UVB irradiation

The DSP-assessed erythema results are summarized in Figure 2. The erythema measured on the oil-treated buttock treated was lower than on the untreated buttock in 8 of 9 subjects included in the analysis. Overall, pretreatment with the nature-based facial oil significantly ($P < .01$) reduced UVB-induced erythema compared to untreated skin. Figure 3 shows representative H&E biopsy sections with fewer sunburn cells in specimens taken from sites pretreated with the oil compared to untreated skin in 6 of 10 subjects.

4 | DISCUSSION

Exposure to UV radiation has a cumulative, damaging effect on skin leading to premature aging, which can be mitigated with antioxidants. Plants are an abundant source of metabolites protecting from ROS in the environment by neutralizing endogenous free radicals and protecting from oxidative stress.[12]

These studies examined the antioxidant activity of a nature-based facial oil based on botanical oils (Table 1). *Rosa canina* oil is very high in linoleic acid, an essential fatty acid that is necessary for skin barrier health, and antioxidants.[13-15] Borage, evening primrose, and sunflower seed oils also contain high concentrations of this omega-6 essential fatty acid.[16-18] Jojoba seed oil contains unique fatty alcohol esters that provide high oxidative stability.[19,20] Hazel seed, wheat germ, and soybean are antioxidant oils selected for their viscosity to enhance product aesthetic properties.[21-24] Tocopherol, retinyl palmitate, ascorbyl palmitate, and β-carotene provide antioxidant protection for the botanical oils. Finally, rosemary leaf extract functions as a naturally occurring preservative.[25]

As UVA and UVB radiation affect the skin differently, separate in vivo models were used to assess the nature-based facial oil's antioxidant potential. UVA exposure transiently increases skin chemiluminescence due to increased oxidative stress. This study revealed pretreatment with the nature-based facial oil significantly reduced chemiluminescence following UVA exposure indicating reduced oxidative stress.

Skin damage following UVB exposure is more direct, occurring when DNA and skin proteins absorb the radiation. Therefore, UVB protection was studied in a model that used erythema and sunburn cell formation as endpoints. After 8 weeks of pretreatment with the nature-based facial oil, erythema following UVB challenge was significantly reduced corresponding to fewer sunburn cells in 66.67% of subjects.

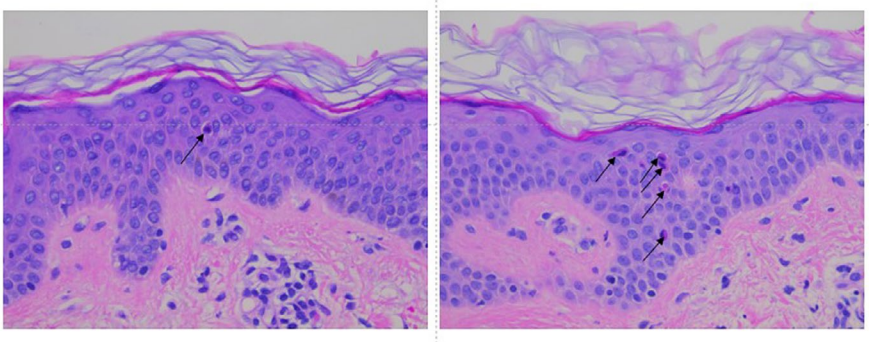

FIGURE 3 Sunburn Cells on Treated (A) and Untreated (B) Buttock Skin. Pretreatment with the nature-based facial oil significantly reduced sunburn cell counts compared to untreated skin [Color figure can be viewed at wileyonlinelibrary.com]

5 | CONCLUSION

Topical treatment with a nature-based facial botanical oil provided antioxidant protection against UVA/UVB-induced oxidative stress.

ACKNOWLEDGMENT

The authors would like to thank Keith Ertel, KDE Scientific Consulting, LLC for the assistance in preparation of this manuscript.

CONFLICT OF INTEREST

Dr Draelos is an investigator for Burt's Bees. Dr Levy is a consultant for Burt's Bees. Dr Gunt is an employee of Burt's Bees. All subjects involved in the human research portion of this study completed consent and followed all GCP guidelines. The study and consent were approved by the Allendale Institutional Review Board, Old Lyme, CT, USA.

