P38: Synthesis and characterization of oxidized bacterial cellulose through electrochemical methods: its biodegradability and potential as hemostatic material

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Abstract

Bacterial cellulose (BC) is a biocompatible material with high purity, high crystallinity, high degree of polymerization and high-water content [1,2]. It could be applied in several fields, being the biomedical field the most relevant to this work where biodegradability is a key requirement. BC may be chemically modified through its hydroxyl groups, e.g., by oxidation, becoming reabsorbable and acquiring new features, such as hemostatic behaviour. Oxidation of BC membranes was achieved through electrolysis using tetramethylpiperidine-1-oxyl (TEMPO) radical. TEMPO is able to perform selective oxidation of the primary hydroxyl groups, meaning that only C6 is oxidized into carboxyl groups [3].

BC membranes were characterized by FT-IR, SEM, XRD and 13C-NMR. The degree of oxidation was evaluated by titration of the carboxyl groups and the hemostatic behaviour was investigated through whole blood coagulation tests. Both in vitro and in vivo biodegradability of oxidized membranes was evaluated. In vitro biodegradability was assessed in ultra-pure water after 3, 7, 14 and 63 days of incubation while in vivo biodegradability was studied in a rat model, for 3, 14 and 56 days.

FT-IR spectra showed an increase on the absorption band around 1628 cm-1 attributed to the carboxylic acid vibration, as compared to non-oxidized membranes, revealing the formation of carboxylic acid groups [4]. SEM images revealed that the morphology of the membranes was not changed by the oxidation [5]. XRD patterns for all the oxidized samples were very similar to non-oxidized ones, suggesting that the crystal structure was preserved [6]. 13C-RMN results showed that the signal around 62 ppm corresponding to superficial C6 primary hydroxyl group decreased after the oxidation, while the peak around 174.6 ppm assigned to carboxylate groups appeared after oxidation, confirming the selective oxidation of C6 [7]. In vitro results showed that almost no degradation occurred on non-oxidized membranes demonstrating the relevance of the oxidation on the improvement on BC biodegradability. The hemostatic behaviour of the membranes evaluated through the whole blood clotting times assay demonstrated that, contrarily to non-oxidized membranes, the oxidized ones exhibited hemostatic activity [8]. In vivo biodegradability and biocompatibility of oxidized membranes was evaluated. Membranes were implanted subcutaneously and the inflammatory response was studied. The obtained results showed that there were no microscopic evidences of inflammation and even after 56 days of implantation, the oxidized membranes did not degrade completely. Nevertheless, oxidized membranes revealed good biocompatibility [9].

References

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