Cellulose Nanofibers Produced From Banana Peel by Chemical and Enzymatic Treatments: Characterization and In Vitro Cytotoxicity Assessment

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Introduction:
Cellulose has potential to be used in a variety of technological and environmental friendly applications. One of these possibilities is the development of biodegradable film composites. Cellulose nanofibers (CNFs) have been explored as an alternative to reinforce biopolymeric matrices, since they have potential to improve thermal stability, mechanical and barrier properties.

This study investigated the use of different treatments for the production of CNFs from banana peel (Musa paradisiaca) in order to apply them as a reinforcing agent in composite films.

Method:
CNFs were produced by chemical (NC) (acid hydrolysis with H2SO4) and enzymatic (NE) (hydrolysis with xylanase) treatments. Also, the insoluble residue from NE was treated with catalytic oxidation with 2,2,6,6-tetramethylpiperidine-1-oxyl (TEMPO) (NE-CO), tert-butanol (NE-Tb) or 2-(Diethylamino)ethyl chloride hydrochloride (NE-DEAE). Transmission electron microscopy (TEM) and dynamic light scattering (DLS) were used to assess CNFs morphology, diameter and surface charge (ζ-potential). Once these CNFs will be applied in biodegradable films, CNFs biocompatibility at different concentrations (50-5000 μg/mL) was evaluated via cell viability measurements (MTT assay) using Caco-2 cells. Data were analyzed (α=0.01) using ANOVA and Tukey's post hoc means comparison test.

Significance:
The different treatments isolated CNFs efficiently from banana by-products, which are very promising as reinforcing agent in biopolymeric matrices. Also, the toxicological assessment of CNFs shows the innovative character and quality of this scientific research.

Results:
TEM analysis showed that the treatments were effective for the isolation of banana fibers at nanometer scale, and suggested that amorphous fractions were removed. CNFs had an average diameter of 18.8 nm (NC), 3.7 nm (NE), 7.5 nm (NE-Tb), and 26.9 nm (NE-DEAE). NE-CO treatment was aggressive and degraded the fibers. NE-Tb treated samples showed CNFs to be better distributed and dispersed, once NE-Tb inhibited CNF aggregation. CNFs suspensions exhibited negative ζ-potential in water: -36.6 mV (NC), -29.1 mV (NE), -29.4 mV (NE-Tb) and -53.0 mV (NE-DEAE). The surface charge of CNFs produced with NE treatment increased considerably after the additional treatments (i.e. NE-Tb, NE-DEAE), which prevent the formation of CNF aggregates, thereby yielding a more stable colloidal suspension.

In vitro studies showed that CNFs produced were not cytotoxic at concentrations less than 2000 μg/mL.

Category:
Carbohydrate