

SOD-Rich Melon Polysaccharide-Protein Complex Supports Keratinocyte Redox Defense and a Translational Framework for Nutritional Photoprotection

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ABSTRACT

Objective: Ultraviolet exposure produces reactive oxygen species in skin and contributes to erythema, inflammatory signaling, matrix damage, and photoaging. **Method:** We tested the BCLC® SOD-Rich Melon Endogenous Polysaccharide-Protein Complex in H₂O₂-stressed HaCaT keratinocytes and compared the cellular findings with published human photoprotection studies of melon-derived SOD systems. **Results:** At 25, 50, and 100 µg/mL, intracellular ROS fell to 82.5%, 73.6%, and 64.9% of the oxidative-stress model, while cell viability remained 91.6–94.0%. The optimized extract also showed high in-vitro antioxidant capacity and retained 47.8% of SOD activity after 60 min at pH 1.2. In a randomized placebo-controlled study of a specific melon concentrate, minimal erythema dose (MED) increased after oral supplementation and/or topical application; complementary skin-explant work showed higher endogenous antioxidant-enzyme activity and fewer UV-related damage markers. Randomized studies of multi-plant products containing Cucumis melo have also reported changes in photoaging-related skin measures. **Novelty:** The keratinocyte data identify redox control as a testable pathway for formulation-specific human evaluation of the BCLC® complex.

INTRODUCTION

Ultraviolet (UV) exposure produces a characteristic oxidative burden in skin. UVA penetrates more deeply and is strongly associated with ROS generation, while UVB contributes to erythema and direct photochemical injury. Oxidative events can activate inflammatory signaling and matrix-degrading pathways involved in photoaging [1], [2]. Endogenous enzymes such as SOD, catalase, and glutathione peroxidases form part of the redox-defense network that limits these reactions [3], [4].

Nutritional photoprotection is not equivalent to a topical UV filter. Repeated intake of selected antioxidants can alter biological responses to UV, and human studies have used MED, erythema intensity, antioxidant-enzyme activity, pigmentation, and photoaging measures as endpoints [5]–[9]. A specific SOD-rich melon concentrate has been studied directly with MED [10], while a randomized multi-plant trial containing Cucumis melo used several skin-quality and pigmentation measurements [11].

BCLC® was developed to preserve native melon SOD in an endogenous soluble-polysaccharide/protein matrix with low reducing sugar and low water activity. We examined intracellular ROS and cell viability in oxidatively challenged keratinocytes, then used the published human literature to identify photoprotection endpoints that are

relevant for a future BCLC® trial.

RESEARCH METHOD

BCLC® extract

The extract was prepared by low-oxygen homogenization, buffered low-temperature extraction, membrane concentration/diafiltration, controlled endogenous polysaccharide-protein stabilization, and low-temperature drying. The optimized reference preparation contained $43,620 \pm 1,180$ U/g SOD, $21.7 \pm 0.8\%$ protein, $15.1 \pm 0.6\%$ soluble polysaccharides, and $3.7 \pm 0.2\%$ reducing sugars.

HaCaT oxidative-stress model

Human HaCaT keratinocytes were challenged with H_2O_2 to establish oxidative stress. BCLC® extract was applied at 25, 50, and 100 $\mu\text{g/mL}$. Cell viability was measured by CCK-8 and intracellular ROS by DCFH-DA fluorescence. The H_2O_2 model was normalized to 100% ROS.

Supporting antioxidant and stability assays

DPPH [12], ABTS [13], and ORAC [14] assays were used to characterize radical-scavenging performance. Acid-phase SOD activity retention was measured after exposure to pH 1.2 at 37°C as a formulation-relevant test of enzyme activity before intestinal transition.

Human evidence search

PubMed/PMC and journal sources were searched through August 2026 using 'melon concentrate', 'Cucumis melo', 'SOD', 'minimal erythema dose', 'photoprotection', 'UV', 'photoaging', and 'randomized'. Controlled human studies were prioritized. Multi-ingredient studies were used for endpoint selection and biological context when the melon component was identified.