ORCID

Zoe Diana Draelos https://orcid.org/0000-0001-9803-7415

REFERENCES

1. United States Environmental Protection Agency. Health effects of UV radiation. Available from: https://www.epa.gov/sunsafety/health-effects-uv-radiation. Accessed: October 17, 2019
2. Cleaver JE, Crowley E. UV damage, DNA repair and skin carcinogenesis. *Front Biosci J Virtual Libr*. 2002;7:d1024-d1043.
3. Chien A, Jacobi H. UV radiation & your skin. The facts. The risks. How they affect you. Available from: https://www.skincancer.org/risk-factors/uv-radiation/. Accessed: October 22, 2019
4. Pandel R, Poljšak B, Godic A, Dahmane R. Skin photoaging and the role of antioxidants in its prevention. *ISRN Dermatol*. 2013;2013.
5. Pinnell SR. Cutaneous photodamage, oxidative stress, and topical antioxidant protection. *J Am Acad Dermatol*. 2003;48(1):1-19.
6. Fuchs J, Huflejt ME, Rothfuss LM, Wilson DS, Carcamo G, Packer L. Impairment of enzymic and nonenzymic antioxidants in skin by UVB irradiation. *J Invest Dermatol*. 1989;93(6):769-773.
7. Godic A, Poljšak B, Adamic M, Dahmane R. The role of antioxidants in skin cancer prevention and treatment. *Oxid Med Cell Longev*. 2014.
8. Stäb F, Wolber R, Blatt T, Keyhani R, Sauermann G. Topically applied antioxidants in skin protection. *Methods Enzymol*. 2000;319:465-478.
9. Chiu A, Kimball AB. Topical vitamins, minerals and botanical ingredients as modulators of environmental and chronological skin damage. *Br J Dermatol*. 2003;149(4):681-691.
10. Jain A, Rieger I, Rohr M, Schrader A. Antioxidant efficacy on human skin in vivo investigated by UVA-induced chemiluminescence decay analysis via induced chemiluminescence of human skin. *Skin Pharmacol Physiol*. 2010;23(5):266-272.
11. Evelson P, Ordóñez CP, Llesuy S, Boveris A. Oxidative stress and *in vivo* chemiluminescence in mouse skin exposed to UVA radiation. *J Photochem Photobiol B*. 1997;38(2):215-219.
12. Murray JC, Burch JA, Streilein RD, Iannacchione MA, Hall RP, Pinnell SR. A topical antioxidant solution containing vitamins C and E stabilized by ferulic acid provides protection for human skin against damage caused by ultraviolet irradiation. *J Am Acad Dermatol*. 2008;59(3):418-425.
13. Lin T-K, Zhong L, Santiago JL. Anti-inflammatory and skin barrier repair effects of topical application of some plant oils. *Int J Mol Sci*. 2018;19(1):70.
14. Elias PM, Brown BE, Ziboh VA. The permeability barrier in essential fatty acid deficiency: evidence for a direct role for linoleic acid in barrier function. *J Invest Dermatol*. 1980;74(4):230-233.
15. Prottey C, Hartop PJ, Black JG, McCormack JI. The repair of impaired epidermal barrier function in rats by the cutaneous application of linoleic acid. *Br J Dermatol*. 1976;94(1):13-21.
16. Eskin NAM. Borage and evening primrose oil. *Eur J Lipid Sci Technol*. 2008;110(7):651-654.
17. Friedman Z, Shochat SJ, Maisels MJ, Marks KH, Lamberth EL. Correction of essential fatty acid deficiency in newborn infants by cutaneous application of sunflower-seed oil. *Pediatrics*. 1976;58(5):650-654.
18. Press M, PeterJ H, Prottey C. Correction of essential fatty-acid deficiency in man by the cutaneous application of sunflower-seed oil. *The Lancet*. 1974;303(7858):597-599.
19. Isbell TA, Abbott TP, Carlson KD. Oxidative stability index of vegetable oils in binary mixtures with meadowfoam oil. *Ind Crops Prod*. 1999;9(2):115-123.
20. Sandha GK, Swami VK. Jojoba oil as an organic, shelf stable standard oil-phase base for the cosmetic industry. *Rasayan J Chem*. 2009;2(2):300-306.
21. Pratt DE, Birac PM. Source of antioxidant activity of soybeans and soy products. *J Food Sci*. 1979;44(6):1720-1722.
22. Malecka M. Antioxidant properties of the unsaponifiable matter isolated from tomato seeds, oat grains and wheat germ oil. *Food Chemistry*. 2002;79(3):327-330.
23. Sarkis JR, Côrrea APF, Michel I, Brandeli A, Tessaro IC, Marczak LDF. Evaluation of the phenolic content and antioxidant activity of different seed and nut cakes from the edible oil industry. *J Am Oil Chem Soc*. 2014;91(10):1773-1782.
24. Siger A, Nogala-Kalucka M, Lampart-Szczapa E. The content and antioxidant activity of phenolic compounds in cold-pressed plant oils. *J Food Lipids*. 2008;15(2):137-149.
25. Nieto G, Ros G, Castillo J. Antioxidant and antimicrobial properties of rosemary (*Rosmarinus officinalis*, L.): a review. *Medicines*. 2018;5(3):98.

How to cite this article: Diana Draelos Z, Gunt H, Levy SB. Nature-based botanical facial oil oxidative stress protection. *J Cosmet Dermatol*. 2021;20:522–525. https://doi.org/10.1111/jocd.13879