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Smart biomaterials derived from biomass and metal nanoparticles for advanced multifunctional food packaging

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Introduction

Bio-based smart materials are a potential option for food packaging in terms of sustainability and real-time monitoring of food quality, assuring health safety and providing economic and environmental benefits. Biopolymer matrices show physico-chemical and functional properties which make them suitable alternatives to petroleum-derived polymers, including optical, mechanical, barrier and biodegradability characteristics. Biocomposites containing metal nanoparticles (NPs) are gaining importance in active food packaging since they could play a double role: NPs can act as nanofillers to enhance mechanical and barrier properties and they can also interact directly with food due to their potential antimicrobial/antioxidant activity.
The considerable impact and new trends based on agricultural biomass represent a sustainable, extensive and accessible source of bioactive compounds (polysaccharides, proteins, lignin, cellulose, hemicelluloses, polyphenols, flavonoids, natural dyes) which can be converted to new and eco-friendly high added-value products. These natural compounds can be obtained by using advanced sustainable methods based on microwave-assisted extraction (MAE) and ultrasound-assisted extraction (UAE). Anthocyanins are natural pigments present in plants and fruits which are highly responsive to pH changes, which makes anthocyanin-rich films able to monitor the quality of packaged foods. Anthocyanins from renewable sources, such as those derived from blood orange, have great potential for sensing chemical and physical changes in the environment to monitor food quality, such as for protein-rich foods. In the process of protein decomposition (meat, fish), many volatile substances will be produced, resulting in an alkaline atmosphere in the packaging, modifying the visual appearance of anthocyanin-based materials.

Experimental

In this work, several successful examples of functional smart and active biomaterials derived from agro-food waste valorization will be studied. Novel innovative nano-biomaterials for food packaging applications added with ZnO-NPs and Se-NPs obtained through a green synthesis method by MAE from cocoa bean shell waste will be shown. Moreover, smart biomaterials derived from blood orange will be developed by using peel wastes and anthocyanins from orange juice. Different anthocyanins encapsulation sustainable strategies will be followed for their preservation.

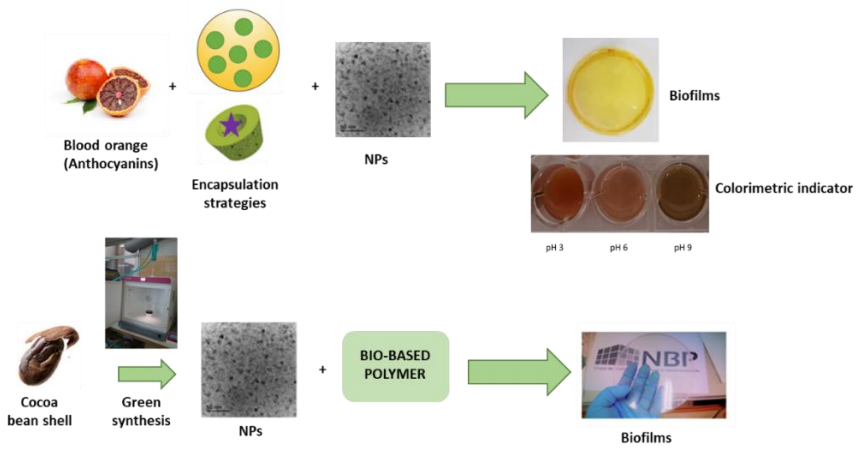

Figure1. Scheme of the experimental methodology followed in this work.

Results and Discussion

MAE and UAE have demonstrated excellent performance for the extraction and synthesis processes of active biomolecules and metal nanoparticles (NPs), respectively. The obtained NPs were successfully incorporated into bio-based polymers to obtain functional nanocomposite films improving thermal, mechanical, UV and water vapour barrier properties. Antimicrobial and photocatalytic properties were also enhanced. A high encapsulation performance was obtained for the studied biomaterials and the developed anthocyanins-based systems showed high antioxidant activity and sensitivity to pH changes to be used as smart food packaging materials.

Conclusions

Biomass derived biomaterials based on anthocyanins and/or metal nanoparticles have shown potential applications for the development of smart systems for food packaging, increasing sustainability, food safety and contributing to the circular economy.

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Biography

María Carmen Garrigós, Chemistry PhD (2003). Full Professor in the University of Alicante (Spain). Multidisciplinary expertise on Analytical Chemistry, Polymer Science and Food Science. She is currently the head of the Research Group in Polymer and Nanomaterials Analysis (NANOBIOPOL). Author of 100 research papers with an h index of 32. She has participated in 45 research competitive research projects with public financing (20 of them as Principal Investigator), including 5 consecutive national projects and 5 international projects. She has been co-chair of the last BIOPOL-2022 conference.