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Toward oxidation of bacterial nano-cellulose

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ABSTRACT

In this study, the effect of oxidation treatments, using hydrogen peroxide (H_2O_2) and potassium periodate (KIO_4), on the significant properties of BNC was evaluated. According to the results, oxidation reduced tangling of the fibers, created porous structures, and also increased water absorption and water retention values. Oxidation was confirmed by observing the formation of hemiacetal bonds and COO^- bonds in FTIR. Mechanical properties of oxidized BNCs were decreased compared to neat BNC; however, OBNC-KIO_4 samples were still stronger than OBNC-H_2O_2 samples.

Keywords: BNC, oxidation treatment, mechanical properties, water retention

1. INTRODUCTION

Cellulose is a biopolymer obtained from biosynthesis of plants, animals, or bacteria, while the general term "nanocellulose" refers to cellulosic extracts or processed materials. Increased requirement for high performance materials with suitable mechanical and physical properties, makes nanocellulose the most interesting renewable material for advanced applications.

Among different types of nanocellulose, bacterial nanocellulose (BNCs) is a useful nanomaterial with special properties produced by several species of bacteria. The most common productive bacterium is *Gluconacetobacter xylinus* discovered in 1886 by A.J. Brown. Acetic acid bacteria (AAB) have a long history of use in several fermentation processes. Their exploitation gradually emerged in biotechnological applications, especially in the biosynthesis of useful chemicals and processes for the manufacture of several fermented food products. Taxonomic studies, from traditional to polyphasic approaches, have gradually allowed the proper classification of several ABB into distinct genera and species, among them, the BNC producers, notably *G. xylinus*.

Though the molecular formula and morphological structure of BNC is similar to nanocellulose obtained from wood, the former represents many advantages. It is pure cellulose with three-dimensional network which provides enhanced mechanical properties [1]. BNCs are excreted as exopolysaccharide at the interface to the air as ribbon-shaped fibrils, less than 100 nm wide, which are composed of much finer 2-4 nm nanofibrils [2]. The resulting form-stable bacterial cellulose is composed of an ultrafine nanofiber network structure enclosing up to 99% water [3]. The coefficient of thermal expansion of BNC nanofibers in the axial direction is similar to that of glass (as small as 0.1 ppm/K), Young's modulus (∼138 GPa) and tensile strength (estimated to be at least 2 GPa) of BNC nanofibers are almost equal to those of aramid fibers [4].

The main issue is that BNC has a similar chemical structure to other types of celluloses and is not degradable in the human body. Moreover, its chemical reaction with other materials is very weak or impossible due to lack of accessibility of hydroxyl groups and absence of other functional groups. Therefore, chemical and structural