

# Isolation and Characterization of Nanocrystalline Cellulose from Totally Chlorine Free Oil Palm Empty Fruit Bunch Pulp

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## Abstract

Nanocrystalline cellulose (NCC) was isolated from a totally chlorine free (TCF) bleached oil palm empty fruit bunch (OPEFB) pulp via acid hydrolysis using a 58 % sulfuric acid concentration and ultrasonic treatment. The effects of acid concentration and hydrolysis time were investigated. Characterization of OPEFB–NCC was carried out using TEM, FTIR,  $^{13}\text{C}$ -NMR, XRD, zeta potential and TGA. The optimal hydrolysis time was 80 min as indicated by the leveling off of the OPEFB–NCC dimensions (length 150 nm and diameter 6.5 nm) with no significant loss of crystallinity at this point. The presence of a shoulder peak at  $1231\text{ cm}^{-1}$  (assigned to a sulfate group) in the FTIR spectrum of NCC is indicative of a successful esterification. This is further corroborated by the  $^{13}\text{C}$ -NMR analysis whereby the distinct C4 amorphous and crystalline peaks present in OPEFB–TCF pulp had almost disappeared and the cluster of signals for C2, C3, C5, and a well separated signal of C6 had merged into one single peak in the OPEFB–NCC sample. These observations allude to most of the amorphous region having been removed and to the strong possibility of sulfonation having not only occurred on the C6, but also on C2 and C3. OPEFB–NCC isolated over shorter hydrolysis time was more thermally stable; however, the char fraction decreases with hydrolysis time despite having a higher zeta potential. The results of this investigation demonstrate that NCC can be produced from pulp made by chlorine free environmentally benign processes with ensuing savings in energy and chemicals.

**Keywords :** Nanocrystalline cellulose Sulfuric acid hydrolysis Totally chlorine free Empty fruit bunch Ultrasonic treatment

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