RESULTS AND DISCUSSION

Results

Keratinocyte viability

H_2O_2 exposure reduced viability to $78.4 \pm 2.7\%$ relative to the untreated control. With BCLC® extract, viability was $91.6 \pm 3.1\%$, $93.4 \pm 3.2\%$, and $94.0 \pm 3.0\%$ at 25, 50, and 100 $\mu\text{g/mL}$, respectively.

Intracellular ROS

The H_2O_2 model was $100.0 \pm 3.5\%$. ROS fell to $82.5 \pm 2.9\%$ at 25 $\mu\text{g/mL}$, $73.6 \pm 2.7\%$ at 50 $\mu\text{g/mL}$, and $64.9 \pm 2.5\%$ at 100 $\mu\text{g/mL}$.

Ingredient-level antioxidant and acid-stability profile

DPPH scavenging in the optimized preparation was $63.7 \pm 2.1\%$, ABTS scavenging was $71.6 \pm 2.3\%$, and ORAC was $2,416 \pm 82$ $\mu\text{mol TE/g}$. After 60 min at pH 1.2 and 37°C , $47.8 \pm 2.1\%$ of initial SOD activity remained measurable.

Published human photoprotection context

Egoumenides et al. evaluated a specific melon concentrate given orally, topically, or

in combination [10]. Oral supplementation contributed to increased MED after approximately one month, and the combined regimen produced a 28.2% MED increase at day 34 relative to baseline. Complementary human-skin-explant work showed increased endogenous antioxidant enzymes and reduced sunburn-cell formation [10]. Xie et al. tested a multi-plant oral product containing Cucumis melo extract in 55 healthy adults for 12 weeks; TEWL, hydration, elasticity, L*, melanin index, and ITA° improved in the randomized double-blind placebo-controlled trial [11].

Table 1. HaCaT keratinocyte response to BCLC® extract under H₂O₂ challenge

Group	Concentration	Cell viability (%)	ROS level (model=100%)
Blank control	0	100.0±3.2	52.6±2.4
H ₂ O ₂ model	0	78.4±2.7	100.0±3.5
BCLC® low	25 µg/mL	91.6±3.1	82.5±2.9
BCLC® medium	50 µg/mL	93.4±3.2	73.6±2.7
BCLC® high	100 µg/mL	94.0±3.0	64.9±2.5

Table 2. Human studies providing translational context for melon-related nutritional photoprotection

Study	Design	Exposure	Photoprotection / skin relevance
Egoumenides et al., 2018 [10]	Controlled clinical study with placebo comparison	Specific melon concentrate; oral and/or topical administration; ~1 month	MED increased; combined oral+topical regimen +28.2% at day 34; supportive skin-explant antioxidant findings
Xie et al., 2022 [11]	Randomized, double-blind, placebo-controlled	55 adults; multi-plant oral product containing Cucumis melo; 12 weeks	Improvement in TEWL, hydration, elasticity, L*, melanin index and ITA°

