Cultivated Pocillopora acuta coral as a sustainable and effective biomaterial: enhanced osteogenic potential and structural integrity

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Abstract

This study explored the potential applications of cultivated corals as biomaterial sources for bone regeneration. *In vitro* assays revealed that *Pocillopora acuta* (PA) coral-derived material significantly enhanced the attachment and proliferation of MC3T3-E1 preosteoblasts, underscoring its superior osteoconductive properties. Optimal sintering conditions were identified at 400∘C, which effectively eliminated residual organic matter while preserving cell viability. Structural analyses using micro-computed tomography, scanning electron microscopy, and atomic force microscopy, indicated that sintering modified the coral porosity and crystalline structure, thereby supporting bone regeneration without compromising material integrity. Osteogenic differentiation assays further demonstrated that sintered PA corals promoted elevated levels of osteogenic markers, including alkaline phosphatase and osteocalcin, along with key transcription factors such as Runx2 and osterix. *In vivo,* implantation into rat cranial defects revealed that the sintered PA coral material significantly enhanced bone formation, exhibiting superior bone mineral density and regenerative mass compared with *Acorproa sp.* coral material and commercial products. These findings demonstrate that cultivated sintered PA coral-derived material is a promising candidate for a bone graft substitute, offering both ecological sustainability and effective bone regeneration potential. Future research should concentrate on assessing its long-term clinical applicability.

Keywords: Cultivated coral, Bone graft, Pocillopora acuta, Preosteoblasts, Sinter, Osteogenesis.

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