



Technical Literature

Kemin Health, L.C.
600 East Court Ave, Suite A
Des Moines, Iowa 50309-2058 USA
tel: 515.248.4000 fax: 515.248.4051
toll free: 888.248.5040
www.kemin.com

Clinical Evidence Shows Long-term Beneficial Effects of FloraGLO® Lutein on Human Skin

Sheila Dana and Justin Green, Technical Service Managers
Richard Roberts, Senior Scientific Affairs Manager

Key Conclusions

- FloraGLO Lutein may provide specific skin health benefits when used as a dietary supplement, topical treatment or the two combined.
- The potential skin health benefits of FloraGLO Lutein, especially with a combination of oral and topical use, may include significant increases in skin hydration, lipid content, and elasticity, and may minimize signs of premature aging.
- Using FloraGLO Lutein may result in increased photoprotective activity and significantly decreased skin lipid peroxidation, a symptom of damage due to light exposure.

Introduction

Signs of premature skin aging caused by a lifetime of damaging environmental exposure can appear in the form of wrinkles, dryness, sagging, discoloration, and cancers of the skin (1-4). While sun-induced UV damage is believed to be the primary culprit, certain wavelengths of visible light can also penetrate deeper into the skin and produce irreversible damage (3-5). Antioxidants naturally present in human skin provide some protection from environmental assault; however, the protective capacity of the skin is rapidly depleted by even moderate UV light exposure (6,7).

Lutein, well known for its role in eye health, has also been detected in significant quantities in other tissues including the skin, breast, and brain (8-11). Like the eyes, the skin may benefit from the ability of lutein to absorb high-energy wavelengths of blue-light and to quench free radicals that may develop from constant exposure to light, particularly sunlight. Therefore, the role of lutein in skin health is an emerging and exciting area of research.

Previous studies have indicated beneficial effects of lutein intake on the skin of mice and humans. Dietary supplementation with FloraGLO® Lutein (FGL) decreased UV B-induced inflammation, immunosuppression, epidermal hyperplasia (skin thickening), and formation of apoptotic (sunburn) cells, in the skin (12,13) of hairless mice, a standard model for studying the effects of UV radiation on skin. A human observational study by the National Cancer Institute showed that subjects in the highest quintile of dietary lutein consumption had a 44% lower risk of melanoma compared to those with the lowest intake (14).

Dr. Pierfrancesco Morganti, professor of applied cosmetic dermatology at the University of Naples, has previously shown that a diet supplemented with antioxidants may provide specific benefits for human skin health (15,16). The present report summarizes his most recent clinical study published in the *Journal of Skin Pharmacology and Physiology* (17). This study demonstrates the benefit of FGL at improving skin hydration, skin lipid content, and skin elasticity, while minimizing lipid peroxidation and enhancing photoprotective activity in the skin when taken orally, applied topically, or administered by both routes simultaneously.

Study Design

The randomized, placebo-controlled, multicenter study enrolled forty healthy female subjects, age 25-50 (average age = 35 years), of varied skin types, each exhibiting signs of premature aging. Subjects were balanced into four study groups with 10 patients each by age, skin type and skin condition. Two weeks before treatments began, the consumption of a Mediterranean diet low in β -carotene was initiated and maintained by all subjects throughout the study in order to minimize confounding effects. The baseline conditions of subjects' skin for all assessment parameters were determined during this period. Treatment effects were evaluated at 2-week intervals over a 12-week study period.

An equal number of subjects per group consumed oral treatments with meals and applied topical treatments to their skin on the face, neck, and right forearm. Subjects were given one of four different treatments: (1) an oral soft gel supplement of FloraGLO Lutein 20% Liquid in Safflower Oil (providing 5 mg lutein and 0.3 mg zeaxanthin taken twice per day for a total of 10 mg lutein and 0.6 mg zeaxanthin) in combination with a topical application of FloraGLO Lutein 5% Oil-Free Liquid (providing 50 ppm lutein and 3 ppm zeaxanthin applied twice per day), (2) the oral FGL supplement plus a topical placebo, (3) an oral placebo supplement plus the FGL topical treatment, or (4) an oral placebo supplement plus a topical placebo.

