

SOD-Rich Melon Polysaccharide-Protein Complex Modulates Melanogenesis-Related Responses: Experimental Evidence and Translational Context for Oral Skin Brightening

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ABSTRACT

Objective: The BCLC® SOD-Rich Melon Endogenous Polysaccharide-Protein Complex was examined in two skin-relevant cell models. **Method:** In α -MSH-stimulated B16-F10 cells, melanin content fell from the model reference of 100% to 92.5%, 84.8%, and 76.3% at 25, 50, and 100 μ g/mL, respectively. Tyrosinase activity decreased to 94.6%, 88.4%, and 80.2%, while cell viability remained above 93% at the highest dose. In H₂O₂-stressed HaCaT keratinocytes, the same extract reduced intracellular ROS and also showed strong in-vitro radical-scavenging activity. The material contains SOD, endogenous soluble polysaccharides, and protein in a low-reducing-sugar matrix without an exogenous prolamin or lipid coating. **Results:** Human studies of other SOD-rich melon or melon-containing oral products have reported changes in luminosity, L* value, ITA°, melanin-related indices, and broader skin-quality measures. **Novelty:** The cell results identify a redox-melanogenesis pattern that can be tested prospectively with objective skin-color endpoints in a formulation-specific BCLC® study.

INTRODUCTION

Skin tone depends on the amount, type, distribution, and transfer of melanin, together with vascular, optical, and structural features of the epidermis and dermis. In melanocytes, α -melanocyte-stimulating hormone (α -MSH) signaling converges on microphthalmia-associated transcription factor (MITF), tyrosinase, and related melanogenic proteins [1]–[3]. Oxidative and ultraviolet stress can interact with this system through melanocyte signaling and keratinocyte-derived mediators [4].

Cucumis melo is a botanical source of SOD, which catalyzes superoxide dismutation [5]. Redox imbalance is also relevant to the cellular environment in which pigmentation develops [6]. Oral melon-SOD products have been studied in stress, exercise, photoprotection, and skin-radiance settings [7]–[12], and reviews of nutritional photoprotection place such interventions within a broader antioxidant context [13]. Most of those formulations used other carrier systems or multiple active ingredients. BCLC® instead uses an endogenous melon polysaccharide-protein stabilization system, so its own cell and formulation data remain the appropriate starting point for interpretation.

Two questions were examined. First, we tested whether the stabilized BCLC® extract changed melanin content and tyrosinase activity in α -MSH-stimulated B16-F10 cells. Second, we compared those cell responses with human studies that used objective

skin-color or radiance endpoints. Particular attention was given to L^* , ITA° , melanin index, and related instrument-based measures rather than subjective appearance alone.

MATERIALS AND METHODS

2.1 Test material. The BCLC® complex was produced by low-temperature, low-oxygen extraction of melon flesh/placental tissue, membrane concentration and diafiltration, controlled formation of an endogenous soluble-polysaccharide/protein complex, and low-temperature drying. The optimized reference material had SOD activity of $43,620 \pm 1,180$ U/g, total protein of $21.7 \pm 0.8\%$, soluble polysaccharides of $15.1 \pm 0.6\%$, reducing sugars of $3.7 \pm 0.2\%$, and water activity of 0.31 ± 0.01 .

2.2 B16-F10 melanogenesis model. B16-F10 cells were stimulated with α -MSH. The extract was applied at 25, 50, and 100 $\mu\text{g/mL}$ for 72 h under non-cytotoxic conditions. Cell viability, cellular melanin content, and tyrosinase activity were measured. Melanin and tyrosinase values were normalized to the α -MSH model group (100%). Arbutin at 200 μM served as a positive control.

2.3 Keratinocyte redox model. HaCaT keratinocytes were exposed to H_2O_2 -induced oxidative stress. Extract concentrations of 25–100 $\mu\text{g/mL}$ were evaluated for cell viability and DCFH-DA-detected intracellular ROS. The assay was used to examine the redox behavior of the same preparation tested in the melanogenesis model.

2.4 Literature evidence. PubMed/PMC and journal databases were searched through August 2026 using terms for melon, *Cucumis melo*, SOD, skin radiance, pigmentation, L^* value, ITA° , melanin index, photoprotection, and randomized clinical trials. Multi-ingredient human studies were retained when the melon component was identified and objective skin-color endpoints were reported.

