
SBPMat
B-MRS
SOCIEDADE BRASILEIRA
DE PESQUISA EM MATERIAIS
SALVADOR
XXIII B-MRS Meeting 2025
September 28th to October 2nd
BRICS
Brasil 2025

Starch-based biomembranes functionalized with annatto extract via HNADES; a promising approach for guided bone regeneration applications

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Bone defects remain a major challenge in regenerative medicine. Guided bone regeneration (GBR) uses biomaterials to assist bone healing, driving interest in bioabsorbable and bioactive alternatives [1]. Starch, a renewable polymer with good rheological properties, is suitable for biomembrane formation [1], while annatto extract offers known antioxidant and bioactive effects [2]. In this study, an apolar natural deep eutectic solvent (HNADES), composed of lauric and octanoic acids (1:1), was used to extract annatto compounds for incorporation into potato starch-based biomembranes. Ethanol extraction was also performed for comparison. Extracts were analyzed for pH, viscosity, color, and bioactive content (HPLC and spectrophotometry), along with antioxidant activity (ABTS). Biomembranes were prepared via solvent casting using 5 g starch (d.b.)/100 g solution, with 0, 5, or 10 g of annatto extract per 100 g starch, named Control, Extr_5%, and Extr_10%, respectively. NADES produced extracts with superior color, carotenoid content, and antioxidant activity, making it the preferred extraction method. Extracts up to 10% were evenly dispersed in the matrix. Increased extract levels reduced biodegradability, solubility, and wettability, while improving mechanical strength and rigidity, though reducing flexibility. The extract also increased surface roughness without affecting internal density. Membranes with 10% extract had higher antioxidant activity and total carotenoids. *In vitro* mineralization showed enhanced salt deposition, suggesting potential for GBR applications. Cell viability and further tests are ongoing. These biomembranes show promise as functional, bioactive materials for bone tissue engineering, particularly in applications related to Guided Bone Regeneration (GBR).

Acknowledgements
FAPESP (2020/08727-0, 2023/17512-6, and 2024/10994-8)

References
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