SeaUrch-ink: a novel sea urchin collagen-derived bioink for sustainable 3d bioprinting applications

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Abstract

Marine-derived biomaterials are gaining attention in regenerative medicine for their biocompatibility, biodegradability, and bioactivity. Among them, native collagen extracted from sea urchin Mutable Collagenous Tissues is particularly promising. Our approach uses an environmentally-friendly, non-destructive method to isolate native fibrillar collagen from sea urchin waste, preserving its structural and functional integrity, including GAG decoration. Over the years this collagen has been used to develop scaffolds, which showed *in vitro* biocompatibility and cellular infiltration (Ferrario et al., 2020), and *in vivo* wound healing by controlling inflammation and promoting re-epithelialization (Carolo et al., 2023). More recently, hydrogels have also been explored. To further develop innovative biomaterials for biomedical applications, this study presents *SeaUrch-ink*: the first sea urchin collagen-based bioink for 3D bioprinting.
To improve printability and structural integrity, collagen fibrils (C) were combined with alginate (A), a marine polysaccharide. Various A:C ratios were tested, and printing parameters (needle size, pressure, and speed) were optimized. The hydrogels were crosslinked with CaCl to improve mechanical stability. The best-performing formulation resulted in structurally stable hydrogels which where charecterised by SEM analysis, degradation tests (in SBF and collagenase), and swelling behaviour.

SEM revealed aligned native collagen fibrils-key for cell guidance and mechanical performance. The hydrogels showed moderate degradation and typical swelling upon hydration.
These results highlight the potential of sea urchin collagen, combined with marine polysaccharides, as sustainable and innovative platform for bioprinting. Future work will focus on mechanical testing and *in vitro* biocompatibility to further investigate the biomedical potential of these novel sea urchin biomaterials.

Keywords: Sea urchin collagen, bioink, 3d bioprinting, hydrogels, collagen based biomaterials, biomedical applications

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