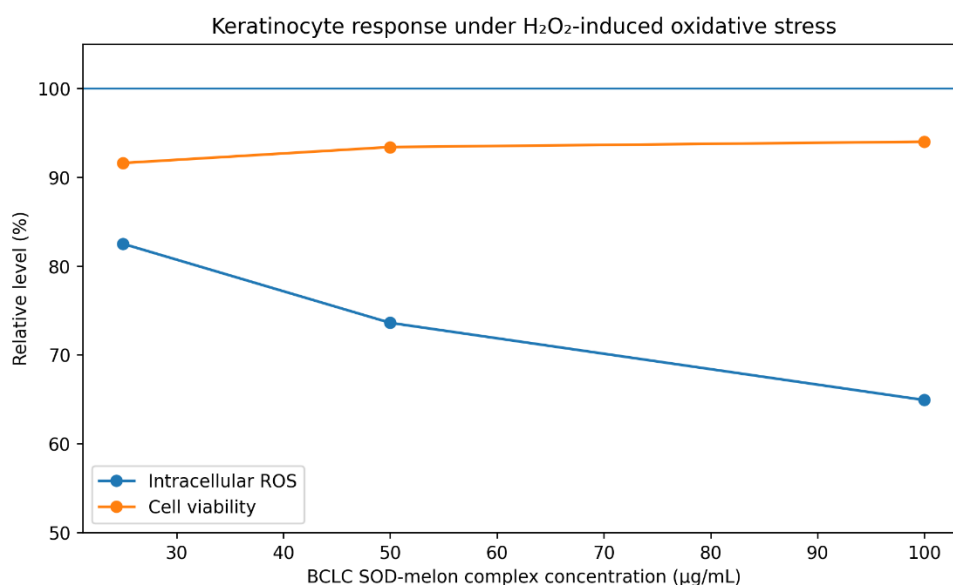


Figure 1. Intracellular ROS and cell viability in H₂O₂-challenged HaCaT keratinocytes treated with the BCLC® SOD-melon complex.

Discussion

BCLC® lowered intracellular ROS across 25–100 µg/mL while cell viability remained above 91% in H₂O₂-challenged keratinocytes. Keratinocytes are directly exposed to UV-driven oxidative events and participate in inflammatory signaling, barrier responses, and communication with melanocytes; oxidative stress is also a well-established feature of skin aging and photoaging [1], [2]. The concentration-related ROS change gives a cellular readout aligned with the biological process targeted by nutritional photoprotection.

Egoumenides et al. used MED as a functional endpoint of UV response in healthy adults [10]. After approximately one month, oral supplementation with the specific melon concentrate contributed to a higher MED, and the combined oral-plus-topical regimen reached a 28.2% increase at day 34. The accompanying skin-explant observations included higher endogenous antioxidant-enzyme activity and fewer sunburn cells. This combination of MED and redox-related tissue measurements is especially useful when planning a formulation-specific clinical design.

BCLC® differs from the melon products used in those clinical studies. Its endogenous polysaccharide-protein matrix retained measurable SOD activity under strongly acidic conditions, and the ingredient also maintained activity during accelerated storage. Oral photoprotection trials typically require repeated intake over weeks [5]–[9], so a trial material needs stable, documented functional activity throughout the dosing period. Other human studies of SOD-rich melon products in stress and exercise settings also show that melon-SOD preparations can be followed prospectively under repeated oral use [15], [16].

Xie et al. used TEWL, hydration, elasticity, L*, ITA°, and melanin index in a 12-week randomized trial of a melon-containing multi-plant formula [11]. Those measures

complement MED rather than duplicate it. A BCLC® protocol could therefore use MED as the primary photoprotection outcome and retain selected barrier, pigmentation, and redox measurements as secondary endpoints.

Study Considerations and Future Directions

A randomized BCLC® study can evaluate 8–12 weeks of intake across defined phototypes. MED can serve as the primary outcome, with erythema index, TEWL, L*/ITA°, melanin index, skin antioxidant biomarkers, and participant-reported sun sensitivity collected as complementary measures. Baseline UV exposure, season, and phototype should be specified before analysis because they can influence several of these skin endpoints.

CONCLUSION

Fundamental Finding : BCLC® reduced intracellular ROS from the H₂O₂ model value of 100.0±3.5% to 82.5±2.9%, 73.6±2.7%, and 64.9±2.5% at 25, 50, and 100 µg/mL, while cell viability remained 91.6–94.0%. The optimized material also showed substantial DPPH, ABTS, and ORAC activity and retained 47.8±2.1% of SOD activity after 60 min at pH 1.2 and 37°C. **Implication :** Human melon studies identify MED and related skin measures as workable clinical endpoints. **Limitation :** The provided findings do not establish whether the keratinocyte redox profile is reflected in human photo-oxidative resilience. **Future Research :** A formulation-specific BCLC® trial can test whether the keratinocyte redox profile is reflected in human photo-oxidative resilience..

