ORAL COMMUNICATIONS

BIOFUNCTIONALIZED ELECTROSPUN FIBERS FOR SKIN REGENERATION

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Skin wound repair is a complex biological process requiring the precise coordination of cellular proliferation, cell–matrix interactions, cell migration and inflammatory signaling. Dysregulation of these events, particularly in chronic wounds, hinders effective tissue regeneration. In the field of regenerative biology, the development of biomimetic substrates that not only provide structural support but also actively modulate cellular behavior represents a promising strategy for effective healing.

Three-dimensional matrices were fabricated by electrospinning poly(3-hydroxybutyrate) (P3HB) to evaluate their potential in wound healing applications. Preliminary biological evaluation involved culturing murine fibroblasts (L929) directly on the P3HB scaffolds. Cell viability and metabolic activity were monitored over a 5-day culture period through MTT and LDH assays.

To enhance bioactive properties, P3HB fibrous scaffolds were functionalized with 4% hesperidin (P3HB-4H), a citrus-derived flavanone characterized by antioxidant, anti-inflammatory and regenerative properties. The immunomodulatory effect was then tested using human keratinocytes (HaCaT). Specifically, COX-2 expression was analyzed via immunofluorescence under basal conditions and following TNF-α-induced inflammation.

Results indicated the absence of cytotoxic effects and showed a steady increase in metabolic activity, suggesting that the three-dimensional scaffold effectively supports cell expansion. While TNF-α treatment induced high COX-2 levels in cells cultured on P3HB scaffolds, the hesperidin-loaded scaffolds significantly lowered this inflammatory signal, suggesting a potential anti-inflammatory effect mediated by the bioactive compound.

Cellular models based on keratinocytes and fibroblast-keratinocyte interactions are employed to more accurately reproduce the skin microenvironment and to investigate wound healing processes in vitro. This study highlights the ability of P3HB-4H to foster a pro-regenerative environment by dampening inflammatory pathways, making them suitable candidates for advanced skin repair strategies.