

The effect of filler loading, biological treatment, and bioplastic blend ratio on flexural and impact properties of blended bioplastic reinforced with spent coffee ground

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Abstract

In this study, the mechanical and morphological characteristics of poly(hydroxyalkanoate) (PHA)/poly(lactic acid) (PLA) blend matrix reinforced with spent coffee ground (SCG) were investigated across various weight ratios (100/0, 75/25, 50/50, 25/75, and 0/100) and SCG contents (10–40 wt%). SEM micrographs revealed a phase-separated structure with cracks on the fracture surface, consistent with the lower flexural properties of biocomposites. The incorporation of SCG reduced mechanical properties, mainly due to its incompatibility with the PHA/PLA matrix. Biocomposites with high SCG content demonstrated lower energy absorption capabilities, likely due to SCG aggregates acting as stress concentrators and disrupting load-transferring mechanisms. Moreover, increasing PHA content in the blends led to higher PLA crystallinity, as PHA acted as a nucleating agent for PLA. For biological treatment, biocomposites with PHA/PLA ratio (50/50) and SCG loading (20 wt%) were employed. The microscopic analysis highlighted well-dispersed treated SCG within the matrix and improved interfacial contact. Biocomposites with treated SCG demonstrated remarkable enhancements of 52% and 113% in flexural strength and modulus, respectively. These findings proved the effectiveness of sustainable fungal treatment in enhancing interfacial adhesion and improving the mechanical performance of biocomposites.

Highlights

- Percentage of SCG in bioplastic blend as a significant effect on the flexural properties and impact strength.
- The ratio of the bioplastic blend has the strong influence on the flexural properties and impact properties.
- Biological treatment of SCG has improved the interfacial interaction between SCG and bioplastic blend.
- The treated SCG has rougher surface which facilitates the interfacial locking between bioplastic blend and treated SCG.
- The biological treatment of SCG has improved the mechanical properties of the composites.