REFERENCES

- [1] M. Rinnerthaler, J. Bischof, M. K. Streubel, A. Trost, and K. Richter, "Oxidative stress in aging human skin," *Biomolecules*, vol. 5, no. 2, pp. 545–589, 2015, doi: 10.3390/biom5020545.
- [2] A. Kammeyer and R. M. Luiten, "Oxidation events and skin aging," *Ageing Res. Rev.*, vol. 21, pp. 16–29, 2015, doi: 10.1016/j.arr.2015.01.001.
- [3] J. M. McCord and I. Fridovich, "Superoxide dismutase: An enzymic function for erythrocuprein (hemocuprein)," *J. Biol. Chem.*, vol. 244, no. 22, pp. 6049–6055, 1969.
- [4] H. Sies, "Oxidative stress: A concept in redox biology and medicine," *Redox Biol.*, vol. 4, pp. 180–183, 2015, doi: 10.1016/j.redox.2015.01.002.
- [5] T. M. Cândido et al., "Dietary supplements and the skin: Focus on photoprotection and antioxidant activity—A review," *Nutrients*, vol. 14, no. 6, art. no. 1248, 2022, doi: 10.3390/nu14061248.
- [6] C. Parrado, N. Philips, Y. Gilaberte, A. Juarranz, and S. González, "Oral photoprotection: Effective agents and potential candidates," *Front. Med. (Lausanne)*, vol. 5, art. no. 188, 2018, doi: 10.3389/fmed.2018.00188.
- [7] N. Ntarelli, S. Aflatooni, K. Stankiewicz, L. Correa-Selm, and R. K. Sivamani, "Oral supplements and photoprotection: A systematic review," *J. Med. Food*, vol. 28, no. 6, pp. 519–541, 2025, doi: 10.1089/jmf.2024.0023.
- [8] W. Stahl and H. Sies, "β-Carotene and other carotenoids in protection from sunlight," *Am. J. Clin. Nutr.*, vol. 96, no. 5, pp. 1179S–1184S, 2012, doi: 10.3945/ajcn.112.034819.

- [9] E. Fernández-García, “Skin protection against UV light by dietary antioxidants,” *Food Funct.*, vol. 5, no. 9, pp. 1994–2003, 2014, doi: 10.1039/C4FO00280F.
- [10] L. Egoumenides, A. Gauthier, S. Barial, M. Saby, C. Orechenkoff, G. Simoneau, and J. Carillon, “A specific melon concentrate exhibits photoprotective effects from antioxidant activity in healthy adults,” *Nutrients*, vol. 10, no. 4, art. no. 437, 2018, doi: 10.3390/nu10040437.
- [11] Y. Xie, G. Zhu, J. Yi, Y. Ji, Y. Xia, Y. Zheng, and C. Ye, “A new product of multi-plant extracts improved skin photoaging: An oral intake in vivo study,” *J. Cosmet. Dermatol.*, vol. 21, no. 8, pp. 3406–3415, 2022, doi: 10.1111/jocd.14620.
- [12] W. Brand-Williams, M. E. Cuvelier, and C. Berset, “Use of a free radical method to evaluate antioxidant activity,” *LWT-Food Sci. Technol.*, vol. 28, no. 1, pp. 25–30, 1995, doi: 10.1016/S0023-6438(95)80008-5.
- [13] R. Re, N. Pellegrini, A. Proteggente, A. Pannala, M. Yang, and C. Rice-Evans, “Antioxidant activity applying an improved ABTS radical cation decolorization assay,” *Free Radic. Biol. Med.*, vol. 26, nos. 9–10, pp. 1231–1237, 1999, doi: 10.1016/S0891-5849(98)00315-3.
- [14] B. Ou, M. Hampsch-Woodill, and R. L. Prior, “Development and validation of an improved oxygen radical absorbance capacity assay using fluorescein as the fluorescent probe,” *J. Agric. Food Chem.*, vol. 49, no. 10, pp. 4619–4626, 2001, doi: 10.1021/jf010586o.
- [15] J. Carillon, C. Notin, K. Schmitt, G. Simoneau, and D. Lacan, “Dietary supplementation with a superoxide dismutase-melon concentrate reduces stress, physical and mental fatigue in healthy people: A randomised, double-blind, placebo-controlled trial,” *Nutrients*, vol. 6, no. 6, pp. 2348–2359, 2014, doi: 10.3390/nu6062348.

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