

The Sea Urchin Collagen, Recycled from the Food Industry Waste, is a Novel and Valuable Biomedical Resource

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Abstract

The marine environment could be a huge source of undiscovered “blue” materials that might be exploited for different applications. The sea urchin (*Paracentrosus lividus*) is a greatly appreciated food in Italy and other Mediterranean countries; however, its edible part is restricted to a small portion and the majority of the product becomes waste. Consequently, we proposed to recycle the sea urchin by-products, originated from the food industry (e.g., restaurants), and reconvert them into a valuable and innovative source of collagen to develop an innovative biomaterial for skin wound healing. In this work, we describe the application of a collagen-based skin-like scaffold (CBSS), a skin substitute previously developed by Ferrario et al. (2020), to treat experimental skin wounds in a large animal model. The wound healing process was assessed with clinical, histopathological, and molecular analysis at 7, 14, 21, and 42 days post-wounding. CBSS-treated wounds showed a reduction of inflammation in comparison to untreated ones. Moreover, the CBSS application improved cell proliferation and wound re-epithelialization, thus favouring wound healing. Concomitantly, the biomaterial induced the expression of VEGF-A, supporting neoangiogenesis and the maturation of the granulation tissue into a mature dermis. These results were further corroborated by the observed gene expression of collagen type I and III: the CBSS properly regulated the

expression of these two genes leading to an appropriate deposition of collagen in the wound bed. On the contrary, untreated wounds showed an altered gene expression of collagen type I and III, leading to the appearance of dermal fibrosis at 42 days. Moreover, histologically, treated wounds presented a correct development of skin adnexa since day 14; this observation was supported by the upregulated gene expression of hKER in treated wounds. Overall, the application of a biomaterial made with recycled collagen, obtained from the sea urchin by-products, led to a better quality of the healed skin, resembling its appearance before injury (i.e., presence of skin appendages, proper development and organization of the dermis). The positive results obtained in this study, make the sea urchin-derived CBSS a promising biomaterial for skin wound healing application demonstrating how “blue biotechnologies” might handle seafood waste in a sustainable and circular economy context.

Keywords: sea urchin; food waste; regenerative medicine; circular economy; marine collagen

References

Ferrario C., Rusconi F., Pulaj A., et al, 2020. From Food Waste to Innovative Biomaterial: Sea Urchin-derived Collagen for Applications in Skin Regenerative Medicine. *Mar. Drugs* 18, 414. doi: 10.3390/md18080414

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