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MECHANICAL AND BIOLOGICAL PROPERTIES OF BIO-BASED SCAFFOLDS FOR TISSUE REGENERATION

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Green polymers derived from vegetable oils are promising materials for production of scaffolds for tissue engineering due to their low cost, availability and biodegradability. Unsaturated vegetable oils could be precisely engineered at a molecular level into renewable polymeric scaffolds in a way similar to some polymers derived from petroleum-based monomers. The reactivity of the unsaturated bonds of the triglycerides is what allows vegetable oil to be used in oil based polymers. Herein we report the first preparation of scaffolds for tissue engineering based on semi-interpenetrating networks from soybean oil. Materials and Methods: Initially, epoxidized soybean oil (ESO) was synthesized by the Prileshjew's reaction. A solution of soybean oil (284 mM) and glacial formic acid (304 mM) was heated at a 50°C. Sulfuric acid (5 mM) was added into the solution. Then, H2O2 solution (1,032 mM) was added slowly from a dropping funnel and reacted at 50 °C for 7 h. The molar ratio of soybean oil: formic acid: hydrogen peroxide was 1:3:9. The crude product was filtered and washed thoroughly with distilled water until a pH of 7.0 was obtained. The oil phase was dried with anhydrous sodium sulfate and then filtered. Finally, the residual water was removed using a rotary evaporator at 50°C under vacuum. The epoxidation degree (ED) of ESO was calculated from the 1H-NMR. An ED of 75 % was obtained. Acrylated epoxidized soybean oil (AESO) was prepared after reaction between ESO and 2-hydroxyethyl methacrylate (HEMA). About 60 mM of ESO were placed in a 250 mL round-bottom flask equipped with a magnetic stirrer and a reflux condenser. Hydroquinone was used as a free radical inhibitor. The molar ratio of ESO: HEMA was 10:1. The reaction temperature under nitrogen atmosphere and time was 120 °C and 7 h, respectively. The reactional mixture was cooled to room temperature (25 oC) and diluted with hexane before purifying by thoroughly washing with distilled water. The final step was dehydration with anhydrous sodium sulfate and the solvent was evaporated using an evaporator. The number of HEMA groups/molecule of the resulting product was determined from the 1H-NMR spectrum. A mixture of AESO and 1 wt% of benzoyl peroxide was heated at 70°C for 20 min in a closed container before casting into a glass mold. Then, the mixture was cured at 90°C for 20 min in a thermal oven and at 90°C for 30 min in a vacuum oven sequentially. After washed thoroughly with distilled water the obtained membranes were lyophylized. Results and Discussion: Membrane surface and cross-section morphologies of the bio-based scaffolds were visualized by using SEM. As shown in this series of images, all the membranes have asymmetric structure consisting of a thin fine porous selective layer and much thicker porous sub-structure. The glass transition temperature (Tg) of the bio-based scaffolds were studied by differential scanning calorimetry (DSC). The Tg of PHEMA was 94°C while the Tg of the scaffold were in the range of –9 to 50°C. This may be due to the flexible and relatively short chains of the triglyceride in the produced bio-based scaffold contributed to the lower Tg. The Tg also depended on the number of HEMA groups. It was observed that more HEMA groups caused more crosslinking and produced a higher Tg. The biocompatibility evaluation of the bio-based scaffolds provides encouraging indications for long-term safety. In fact, in the cytotoxicity study, the material extracts did not induce toxic effects on the Chinese hamster ovary (CHO) cells, showing high cell viability of the synthesized bio-based scaffolds. The values of Young modulus (250 kPa) along with the calculated molecular weight between crosslinks for swollen bio-based scaffolds were determined. As expected, the E value increased with increasing HEMA concentration in AESO due to the increased crosslinking density. However, the E values obtained for the bio-based scaffolds were comparable to human skin. Conclusions: The results obtained in this work indicate that the bio-based scaffolds could be a good candidate for the biomedical applications, such as wound dressing and scaffolds for tissue engineering. The authors would like to acknowledge the financial support from the CNPq, CAPES, FAPEMIG and FINEP.