Five skin physiological parameters were measured throughout the study. The level of skin lipid peroxidation was measured by assaying the amount of malondialdehyde (MDA) that was generated following 2 minutes of UV light exposure. Skin hydration and superficial skin lipid levels were evaluated using a computerized technology that probes the skin and automatically averages 15 readings per minute during the sampling period. Skin hydration was determined by measuring the total electric capacitance of a skin area between the nose and cheek. Surface skin lipid levels were detected by changes in the transparency of the frosted plastic foil following contact with the skin surface. Skin elasticity was measured as the extension of forearm skin in response to vacuum suction for five repeated 20-second exposures. The final values for skin hydration, skin lipids, and skin elasticity were reported as the percentage change from baseline values established in the 15 day period prior to initiation of the study.

Results

All the treatments containing FloraGLO Lutein had significant positive impact on each of the parameters evaluated.

Lipid peroxidation in the skin was significantly suppressed with all FGL treatments (Figure 1A) relative to placebo. UV-light induced production of malondialdehyde (MDA) was significantly reduced over time with all FGL treatments. The topical treatment and oral supplementation individually produced comparable results. The combined oral and topical treatment with FGL resulted in the greatest decrease in skin lipid peroxidation throughout the study.

Superficial skin lipid levels were significantly improved by all FGL treatments (Figure 1B). Topical FGL treatment provided an increase in surface skin lipids as early as at week 2. Oral FGL supplementation resulted in greater amounts of surface skin lipids throughout the study. The combined FGL oral and topical treatments resulted in greater skin lipid increases than either treatment individually. Maximum effects of the FGL treatments were observed at week 12: 63% increase for the oral/topical combination, 46% increase for the oral treatment, and 23% increase for the topical treatment, as compared to 10% increase for the placebo.

Skin hydration was significantly improved by all three FGL treatments relative to placebo (Figure 1C). Both topical treatment and oral supplementation with FGL showed comparable increases in skin hydration throughout the course of the study. The combined oral and topical FGL treatment showed a greater effect than either the oral or the topical treatments alone.

All three FGL treatments resulted in significantly improved skin elasticity relative to placebo (Figure 1D). Skin elasticity increased within the first 4 weeks with oral FGL treatment and then remained steady. The topical treatment and the combined treatment each showed comparable increases in elasticity through the course of the study.

Photoprotective activity is highest with combined FGL treatment (Figure 2).

Significant beneficial effects of FGL usage on free radical-related photoprotective activity, as compared to placebo, were detected early and were sustained throughout the entire study as shown by significant increases from placebo in all FGL treatments at all times. The combined oral and topical treatment exhibited the greatest efficacy on photoprotection, indicating that there may be a synergistic effect from the combined FGL treatments.

