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A NEW GREEN COMPOSITE BASED ON POLYLACTIC ACID MIXED WITH BIOMASS FROM UAE DATE PALM WASTE FOR CUTLERY AND FOOD PACKAGING APPLICATIONS

by

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Abstract

Petroleum-based plastic cutlery is widely used and due to their non-biodegradable properties, they cause serious threats to the environment. Therefore, there is a need to fabricate such products from biodegradable material. Date palm rachis waste (DPR) was used as a filler in three levels of 30 wt%, 40 wt%, and 50 wt% for cost-performance optimization balance and improving the thermal behaviors of the biodegradable polylactic acid (PLA). The preparation of biodegradable PLA/date palm waste composites was done using melt mixing extruder at 180°C by varying parameters such as mixing time, the composition of date palm waste biomass, biomass particle size, plasticizers type and plasticizers composition of 1%,5%, and 10% by weight. Biodegradable cutlery along with testing specimens were prepared by compression molding. The produced biodegradable composites were subjected to different characterization and analysis techniques, physical tests, thermal tests, and mechanical tests. Scanning electron microscope displayed a uniform dispersion of the DPR of 90 µm in the PLA matrix by the addition of 30 wt% biomass and the esterification reaction between –OH of the biomass, the carbonyl (C=O), and the terminal –COOH group in the PLA was observed from Fourier-transform infrared spectroscopy findings. The 30%DPR-PLA composite was considered as the optimum composite because it exhibited lower melt flow index (16 g/10 min) compared to the other two bio-composites, therefore, it will be the best option for processing in large-scale extruders. A slight increase in tensile strength of 30%DPR-PLA composite from 31.82 MPa to 33.20 MPa was noticed by the incorporation of 10 wt% Triethyl citrate (TEC). This research confirmed the superior effect of 10 wt% TEC compared with 10 wt% polybutylene adipate terephthalate (PBAT) in terms of improving the elongation at break of the 30%DPR-PLA composite from 1.8% to 4.20%. However, the water absorption of the 30%DPR-PLA composite for 24 hours was low in saline water (0.25 wt%) and tap water (1.48 wt%) compared with hot water at 50°C (9.34 wt%). On the other hand, the biodegradability tests in outdoor soil showed that the 30%DPR-PLA sample that was placed in the bottom of the watered soil had most color fade off with the highest weight loss of 3.06% after 4 months. This research will have positive consequences on the UAE economy and produce valuable green cutlery products aligned with both 2021 UAE Vision and 2030 Abu Dhabi Vision in terms of sustainability and innovation in the non-oil sector.

Keywords: Biodegradable, PLA, PBAT, TEC, Date Palm Waste, Cutlery, and Green Composites.