

Abstract

Valorization of Pecan Nutshell for the Design of Sustainable Polymeric Materials [†]

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Global pecan nut production is projected to generate USD 3.54 billion by 2033, with a 7.3% Compound Annual Growth Rate (CAGR) between 2023 and 2033 [1]. In 2024, Mexico accounted for 50–55% of global production, mainly in the states of Chihuahua, Sonora, and Coahuila. Roughly 50% of pecan weight corresponds to the woody shell, representing 1–1.5 million tons of nutshell residue annually, of which more than 60,000 tons per year are produced in Mexico. This positions the country as a key source of raw material for the development of biodegradable materials [2].

Pecan nutshell (PNS) is an abundant agri-food byproduct, rich in lignocellulose and phenolic compounds, which has gained increasing attention for its potential in sustainable material development, particularly in food technology [3]. Research efforts have focused on its valorization through hydroalcoholic extraction, chemical modification, and physical treatments, resulting in materials with enhanced functional properties.

This presentation highlights research progress since 2013 on the use of PNS in polymeric materials for active and biodegradable packaging. Its structural and functional attributes enable its incorporation as a reinforcing agent or bioactive source in polymer systems, improving mechanical strength, barrier performance, and bioactivity.

Overall, PNS emerges as a versatile functional ingredient, aligned with the principles of the circular economy, sustainability, and food safety. Its valorization not only reduces agricultural waste but also supports the transition toward responsible, eco-friendly solutions in the agri-food sector.

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