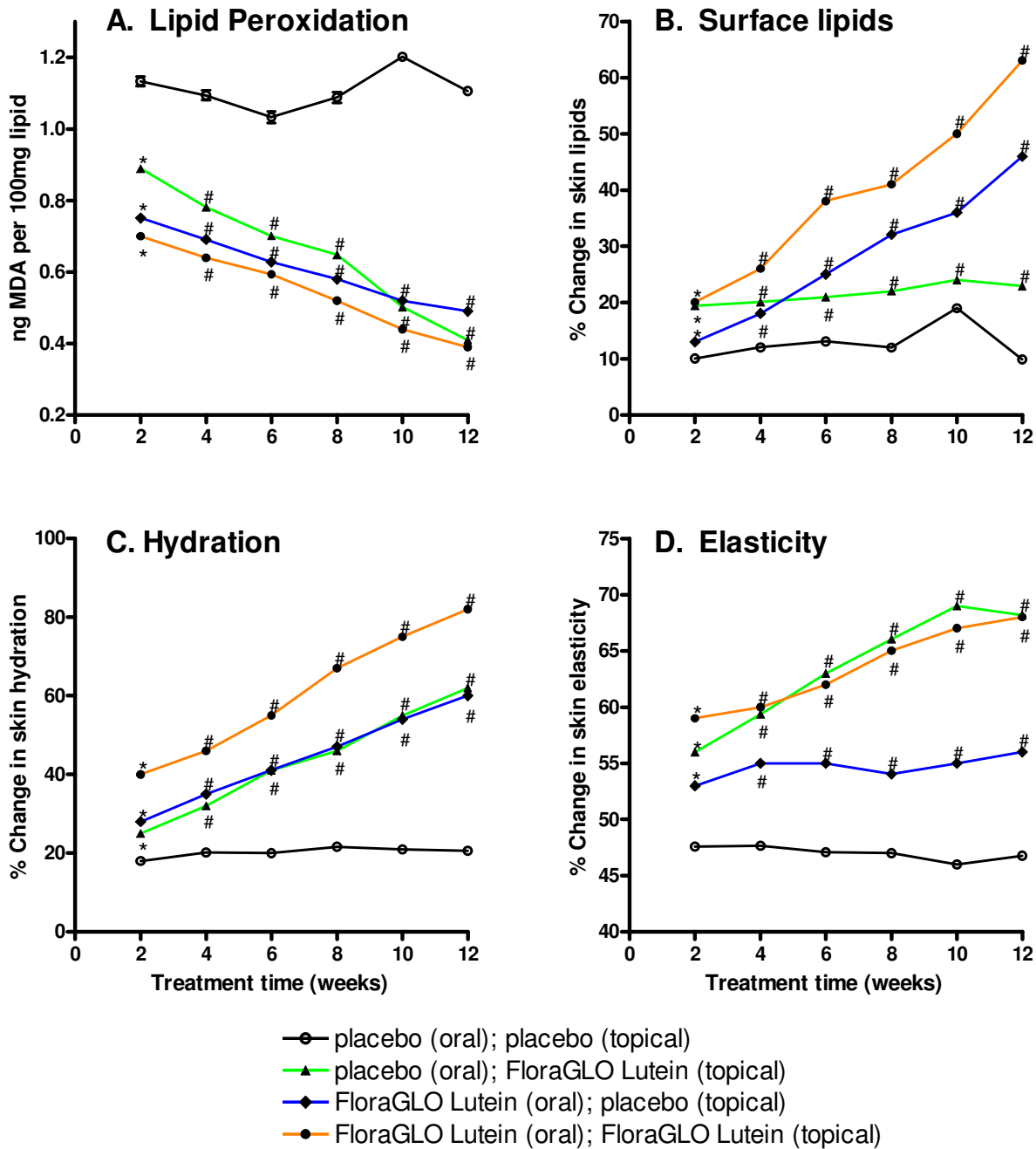


Figure 1. Effects on skin health parameters following FloraGLO Lutein administered orally, topically, or as a combined treatment. * $p < 0.05$ compared to placebo at the same treatment time. # $p < 0.05$ compared to placebo at the same treatment time and $p < 0.05$ compared to the outcome of the same treatment at week 2. A: Skin lipid peroxidation is expressed as malonyldialdehyde (MDA) content in the skin lipids following irradiation by a measured UV light source. B, C, and D: The levels of surface skin lipids, skin hydration, and skin elasticity are expressed as percentage increases from baseline (pre-treatment).

