

Skin Ageing: Reversing Cellular Senescence with Peptides and Exosome Therapeutics

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Abstract:

Skin ageing is a progressive biological process associated with oxidative stress, chronic inflammation, mitochondrial dysfunction, and extracellular matrix degradation, ultimately leading to cellular senescence and impaired skin integrity. The present study investigated the anti-ageing and cytoprotective activity of peptide and exosome treatments against H₂O₂-induced senescence in adult dermal fibroblast (ADF) cells. Cellular senescence was induced using hydrogen peroxide, followed by treatment with peptides and exosomes for 48 h under optimised conditions. Antioxidant activity was evaluated using the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay. Anti-ageing efficacy was assessed through collagenase, elastase, and hyaluronidase inhibitory assays. Intracellular reactive oxygen species (ROS) generation and mitochondrial membrane potential ($\Delta\Psi_m$) were analysed using 2', 7'-dichlorodihydrofluorescein diacetate (DCFH-DA) and Rhodamine 123 fluorescent staining, respectively. Senescence-associated alterations were assessed by morphological analysis and SA- β -galactosidase (SA- β -Gal) staining, while ELISA quantified inflammatory cytokines IL-6 and IL-1 β . The results demonstrated that peptide and exosome treatments significantly reduced intracellular ROS accumulation, restored mitochondrial membrane potential, enhanced antioxidant defence systems, and suppressed pro-inflammatory cytokine secretion in H₂O₂-induced senescent cells. Furthermore, both treatments exhibited substantial elastase inhibition, indicating preservation of extracellular matrix integrity. Moreover, senescence-associated staining analyses further confirmed attenuation of cellular senescence following treatment. Collectively, the findings suggest that peptide- and exosome-based interventions possess potent antioxidant, anti-inflammatory, cytoprotective, and anti-ageing properties with promising applications in regenerative dermatology and anti-ageing therapeutics.

Keywords:

Skin ageing, Cellular senescence, Exosomes, Peptides, Oxidative stress, Antioxidant activity, Inflammaging, Regenerative medicine.