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PECAN NUT SHELL AS A SUSTAINABLE SOURCE OF MULTIFUNCTIONAL COMPOUNDS FOR ACTIVE PACKAGING, FOOD COLORANT STABILIZATION AND SYNTHESIS OF SILVER NANOPARTICLES

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PURPOSE OF THE ABSTRACT

The search for natural and sustainably produced antioxidant additives for use in health, food, or cosmetic applications has received considerable attention in recent years, prompted also by the increasing need for green approaches to innovative functional materials. In this context, agri-food by-products represent an easily accessible source of antioxidant phenolic compounds [1], which have found increasing applications in materials science. Remarkable examples include incorporation into polymers for both stabilization and functionalization purposes for application in active food packaging [2], or their use as reducing agents for the preparation of silver nanoparticles (AgNP) under environmentally friendly conditions, to be applied in catalysis, photonics, electronics, or in medicine, as bactericidal, antifungal and antitumor agents [3]. Among agri-food by-products, pecan nut shell (PNS), which is produced in high amounts (ca. 420,000 tons per year) from pecan nut processing, occupies a prominent role as a green and easily available source of antioxidant and antimicrobial phenolic compounds [4]. In this context, we report herein data concerning the possible use of PNS-derived phenolic compounds in the food industry and in the development of AgNP-based photocatalytic and antibacterial devices.

First, a PNS hydroalcoholic extract (PNSE) was prepared and characterized. In particular, it was found to contain condensed, prodelphinidin-type tannins as the main phenolic components, as demonstrated by chemical degradation and electron paramagnetic resonance (EPR) experiments, and it showed remarkable antioxidant

properties in several chemical assays. PNSE was found to be able to inhibit the enzyme tyrosinase and to act as an efficient anthocyanin stabilizer. In order to explore the possibility of using PNSE as a functional additive for active packaging, polylactic acid (PLA) films containing PNSE were prepared by solvent-casting. These films showed remarkable antioxidant properties and were able to delay the onset of browning in apple smoothies [5].

Whey protein (WP)-based edible films functionalized with PNSE were also prepared and characterized. PNSE was able to significantly improve the film mechanical and barrier properties and also to impart antioxidant properties to the film. WP/PNSE films also inhibited the growth of the foodborne bacteria E. faecalis and S. enterica subsp. enterica ser. Typhimurium [4].

A low-cost, scalable and straightforward mechanochemical protocol for the production of AgNP based on the use of PNS as reducing agent has been also recently developed. Under the optimized conditions, a complete reduction of silver ions was achieved, leading to a material containing ca. 30% w/w Ag(0). Model photocatalytic experiments indicated a good efficiency of AgNP/PNS in the degradation of methylene blue, with a good recycling stability. AgNP/PNS exhibited also antimicrobial properties against E.coli and S. mutans [6].

Finally, the results of ongoing studies describing the possibility to recover polymeric phenolic compounds, mainly lignin, from PNS through green protocols based on the use of deep eutectic solvents will be also reported [7].

In conclusion, the results of these studies open new perspectives for the exploitation of PNS as a low cost and green source of multifunctional polyphenols, endowed with efficient antioxidant and reducing properties for food industry applications or for the preparation of photocatalytic and antimicrobial devices (Figure 1).

FIGURES

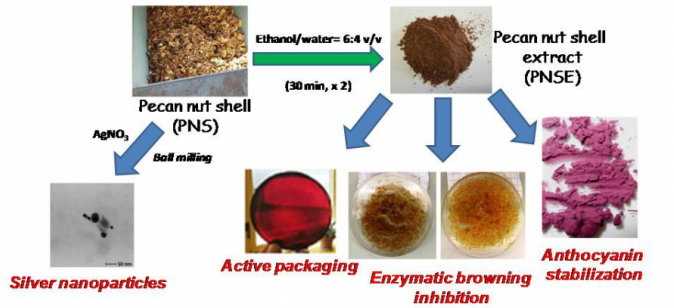

FIGURE 1

FIGURE 2

Figure 1

Overview of the proposed applications of PNS.

KEYWORDS

silver nanoparticles | antioxidant | antimicrobial | food packaging

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