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Rheological evaluation of cassava and potato starch inks modified by ozonation for additive manufacturing of potential bone scaffolds

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Starch is a versatile raw material used in various industries, but its native form has limitations such as high swelling, low mechanical strength, and hydrophilicity [1]. Ozonation, a green modification technique, enhances starch properties and enables its use in 3D printing of bone scaffolds [2]. This approach combines starch's biocompatibility with the precision of additive manufacturing, offering promising applications in bone tissue engineering. Also, rheological studies of starch hydrogels are essential to optimize ink quality for printing [3]. In light of the aforementioned points, native and 30-minute ozonated (ozone processing conditions: 10 wt %; 1 L/min, 50 mg O_3/L, 25 °C) starch inks (hydrogels production: 10%wt, 85 ^{o}C, 30 min) from cassava and potato botanical sources were subjected to a comprehensive evaluation using a range of analytical techniques, including the collapse test, flow curve, strain sweep curve, thixotropy test, and recovery of apparent viscosity after 3D printing. The rheological performance was compared to the printability (printed stars and cylinders (printer: BioedPrinterV4 (BioEdTech, Brazil) analyzed by Image J software). The findings show that ozonated starch inks exhibit greater resistance to filament collapse, as indicated by the flow curves, which display pseudoplastic behavior in the hydrogels, following the Power Law. Furthermore, the strain sweep curves indicate a reduction in the loss factor (tan δ). This indicates a predominantly solid rheological behavior. Thixotropy showed that no statistical difference was observed in the recovery of apparent viscosity after 3D printing of starch inks from potatoes, but a percentage decrease was observed in those from cassava that were ozonated. Finally, rheological characterizations effectively predicted ink performance in relation to printability. Moreover, ozonation proved to enhance the quality of 3D printing, reinforcing their potential for bone tissue engineering applications.

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