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3D printing chitin-based bilayer membranes for biomedical applications

Leonardo Henrique Semensato[1,2], Daniel Souza Correa[3], Danilo Martins dos Santos[4], Sérgio Paulo Campana Filho[5]

[1]Embrapa, [2]Sao Carlos Institute of Chemistry University of Sao Paulo, [3]Embrapa (*LNNA*) , [4]Embrapa (*Instrumentação*) , [5]Sao Carlos Institute of Chemistry University of Sao Paulo (*Físico Química*)

e-mail: leonardo-semensato@outlook.com

Direct ink writing (DIW) 3D printing was employed to produce bilayer membranes aimed at developing biomaterials potentially useful to be applied as: 1) wound dressing and 2) active drug delivery system for periodontal tissue regeneration. Beta-chitin (BCt) was subjected to acidolysis with concentrated HCl, and the resulting whiskers were characterized and then used for the preparation of both kind of biomaterials. Chitosan (CS) was synthed by employing a multistep ultrasound-assisted deacetylation process on beta-chitin, and subsequently subjected to a reaction with glycidyltrimethylammonium chloride, resulting in the production of cationized chitosan (CtCS), which was utilized for the development of a wound dressing. In this case, the ink was prepared by dissolving CtCS (2,9% w/v) in the beta-chitin whiskers aqueous suspension (10 mg/g), followed by the addition of genipin (0,5 mg/mL) to promote the crosslinking reaction. The ink used to the 3D printing of the other biomaterial was prepared by combining lipid nanoparticle-loaded grape seed extract and simvastastin, as well as beta-chitin whiskers, to result in a bilayer membrane that possesses antimicrobial properties and multi-scale porosity for periodontal tissue regeneration. Regardless of their compositions, both inks exhibited pseudoplasticity, thixotropy, and solid-like behavior under low oscillatory strain and liquid-like behavior under high oscillatory strain, which are considered ideal characteristics for DIW 3D printing. The 3D printing parameters were defined, in both cases, so that the membrane inner layer was porous and the outer layer was dense. Results show that the biomaterials produced in this study have a high potential to be applied as wound dressing and for periodontal tissue regeneration, both of which exhibited antimicrobial activity while the latter provided a sustained release of simvastastin and grape seed extract over 24 days. CNPq 311464/2022-0; FAPESP 2017/20973-4, 2018/22214-6, 2019/227