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Pumpkin by-products as a source of preservative compounds for food application: valorization of industrial bioresidues towards a sustainable system

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Considering the interest in replacing synthetic additives with healthier natural alternatives, bioresidues from industrial processes can be an alternative source of rich and cheap compounds to be explored for this. Parts of fruits and vegetables, such as peels, seeds, and leaves, which are often discarded, have been investigated due to their important amounts of high value-added compounds, as well as their potential to be recovered and incorporated into food products. Pumpkin industrialization fits into this scenario: in the pulp processing, large amounts of bioresidues are generated and still undervalued despite being rich in nutritional and bioactive compounds.¹ In this work, the by-products of three varieties of Portuguese pumpkins were evaluated as source of preservative compounds, fostering the circular economy and the valorization of local products. For this purpose, the peel, seeds, and fibers of butternut squash, common pumpkin, and kabocha squash, grown in Bragança – Portugal, were evaluated in terms of their bioactive potential and their composition in tocopherols. For the antioxidant capacity assessment, the hydroethanolic extracts were evaluated through five methods, three chemical (DPPH scavenging activity, reducing power, and β -carotene bleaching inhibition) and two biological (TBARS and OxHLIA) methods. The antibacterial and antifungal capacity of the extracts was tested against five strains of gram-negative bacteria, three gram-positive bacteria, and two strains of fungi with relevance in food, in the maximum concentration of 10 mg/mL. The cytotoxicity was tested in a primary culture of non-tumor porcine liver cells, PLP2, using the sulphorhodamine B (SRB) assay. The samples composition in terms of tocopherols was determined by HPLC coupled to a fluorescence detector.

The evaluated pumpkin by-products presented great bioactivity. Regarding the antioxidant activity, the seeds stood out in both biological methods, being the butternut and kabocha varieties the best ones. In the chemical assays, the results were more heterogeneous, but it is possible to highlight the fibers as the samples presenting the best results, followed by the seeds and, then, the peel. Moreover, in terms of pumpkin varieties, the kabocha squash presented the best result in three of the five assays (DPPH, β -carotene, and TBARS). In the antimicrobial and antifungal activity, the fibers of Butternut squash stood out inhibiting all the tested strains, followed by the fibers of common, and the seeds and the peel of kabocha, which revealed inhibiting capacity against seven bacteria and one fungal strain, in a lower concentration than the other samples. In fact, all samples have inhibited just one of the two fungal strains. None of the samples presented bactericidal nor fungicidal capacity at the tested concentrations and all samples inhibited at least three strains of bacteria. In addition, none of the tested samples showed hepatotoxic activity in a primary culture of non-tumor porcine liver cells (PLP2), at the maximum concentration tested of 400 μ g/mL, demonstrating their safety for food application. Furthermore, all samples presented α -tocopherol, which is the most biologically active isoform of vitamin E. None of the samples presented β -tocopherol and three samples presented the δ isoform. In the samples where γ -tocopherol was found, it was the major one. The peel of common pumpkin presented the highest total tocopherol content. The fibers of kabocha were not assessed due the insufficient quantity of sample, once the content of fibers in this variety was very low.

These results demonstrate the potential of pumpkin by-products to be exploited as a source of high value-added compounds with preservative capacity. As a next step, studies can be carried out on the recovery and application of these compounds in food products, in order to promote a sustainable system focused on a circular economy and the development of healthier food products.

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