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Hydrophobic natural deep eutectic solvents as efficient solvents to recover astaxanthin from brown crab shell residues

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PURPOSE OF THE ABSTRACT

Every year, 6 to 8 million tonnes of waste crab, shrimp and lobster shells are produced glob-ally, which represent an economic burden for shellfish processing companies, particularly in developed countries [1]. However, these shell residues still harbour interesting chemicals, including 20 to 50% of calcium carbonate, 20 to 40% of protein, 15 to 40% of chitin and some minor components, such as astaxanthin and lipids [1, 2]. Therefore, these waste streams, which are an abundant and cheap renewable resource, can represent an opportunity to convert low status wastes in valuable products [3]. In particular, there has been a growing interest in recovering marine carotenoids, such as astaxanthin, for their diverse biological functions and potential application in health, food/animal feed or in personal care/cosmetic products [4, 5].

Deep eutectic solvents (DES) - mixtures of two or more compounds that upon mixing at a determined molar ratio suffer a high melting temperature depression - and more specifically natural DES (NADES), which are based on natural compounds, have been gaining interest in the research community, for their possible application as green solvents in extraction of natural matrices or in biomass processing [6, 7].

Within this context, we aim at exploring the potential of novel NADES to convert by-products and wastes resulting from the Portuguese shellfish industry into high added value products. Particularly, in this work, our goal was to design hydrophobic terpene-based NADES, to efficiently extract astaxanthin from brown crab shell residues.

NADES were prepared by heating the mixture of the two components to 55°C under constant stirring, until a clear liquid was formed. To confirm their successful production, NADES were characterized by different techniques, including DSC, FT-IR and NMR. Furthermore, important physical properties of each solvent, such as density, viscosity and polarity were also studied. The effect of different process parameters on the extraction performance of the hydrophobic NADES prepared were evaluated and optimized, including operating temperature (30 - 60°C), extraction time (2 - 24h) and solid/liquid ratio (0.125 - 0.25gresidue/gNADES), in order to maximize the yield of

astaxanthin recovered from brown crab shell residues. Extractions using NADES were compared with a conventional solid-liquid extraction using acetone as solvent. All resulting extracts were characterized in terms of astaxanthin content by UV-VIS. To evaluate the possible application of astaxanthin-rich extracts as bioactive ingredients, their cytotoxicity was assessed, and samples were screened for their cosmetic and anti-aging potential.

The processes established in this work will allow the utilization of currently undervalued crab shell residues that will give origin to new products, with potential application in cosmetics or personal care products. Furthermore, by recovering the astaxanthin and consequently decolouring the shell residue, is still possible, within a holistic approach for their efficient exploitation, to use the remaining solid effluent to further extract pure and colourless proteins and chitin.

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS

Brown crab shell residues | Natural deep eutectic solvents | Astaxanthin | Biorefinery concept

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