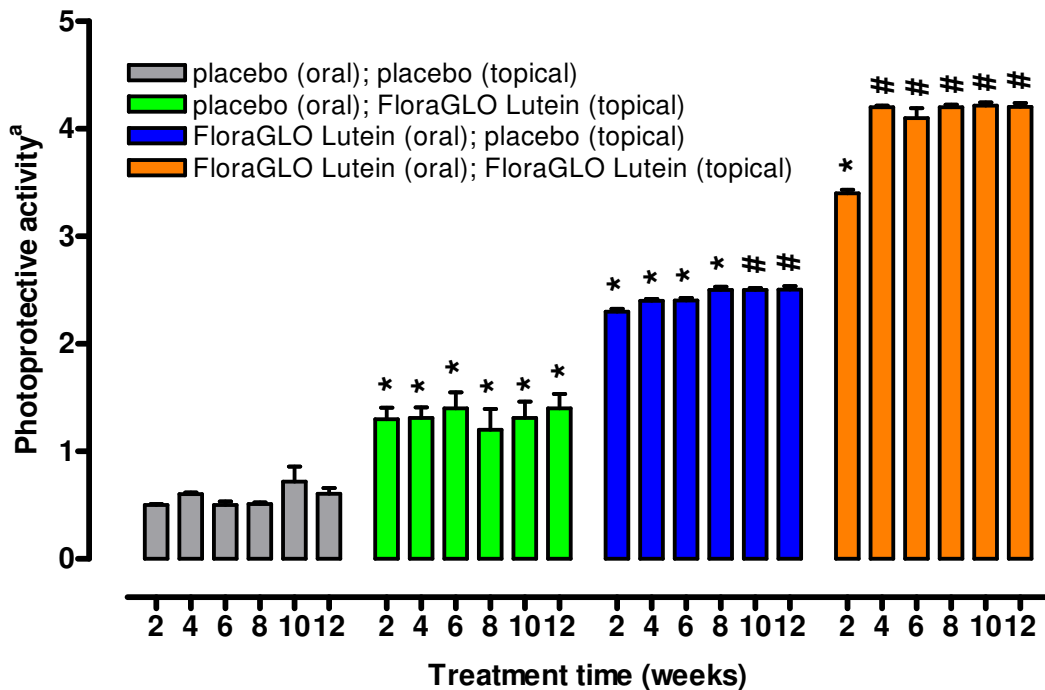


Figure 2. Effects on photoprotective activity following FloraGLO Lutein administered orally, topically or as a combined treatment. *p < 0.05 compared to placebo at the same treatment time. #p < 0.05 compared to placebo treatment at the same treatment time and p < 0.05 compared to the outcome of the same treatment at week 2. ^aPhotoprotective activity is defined as the ratio of minimal erythral UV dose (MED) for treated skin to the MED for untreated skin (measured at baseline before treatment began).

Discussion

Previous studies by Morganti have shown that dietary supplementation with ascorbic acid (90 mg/day), tocopherol (10 mg/day), α -lipoic acid (5 mg/day) and lutein (6 mg/day) over 8 weeks significantly improved subjects' skin health in parameters such as skin hydration and skin lipid content (15). In smokers, it was shown that this same antioxidant treatment significantly reduced reactive oxygen species in the skin by about 40% relative to controls (p<0.005) (16). However, the new study summarized here is the first to show improvements in human skin health through supplementation with FGL alone indicating that lutein is not only important for eye health, but may also provide important skin health benefits.

The reduction in skin lipid peroxidation observed with the FGL treatment in this study has important implications for healthy skin maintenance. Some skin lipids are intercellular lipids in the outermost layer of the epidermis (the stratum corneum) that form an alternating multi-layered structure with water (oil/water/oil/water/etc). This combination of water and skin oils helps reduce the penetration of materials into the skin, reduces the loss of essential skin moisture, and provides lubricity that allows the skin to stretch without loss of barrier properties.

