Beneficiation of wood sawdust into cellulose nanocrystals for application as a bio-binder in the manufacture of particleboard

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ABSTRACT:

This study reports on the beneficiation of wood sawdust into cellulose nanocrystals (CNC) for application as a binder in the manufacture of particleboard. The cellulose nanocrystal from wood sawdust was extracted using acid hydrolysis and an oxidizing agent. This was used as it is for particleboard fabrication, likewise, after cross-linking with several cross-linking agents, viz., CNC-glyoxal, CNC-hexamine, CNC-polyamide–epichlorohydrin, and CNC-polyethylene to make cross-linked binders. The tensile strength performances of the particleboard panels were determined by modulus of rupture (MOR) and elasticity (MOE). The characterization of the CNC by Fourier transform infrared spectroscopy (FTIR) confirmed cellulose functional structures in the CNC. X-ray diffraction (XRD) analysis indicated high crystallinity index (78%) of the CNC and typical nano-dimensions of 2.1–10 nm for diameter and 150–350 nm for length as revealed by the transmission electron microscope (TEM). Thermogravimetric analysis (TGA) and differential thermogravimetric (DTG) analyze high thermal stability (250–400 ℃) of the CNC. Significant mechanical strength performances of the particleboard panels were evident in the modulus of rupture (MOR) and the modulus of elasticity (MOE) values that were determined. The panels met grade 1-L-1 specification of the American National Standards Institute A208.1. The incorporation of cross-linking agents enhanced the static bending and bonding strength properties of the formulated bio-binders. It can be concluded that cellulose nanocrystals extracted from waste wood sawdust could be considered for use as a binder to produce environmentally friendly wood composites bio-adhesives and particleboard panel fabrication.