RESULTS

3.1 Melanin production. Relative melanin content in the α -MSH model was $100.0 \pm 3.6\%$. BCLC® treatment lowered melanin to $92.5 \pm 3.0\%$, $84.8 \pm 2.8\%$, and $76.3 \pm 2.6\%$ at 25, 50, and 100 $\mu\text{g/mL}$, respectively. Cell viability remained $93.4 \pm 2.9\%$ at 100 $\mu\text{g/mL}$.

3.2 Tyrosinase activity. Tyrosinase activity was $94.6 \pm 3.1\%$, $88.4 \pm 2.7\%$, and $80.2 \pm 2.5\%$ at 25, 50, and 100 $\mu\text{g/mL}$, respectively. Melanin content and tyrosinase activity moved in the same direction across the concentration range while viability remained high.

3.3 Redox context in keratinocytes. In H_2O_2 -challenged HaCaT cells, intracellular ROS fell from the model reference of $100.0 \pm 3.5\%$ to $82.5 \pm 2.9\%$, $73.6 \pm 2.7\%$, and $64.9 \pm 2.5\%$ at 25, 50, and 100 $\mu\text{g/mL}$.

3.4 Human evidence context. Dumoulin et al. followed 35 women with dull complexion for eight weeks using a multi-antioxidant supplement containing SOD-rich melon concentrate and reported improvement in skin-radiance measures [10]. Xie et al. conducted a 12-week randomized, double-blind, placebo-controlled study in 55 healthy adults; the multi-plant product contained *Cucumis melo* extract, and changes were reported in L^* , ITA° , melanin index, and other skin-quality measures [11]. In a later 60-

participant double-blind randomized placebo-controlled trial, a melon/olive/pomegranate powder improved plasma antioxidant markers and showed favorable changes in L* and ITA° beginning at eight weeks [12].

Table 1. Melanogenesis-related responses in α -MSH-stimulated B16-F10 cells.

Group	Concentration	Cell viability (%)	Melanin (% of model)	Tyrosinase (% of model)
Blank control	0	100.0±3.1	58.6±2.5	62.3±2.7
α -MSH model	0	100.0±3.3	100.0±3.6	100.0±3.4
BCLC® low	25 µg/mL	98.4±3.2	92.5±3.0	94.6±3.1
BCLC® medium	50 µg/mL	96.5±3.1	84.8±2.8	88.4±2.7
BCLC® high	100 µg/mL	93.4±2.9	76.3±2.6	80.2±2.5
Arbutin control	200 µM	91.3±2.8	63.8±2.4	67.4±2.3

Table 2. Human studies informing skin-brightening endpoints for melon-containing nutraceuticals.

Study	Design	Population duration	/ Skin-related observations
Dumoulin et al., 2016 [10]	Open-label	35 women, 40–70 y; 8 weeks; multi-antioxidant formula with SOD-rich melon	Improved radiance/luminosity and several skin-appearance measures
Xie et al., 2022 [11]	Randomized, double-blind, placebo-controlled	55 healthy adults, 45–60 y; 12 weeks; multi-plant formula containing Cucumis melo extract	L*, ITA°, melanin index and additional skin-quality endpoints improved
He et al., 2025 [12]	Double-blind, randomized, placebo-controlled	60 healthy adults; 12 weeks; melon/olive/pomegranate powder	Plasma antioxidant markers improved; L* and ITA° increased from week 8