The double bond structure of lipids in this layer makes them susceptible to the damaging effects of environmental exposure, particularly to ultraviolet light (i.e., UV-induced free radical damage). This latter type of damage, properly called UV-induced lipid peroxidation, is believed to be responsible for the increased loss of water from the skin following UV light exposure. An important finding of this study is the negative correlation between skin hydration and skin lipid peroxidation for all FGL treatments, indicating that the increased skin hydration is associated with decreasing lipid peroxidation. These results indicate that FGL may protect against UV-induced lipid peroxidation through lutein's known ability to quench the triplet state of photosensitizers and singlet oxygen that are responsible for the formation of free radicals (18).

Increases in skin lipids by orally ingested antioxidants have been reported in previous studies (15, 19). Sebaceous glands have been shown to be the primary delivery route for dietary sources of tocopherols to the skin surface (20). The increases in superficial skin lipids resulting from FGL treatment observed in this study may be a result of the oral route of delivery with subsequent stimulation of sebum output. Sebaceous glands are the reservoir of sebum (skin lipids) that is transported to the skin surface via hair follicles, forming an additional barrier against bacterial growth, frictional damage, and moisture loss. In these skin lipids, the most susceptible component to environmental damage, squalene, has an alternating double bond structure similar to the backbone chain of lutein. Recently published studies have shown that although pure squalene is not susceptible to UV-induced photodegradation, there are components in sebum that make this molecule susceptible to UV light thereby resulting in free radical degradation of squalene (21). Superficial skin lipids and skin lipid peroxidation were negatively correlated for the oral FGL and the combined oral/topical FGL treatments suggesting a protective role of lutein when administered orally.

Skin elasticity and superficial skin lipids were positively correlated for the topical FGL and combined FGL treatments, with pronounced elasticity enhancing effects with topical FGL treatment. The low density of sebaceous glands on the forearm probably restricts the amount of lutein delivered to this area of the skin and may thereby limit the efficacy of oral FGL to improve skin elasticity. The significant changes in skin lipids, skin hydration, and skin elasticity observed in this study suggest that greater skin health benefits may result with longer term supplementation.

Conclusions

The present study concludes that in addition to providing protection from damaging effects of UV light-induced free radical production and reducing lipid peroxidation in and on the skin, supplementation with FGL also increases surface lipids, skin hydration, and skin elasticity. While these benefits can be obtained with individual oral or topical application, the study demonstrated that greater benefits are achieved quickly when a combined oral/topical administration of FGL is used. Furthermore, the study reinforces the benefits to skin health of a continuous regimen of FloraGLO Lutein supplementation.

