Preparation and Characterisation of Cassava Starch-Based Film Reinforced with Plantain Trunk Nanowhiskers

Oderinde A. A.[1] & Adeosun,L. A.[2]

[1]Department of Science Laboratory Technology, Federal Polytechnic, Ilaro, Nigeria.
[2]Department of Chemistry, Federal College of Education, Abeokuta, Nigeria
Corresponding author email: abdulazeez.oderinde@federalpolyilaro.edu.ng

Introduction

Packaging materials for preserving, protecting, marketing and distributing foods reach consumers in safe and high-quality conditions. They can be rigid or flexible. They are created to prevent the deterioration of food as a result of exposure to air, moisture, or pH changes related to the food or its surroundings. Petroleum-based polymer materials like polypropylene (PP), polyester (PET), and polyethylene (PE) have been widely used in packaging because they are cheap, readily available, strong, and malleable upon heating. However, their production and use have led to fossil fuel depletion, increased greenhouse gases, non-biodegradable solid waste pollution, and other environmental problems. Biopolymers have gained attention as eco-friendly alternatives because of their environmental benefits. They can act as effective barriers against gases and solutes, enhancing food quality and extending shelf life, and can be infused with a range of additives such as antioxidants, antimicrobial agents, and nutrients. Starch is a biopolymer that can function in film-forming for packaging. Its use is, however, restricted by poor mechanical and barrier properties, high humidity sensitivity and hydrophilicity. The properties of starch films are improved by reinforcement with cellulose. Cellulose can be obtained from different agricultural wastes such as leaves, plantain trunk, rice husk, corn cob, etc. This study thus examines the effect of varying concentrations of plantain trunk cellulose nanowhiskers on selected properties of cassava starch films.

Materials and methods

Cellulose nanowhiskers were extracted from the plantain trunk using the acid hydrolysis method. Cassava starch-plantain trunk nanowhiskers films (bionanocomposite films) were prepared by the casting method using varying concentrations of nanowhiskers (0.20, 0.25, 0.30, and 0.35% w/w). The structural integrity, crystallinity, thermal, and mechanical properties of cassava starch film (CS00) and the bionanocomposites films (CPT20, CPT25, CPT30 and CPT35) were determined using Fourier transform infrared (FTIR) and scanning electron microscopy (SEM), X-ray diffraction (XRD), thermogravimetric analysis (TGA), tensile strength and Young modulus.

Results and discussion

Bionanocomposite films had rough surfaces with increasing roughness as the nanowhiskers content increased. X-ray diffractograms revealed prominent 2θ values at 5, 13.5, 15, 20, and 60.5^{o} . Results of thermogravimetric analysis (TGA) showed improved thermal resistance following reinforcement. Film mechanical properties, measured as tensile strength and Young modulus, ranged from 32.7±2.5-42.0±2.4 MPa, and 311.0±4.4 - 350.0±3.2 MPa, respectively.

Conclusion

There was consistent dispersion and robust interfacial contact between the neat cassava starch and the plantain trunk cellulose nanowhiskers, implying that plantain trunk nanowhiskers have the potential to function efficiently in bio-nano composites for use in sustainable packaging.

Keywords: Sustainability, Degradability, Polysaccharides, Optimisation,