



Emerging hybrid particle-reinforced high-density polyethylene nanocomposite for bone replacement

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Abstract

The study harnesses snail shell and pumpkin pods (wastes) for green productions of materials for biomedical applications. Snail shell and pumpkin pod nanoparticles were produced and incorporated into the high-density polyethylene (HDPE). Nanoparticles and nanocomposites produced were examined. Results indicate that both nanoparticles are relevant medically and fit in as reinforcements for developing materials for biomedical applications. Improvement in the tensile properties, flexural properties, and impact energy values up to a certain percentage by weight of nanoparticles additions was noted with degradation in the fracture toughness and strain energy release rate at all percentages by weight of nanoparticle additions. Since maximum flexural strength was recorded at 4% by weight, properties of HDPE containing 4% by weight of the snail shell nanoparticles and that containing 2% each of the snail shell and pumpkin pod nanoparticles were compared with properties of the reported human cortical and trabecular bones in the literature. It is noted that mechanical properties of both nanocomposites are superior to those of the trabecular bones in the thoracic lumber region but are inferior to those of the cortical femoral bones. Therefore, both nanocomposites are mechanically suitable for biomedical applications as materials for replacing the trabecular bones in the thoracic lumber region. However, they are recommended for compatibility screening to ascertain their biological suitability.

Keywords Trabecular bone · Cortical bone · Nanocomposites · Mechanical properties · Suitability