

Modification of cellulose degree of polymerization by superheated steam treatment for versatile properties of cellulose nanofibril film

ABSTRACT

Cellulose from oil palm empty fruit bunch (OPEFB) was subjected to superheated steam (SHS) treatment at 150 °C for 1 and 2 h to produce cellulose with different degree of polymerization (DP). The treated OPEFB cellulose was subjected to a wet disc milling process to produce cellulose nanofibrils (CNFs), followed by nanocellulose film production using casting-evaporation technique. Reduction of DP by 23 and 40% were recorded after SHS treatment of OPEFB cellulose for 1 h (SHS1) and 2 h (SHS2), respectively, as compared to the untreated OPEFB cellulose. CNFs produced from treated cellulose (CNF-SHS1 and CNF-SHS2) exhibited smaller diameter and were less entangled compared to CNF from untreated cellulose (CNF-UT). These contributed to smoother CNF-SHS films. The highest light transmittance was recorded for CNF-SHS2 film, followed by CNF-SHS1 and CNF-UT films. The increment in transmittance value is in accordance with the reduction in cellulose DP. Lower DP also caused CNF-SHS films to have less wetting property as a result of smoother film surface. Mechanical properties were affected by DP values suggesting the possibility to control mechanical properties of CNF films in relation to DP. Overall, SHS is an efficient treatment method to reduce cellulose DP with the advantage of controlling CNF film properties towards the production of a versatile CNF film.

Keyword: Cellulose nanofibrils; Oil palm empty fruit bunch; Superheated steam; Degree of polymerization; Wet disc mill; Nanofilm