References

1. **Godar DE, Wengraitis SP, Shreffler J, Sliney DH:** UV doses of Americans. *Photochem Photobiol*, 73:621-9, 2001.
2. **Rhie G, Shin MH, Seo JY, Choi WW, Cho KH, Kim KH, Park KC, Eun HC, Chung JH:** Aging- and photoaging dependent changes of enzymic and nonenzymic antioxidants in the epidermis and dermis of human skin in vivo. *J Invest Dermatol*, 117:1212-7, 2001.
3. **Wlaschek M, Ma W, Jansen-Durr P, Scharffetter-Kochanek K:** Photoaging as a consequence of natural and therapeutic ultraviolet irradiation--studies on PUVA-induced senescence-like growth arrest of human dermal fibroblasts. *Exp Gerontol*, 38:1265-70, 2003.
4. **Scharffetter-Kochanek K:** Photoaging of the connective tissue of skin: its prevention and therapy. *Adv Pharmacol*, 38:639-55, 1997.
5. **Lange BA, Buettner GR:** Electron paramagnetic resonance detection of free radicals in UV- irradiated human and mouse skin. *Curr Probl Dermatol*, 29:18-25, 2001.
6. **Shindo Y, Witt E, Han D, Packer L:** Enzymatic and non-enzymatic antioxidants in epidermis and dermis of human skin. *J Invest Dermatol*, 102:122-124, 1994.
7. **Thiele J, Dreher F, Packer L.** Antioxidant defense systems in skin. In: Elsner P, Maibach H, eds. *Drugs vs Cosmetics: Cosmeceuticals?* New York: Marcel Dekker; 145-188, 2000.
8. **Richer S, Stiles W, Statkute L, Pulido J, Frankowski J, Rudy D, Pei K, Tsupursky M, and Nyland J.** Double-masked, placebo-controlled, randomized trial of lutein and antioxidant supplementation in the intervention of atrophic age-related macular degeneration: the Veterans LAST study (Lutein Antioxidant Supplementation Trial). *Optometry* 75: 216-230, 2004.
9. **Seddon JM, Ajani UA, Sperduto RD, Hiller R, Blair N, Burton TC, Farber MD, Gragoudas ES, Haller J, Miller DT, and et al.** Dietary carotenoids, vitamins A, C, and E, and advanced age-related macular degeneration. Eye Disease Case-Control Study Group. *Jama* 272: 1413-1420, 1994.
10. **Bernstein PS, Khachik F, Carvalho LS, Muir GJ, Zhao DY, and Katz NB.** Identification and Quantitation of Carotenoids and their Metabolites in the Tissues of the Human Eye. *Exp Eye Res* 72: 215-223, 2001.
11. **Hata TR, Scholz TA, Ermakov IV, McClane RW, Khachik F, Gellermann W, and Pershing LK.** Non-invasive raman spectroscopic detection of carotenoids in human skin. *J Invest Dermatol* 115: 441-448, 2000.
12. **Gonzalez S, Astner S, An W, Goukassian D, and Pathak MA.** Dietary lutein/zeaxanthin decreases ultraviolet B-induced epidermal hyperproliferation and acute inflammation in hairless mice. *J Invest Dermatol* 121: 399-405, 2003.
13. **Lee EH, Faulhaber D, Hanson KM, Ding W, Peters S, Kodali S, and Granstein RD.** Dietary lutein reduces ultraviolet radiation-induced inflammation and immunosuppression. *J Invest Dermatol* 122: 510-517, 2004.
14. **Millen AE, Tucker MA, Hartge P, Halpern A, Elder DE, Guerry Dt, Holly EA, Sagebiel RW, and Potischman N.** Diet and melanoma in a case-control study. *Cancer Epidemiol Biomarkers Prev* 13: 1042-1051, 2004.
15. **Morganti P, Bruno C, Guarneri F, Cardillo A, Del Ciotto P, and Valenzano F.** Role of topical and nutritional supplement to modify the oxidative stress. *International J Cosmetic Science* 24: 331-339, 2002.
16. **Morganti P, Fabrizi G, and Bruno C.** Protective effects of oral antioxidants on skin and eye function. *Skinmed* 3: 310-316, 2004.
17. **Palombo P, Fabrizi G, Ruocco V, Ruocco E, Flühr J, Roberts R, and Morganti P.** Beneficial long-term effects of combined oral/topical antioxidant treatment with carotenoids lutein and zeaxanthin on human skin: A double-blinded, placebo-controlled study in humans. *J Skin Pharmacol and Physiol* 20: 199-210. 2007.
18. **Krinsky NI:** Carotenoid protection against oxidation. *Pure Appl Chem* 51:649-60, 1979.
19. **Segger D, Shonlau F:** Supplementation with Evelle improves skin smoothness and elasticity in a double-blind, placebo-controlled study with 62 women. *J Dermatological Treatment* 2004;15:222-226.
20. **Thiele JJ, Weber SU, Packer L:** Sebaceous gland secretion is a major physiologic route of vitamin E delivery to skin. *J Invest Dermatol* 1999;113:1006-10.
21. **Mudiyanselage S, Hamburger M, Elsner P, Thiele J:** Ultraviolet A induces generation of squalene monohydro-peroxide isomers in human sebum and skin surface lipids in-vitro and in-vivo. *J Invest Dermatol* 2003;120:915-922.