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OBTAINING AND CHARACTERIZERING HYBRID NANOCELLULOSE PRODUCED FROM KOMBUCHA SCOBY VIA ACID HYDROLYSIS

Eduardo Luis Longoria [a]; Gustavo Henrique Cuoto[b]; Fernando Molin[b]; Marjorie Benegra[a]
[a] Post Graduate Program of Biomedical Engineering (PPGEB), Federal Technology University of Paraná (UTFPR), Curitiba, Brazil.
[b] Academic Department of Chemistry and Biology, Federal Technology University of Paraná (UTFPR), Curitiba, Paraná, Brasil

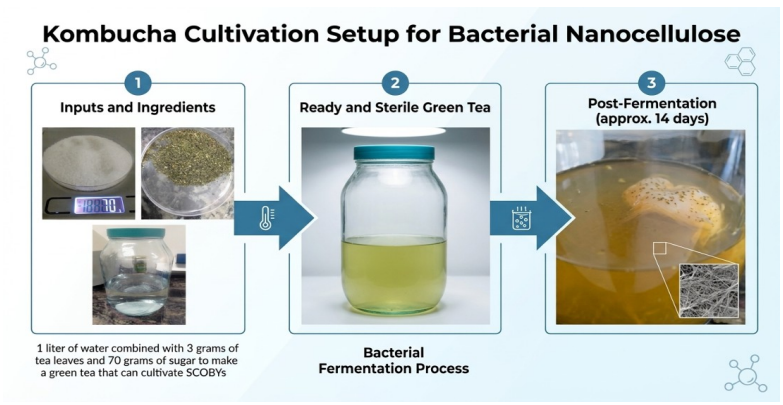
Introduction

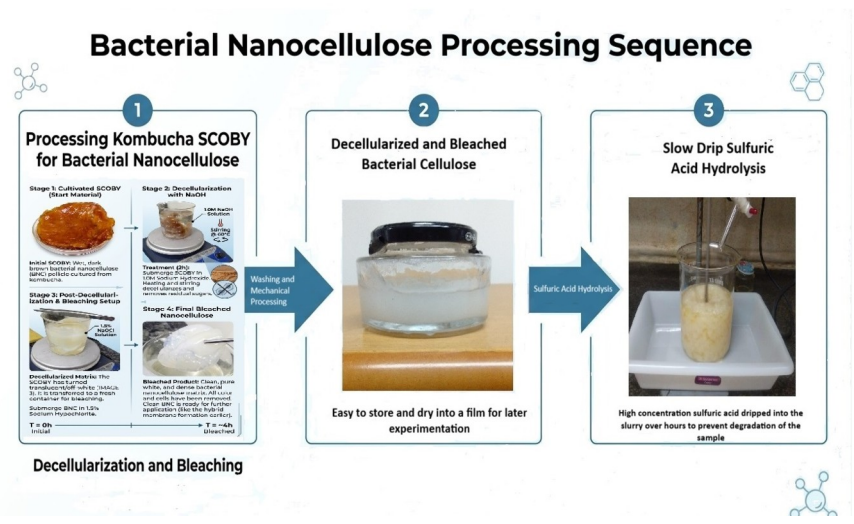
Bacterial nanocellulose (BNC) is seeing increased valorzation, and consequently valorizing waste streams like kombucha SCOBYs from the fermented beverage industry [1]. Processing methods, such as sulfuric acid hydrolysis, enzymatic treatment, or mechanical breakdown, can convert BNC into either short, rigid, rod-like cellulose nanocrystals (CNCs) or longer, flexible, network-forming cellulose nanofibers (CNFs) that retain amorphous regions [2,3]. To leverage the complementary properties of both forms, recent research focuses on developing hybrid cellulose nanomaterials (HCNs) like films, aerogels, and hydrogels by tuning CNC/CNF ratios for target applications, as well as utilizing them in colloidal systems such as Pickering emulsions where factors like pH, salt concentration, and age influence suspension stability [4, 5].

Objectives

Obtain hybrid nanocellulose from bacterial cellulose derived from kombucha SCOBY via acid hydrolysis and characterize its morphological and structural properties.

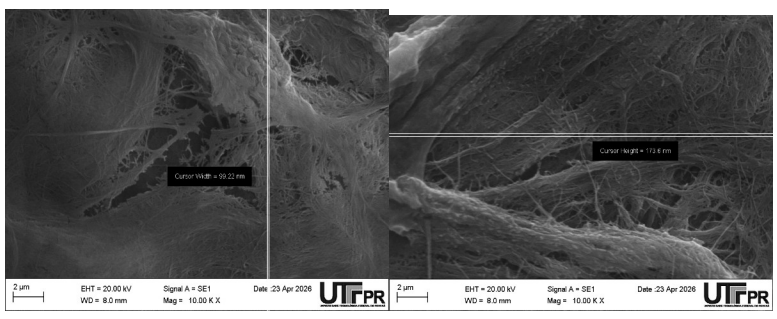
Methodology





Results and Discussion

The FTIR confirmed the existence of functional groups that are consistent with nanocellulosefibers and crystals. While this is the case the presence of a peak at 1743 does indicate the presence of C=O groups that is worth further investigation. The SEM images indicate the presence of structures consistent with cellulose nanofibers. This is corroborated by the 3D height measurements take by the AFM. The CNF/CNC hybrid shows many distinct peaks, consistent with crystal development, as opposed to the the SCOBY sample´s somewhat homogenous surface.



