A paradigm shift in skincare through the power of grape seed-loaded liposomes

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The skin undergoes natural aging and is prone to various conditions/pathologies due to constant exposure to environmental stressors and abrasions. The cosmetic industry has revolutionized skincare, each time in a higher trend for natural and organic products. The growing trend of clean beauty, driven by consumer demand for non-toxic and environmentally friendly products, is increasingly intertwined with sustainability, as brands and consumers alike prioritize ethical sourcing, eco-conscious packaging, and responsible production practices to reduce environmental impact and promote holistic well-being. Plant-derived natural ingredients are increasingly popular in cosmetic formulations due to their bioactive properties and sustainability. Among these, grape by-products are notable for their bioactive molecules, which exhibit significant biological activities. Utilizing these by-products is crucial, but many bioactive compounds like polyphenols are unstable and prone to degradation. Encapsulation in liposomes has emerged as an effective strategy to enhance their stability, skin penetration, among other characteristics. This study involved the extraction of two grape seed extracts: one from a single grape variety (GSE-Ov) and another from a mixture of five varieties (GSE-Sv). Both extracts were evaluated for their antioxidant and antimicrobial properties, along with their chemical composition and molecular structure. The GSE-Ov extract demonstrated superior antioxidant activity, with a 2,2-Diphenyl-1-picrylhydrazyl (DPPH) IC_{50} of 0.079 mg/mL. It also showed antimicrobial effects against *methicillin-sensitive Staphylococcus aureus* (MSSA) and *methicillin-resistant Staphylococcus aureus* (MRSA), with minimum bactericidal concentrations (MBCs) of 3.125 mg/mL and 6.25 mg/mL, respectively. Furthermore, it did not display any antimicrobial activity against *Staphylococcus epidermidis*, what promises to not affect the skin microbiota equilibrium. The key polyphenols identified in GSE-Ov included gallic acid, catechin, and procyanidin B1, and FTIR analysis confirmed that the extraction process preserved the extract's molecular integrity. This extract was encapsulated in pectin-coated soy lecithin liposomes, achieving an encapsulation efficiency of 88.8% and a polyphenol release rate of 59.4% over 24 hours. The liposomes were stable, with a zeta potential of -20.3 mV, an average diameter of 13.6 µm, and a uniformity index of 0.637. They were found to be safe under the concentrations of 5 and 2.5 mg/mL in HaCaT and HDF cell models, respectively, and demonstrated anti-inflammatory effects against IL-1α at 2 mg/mL. This study is an evident first line of research that brings together the potential of grape-seeds as by-products and the clenched systems to encapsulate them. The study addresses all paradigms of eco-conscious innovation, sustainability and circular economy.

Keywords: Grape by-products; Cosmetic(s); Circular economy; Encapsulation; Liposomes.

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