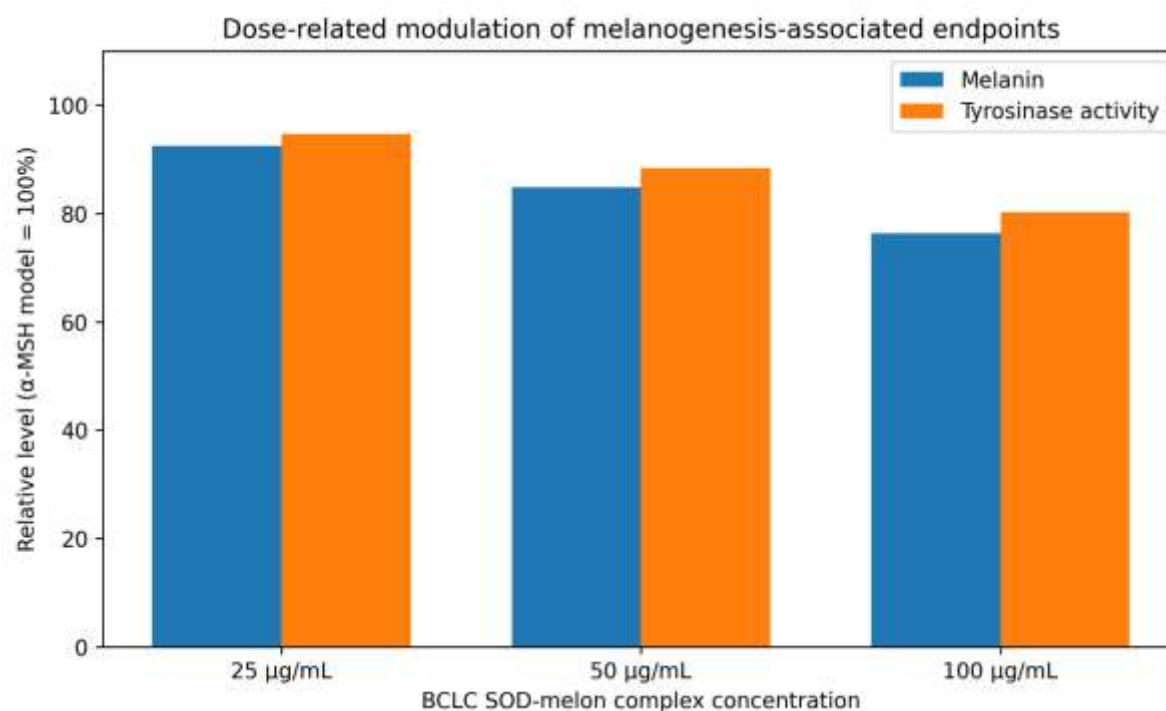


Figure 1. Dose-related changes in melanin content and tyrosinase activity in α -MSH-stimulated B16-F10 cells. The model group is normalized to 100%.

Discussion

At 100 $\mu\text{g/mL}$, melanin content was 23.7% lower and tyrosinase activity was 19.8% lower than the α -MSH model reference; cell viability was $93.4 \pm 2.9\%$. The same preparation also reduced intracellular ROS in H_2O_2 -challenged HaCaT cells. A redox-sensitive melanogenic response is consistent with the biology described for MITF/tyrosinase regulation and oxidative influences on pigmentation [1]–[6]. The concentration-dependent changes in two melanogenesis endpoints are more informative here than a single color-related assay alone.

Human studies give useful anchors for endpoint selection. Dumoulin et al. reported improved radiance/luminosity after eight weeks with a multi-antioxidant formula containing SOD-rich melon [10]. In the randomized study by Xie et al., L^* , ITA° , and melanin index changed over 12 weeks in adults receiving a multi-plant product containing Cucumis melo [11]. He et al. used a 12-week melon/olive/pomegranate intervention and observed changes in plasma antioxidant markers, L^* , and ITA° from week 8 [12]. Egoumenides et al. also demonstrated that a specific melon concentrate can alter an objective UV-response endpoint in healthy adults [9]. These studies used formulations different from BCLC®, but they show that instrument-based skin measures can be followed over an 8–12 week oral intervention period.

The delivery matrices should not be treated as interchangeable. BCLC® is a native melon SOD-polysaccharide-protein complex, whereas the skin studies above used multi-ingredient products or other SOD delivery systems [9]–[12]. The BCLC® cell experiments directly measured ROS, melanin, and tyrosinase for this preparation; the

human literature is most useful for choosing endpoints and trial duration rather than assigning those clinical outcomes to the current formulation.

The polysaccharide fraction is also part of the formulation architecture. Plant protein-polysaccharide interactions can alter colloidal behavior and protein conformation, with pH and ionic conditions influencing the complexes that form [14]. A complementary review of plant protein-polysaccharide complex coacervation likewise notes that composition and processing conditions shape the functionality of the resulting complexes [15]. In the optimized BCLC® reference preparation, 47.8% of SOD activity remained after 60 min of acid exposure. That retention measurement is relevant when defining an oral test material with reproducible enzyme activity.