On the left; Image (a) presents a more compact and densified structure, whereas (b) reveals an interconnected, more porous fibrillar network. The morphological differences observed after acid hydrolysis suggest the presence of distinct nanocellulose arrangements, consistent with a hybrid structure exhibiting characteristics associated with both cellulose nanofibrils (CNF) and cellulose nanocrystals (CNC).

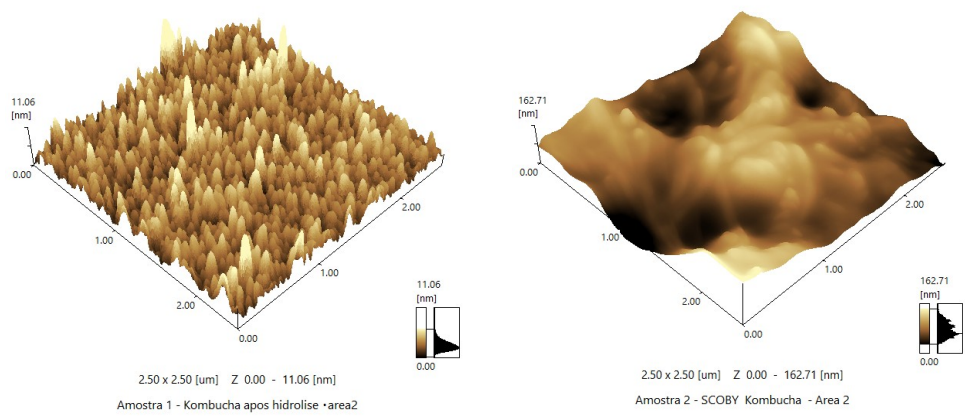


Figure 1. SEM and AFM Images

On the left; Image (a) presents a distinct pattern of individual crystals, whereas (b) reveals an interconnected, and broadly integrated fibrillar network.

AFM revealed differences in the topography of the SCOBY-derived cellulose deposits obtained before and after acid hydrolysis. In the regions evaluated, the hydrolyzed sample exhibited Ra and Rq roughness values substantially lower than those of the SCOBY sample. The variation between the two SCOBY fields indicates heterogeneity in the deposited material. These findings are consistent with morphological changes and/or alterations in the organization of the deposit following processing; however, they are not, in themselves, sufficient to confirm the production, proportion, or dimensions of the cellulose nanocrystals.

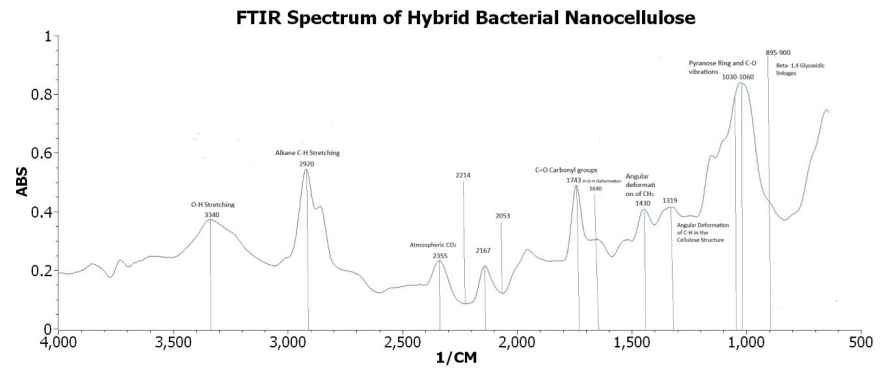


Figure 2. FTIR of Hybrid Nanocellulose and comparison



The reaction yielded a viscous paste that was measured to be 1.68% cellulose by weight. The paste when left in a drying oven yielded an incredibly light and thin film able to be easily examined in the FTIR.

Figure 3. Macroscale Images

Conclusions

The results indicate that sulfuric acid hydrolysis of Kombucha SCOBY cellulose produced a hybrid system containing both cellulose nanocrystals (CNCs) and cellulose nanofibers (CNFs). Despite the relatively high concentration of sulfuric acid used, the incomplete removal of amorphous cellulose suggests that the hydrolysis process can be modulated to retain both nanostructures. Given the established applications of CNCs and CNFs in Pickering emulsions and other colloidal systems, these results suggest that bacterial nanocellulose derived from Kombucha SCOBYs may serve as a viable and accessible raw material for producing CNC/CNF hybrid systems for laboratory applications.

References and Thanks

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