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Composite Materials from Beer Bran Fibers and Polylactic Acid: Characterization and Properties

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Abstract : This work presents the physical and chemical characterization of beer brand fibers and the properties of novel composite materials made of these fibers and polylactic acid (PLA). Treated and untreated fibers were physically characterized in terms of their moisture content (ASTM D1348), density, and particle size (ASAE S319.2). A chemical analysis following TAPPI standards was performed to determine ash, extractives, lignin, and cellulose content on fibers. Thermal stability was determined by TGA analysis, and an FTIR was carried out to check the influence of the alkali treatment in fiber composition. An alkali treatment with NaOH (5%) of fibers was performed for 90 min, with the objective to improve the interfacial adhesion with polymeric matrix in composites. Composite materials based on either treated or untreated beer brand fibers and polylactic acid (PLA) were developed characterized in tension (ASTM D638), bending (ASTM D790) and impact (ASTM D256). Before composites manufacturing, PLA and brand beer fibers (10 wt.%) were mixed in a twin extruder with a temperature profile between 155°C and 180°C. Coupons were manufactured by compression molding (110 bar) at 190°C. Physical characterization showed that alkali treatment does not affect the moisture content (6.9%) and the density (0.48 g/cm³ for untreated fiber and 0.46 g/cm³ for the treated one). Chemical and FTIR analysis showed a slight decrease in ash and extractives. Also, a decrease of 47% and 50% for lignin and hemicellulose content was observed, coupled with an increase of 71% for cellulose content. Fiber thermal stability was improved with the alkali treatment at about 10°C. Tensile strength of composites was found to be between 42 and 44 MPa with no significant statistical difference between coupons with either treated or untreated fibers. However, compared to neat PLA, composites with beer bran fibers present a decrease in tensile strength of 27%. Young modulus increases by 10% with treated fiber, compared to neat PLA. Flexural strength decreases in coupons with treated fiber (67.7 MPa), while flexural modulus increases (3.2 GPa) compared to neat PLA (83.3 MPa and 2.8 GPa, respectively). Izod impact test results showed an improvement of 99.4% in coupons with treated fibers - compared with neat PLA.

Keywords : beer bran, characterization, green composite, polylactic acid, surface treatment
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