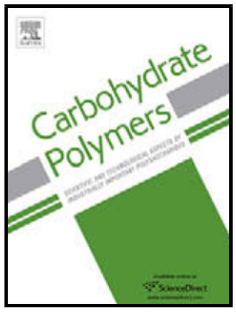

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A new biodegradable sisal fiber–starch packing composite with nest structure

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Highlights
A biodegradable composite was proposed which can replace EPS as packing material.
Cushioning property of composites improve as the density of nest structure increases.
Nest structure becomes dense first and then loosens as the fiber content increases.
Alkaline treatment promotes the formation of dense nest structure.
Weight loss of the composite was 62.36% after biodegradability tests for 28 days.

Abstract
A new completely biodegradable sisal fiber–starch packing composite was proposed. The effects of fiber content and alkaline treatment on the cushioning property of the composites were studied from energy absorption efficiency, cellular microstructure and compatibility between fiber and starch. With increasing fiber content, the nest structure of composites becomes dense first and then loosens, resulting in initial enhancement and subsequent weakening of the cushioning property of the composites. The composite with 4:13 mass ratio of fiber and thermoplastic starch (TPS) exhibit the optimal cushioning property. Alkaline treatment increases the compatibility between sisal fiber and TPS, promotes the formation of dense nest structure, thereby enhances the cushioning property of the composites. After biodegradability tests for 28 days, the weight loss of the composites was 62.36%. It's found that the composites are a promising replacement for expandable polystyrene (EPS) as packing material, especially under large compression load (0.7–6 MPa).

Keywords: sisal fiber–starch packing composites; alkaline treatment; cushioning property; nest structure; compatibility; biodegradability

1. Introduction

The application of plastic packing materials has brought considerable convenience to human society, but also leads to “white pollution” and other environmental problems. To solve these problems, scholars have focused on the use of biomass composites in recent decades; these composites prepared using renewable natural polymers (e.g., cellulose, lignin, starch, chitin, and protein) are ideal substitutes for plastic packing materials (Francucci & Rodriguez, 2016; Yan, Chouw, & Jayaraman, 2014; Dicker et al., 2014). Plant fiber and starch as renewable polymers are ideal materials for preparation of biomass composites due to its characteristics, such as wide