Study Considerations and Future Directions

A BCLC® oral study can be built around prespecified L*, ITA°, melanin index, VISIA-based pigmentation, skin-tone uniformity, and participant-reported dullness scores. Standardized daily intake and an 8–12 week observation period would allow direct comparison with the timing used in the published skin studies. Baseline pigmentation, UV exposure, season, and phototype should be recorded because each can affect skin-color measurements.

CONCLUSION

Fundamental Finding: BCLC® reduced α -MSH-stimulated melanin content and tyrosinase activity across 25–100 $\mu\text{g/mL}$ while maintaining high cell viability, and the same preparation lowered H_2O_2 -induced ROS in HaCaT keratinocytes. **Implication:** Human melon-containing nutraceutical studies have used L*, ITA°, melanin index, melanin index, radiance, and related objective skin measures over oral intervention periods. **Limitation:** The findings are limited to in vitro models, including α -MSH-stimulated melanogenesis and H_2O_2 -induced ROS in HaCaT keratinocytes, and therefore they do not directly establish the effectiveness of BCLC® for improving skin brightness and tone uniformity in humans. **Future Research:** Those endpoints can now be applied directly to a formulation-specific BCLC® study of skin brightness and tone uniformity.

REFERENCES

- [1] A. Slominski, D. J. Tobin, S. Shibahara, and J. Wortsman, “Melanin pigmentation in mammalian skin and its hormonal regulation,” *Physiol. Rev.*, vol. 84, no. 4, pp. 1155–1228, 2004, doi: 10.1152/physrev.00044.2003.
- [2] S. A. N. D’Mello, G. J. Finlay, B. C. Baguley, and M. E. Askarian-Amiri, “Signaling pathways in melanogenesis,” *Int. J. Mol. Sci.*, vol. 17, no. 7, art. no. 1144, 2016, doi: 10.3390/ijms17071144.
- [3] I. F. D. S. Videira, D. F. L. Moura, and S. Magina, “Mechanisms regulating melanogenesis,” *An. Bras. Dermatol.*, vol. 88, no. 1, pp. 76–83, 2013, doi: 10.1590/S0365-05962013000100009.

- [4] M. Brenner and V. J. Hearing, "The protective role of melanin against UV damage in human skin," *Photochem. Photobiol.*, vol. 84, no. 3, pp. 539–549, 2008, doi: 10.1111/j.1751-1097.2007.00226.x.
- [5] 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.
- [6] 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.
- [7] 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.
- [8] M. Saby, A. Gauthier, S. Barial, L. Egoumenides, and B. Jover, "Supplementation with a bioactive melon concentrate in humans and animals: Prevention of oxidative damages and fatigue in the context of a moderate or eccentric physical activity," *Int. J. Environ. Res. Public Health*, vol. 17, no. 4, art. no. 1142, 2020, doi: 10.3390/ijerph17041142.
- [9] L. Egoumenides, A. Gauthier, S. Barial, M. Saby, C. Orechenskoff, 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.
- [10] M. Dumoulin, D. Gaudout, and B. Lemaire, "Clinical effects of an oral supplement rich in antioxidants on skin radiance in women," *Clin. Cosmet. Investig. Dermatol.*, vol. 9, pp. 315–324, 2016, doi: 10.2147/CCID.S118920.
- [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] Y. He, Y. Bu, C.-F. Chiang, Y.-H. Lin, C.-H. Liang, L.-P. Chan, and J. Sun, "Multi-plant concentrated powder improved skin whitening: A double-blinded, randomized, and placebo-controlled clinical study," *J. Cosmet. Dermatol.*, vol. 24, no. 2, art. no. e70011, 2025, doi: 10.1111/jocd.70011.
- [13] 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.
- [14] C. Schmitt and S. L. Turgeon, "Protein/polysaccharide complexes and coacervates in food systems," *Adv. Colloid Interface Sci.*, vol. 167, nos. 1–2, pp. 63–70, 2011, doi: 10.1016/j.cis.2010.10.001.
- [15] S. N. Warnakulasuriya and M. T. Nickerson, "Review on plant protein-polysaccharide complex coacervation, and the functionality and applicability of formed complexes," *J. Sci. Food Agric.*, vol. 98, no. 15, pp. 5559–5571, 2018, doi: 10.1002/jsfa.9228.

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