1st Research Meeting on Biochemistry

SOLANACEAE CROP BY-PRODUCTS AS RENEWABLE SOURCES OF BIOACTIVE PHENOLIC EXTRACTS

Mikel Añibarro-Ortega[1,2], Jovana Petrović[3], Maria Inês Dias[1], Alexis Pereira[1], Marina Soković[3], Isabel C.F.R. Ferreira[1], Miguel A. Prieto[2], Jesús Simal-Gándara[2], José Pinela[1*], Lillian Barros[1]

[1]Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança, Bragança, Portugal, [2]Nutrition and Bromatology Group, Department of Analytical and Food Chemistry, Faculty of Food Science and Technology, University of Vigo, Ourense, Spain, [3]Institute of Biological Research "Siniša Stanković"- National Institute of Republic of Servia, University of Belgrade, Serbia. *jpinela@ipb.pt

Abstract

This work describes the phenolic composition and some biological activities of bell pepper and eggplant by-products, and was conducted to promote the sustainable reintroduction of these resources in the food value chain. Hydroethanolic extracts from these by-products were prepared and used for the characterization of the phenolic profiles and evaluation of antioxidant and antimicrobial activities. The bell pepper by-product extract had a qualitative prevalence of flavonoids and a better performance in the lipid peroxidation and oxidative hemolysis inhibition assays, as well as greater antifungal activity. In turn, phenolic acids stood out as main compounds in the eggplant by-product extract, which presented higher activity against the tested bacterial strains. Overall, the obtained plant extracts seem to be appropriate for the development of alternative food preservatives.

Introduction

The upcycling of agri-food by-products into high added-value products has been promoted in recent years. Solanaceae is one of the main plant families supplying important vegetable and staple food crops worldwide. Bell pepper (*Capsicum annuum* L.) and eggplant (*Solanum melongena* L.) (**Fig. 1**), are two good examples, and their agricultural production generates million tons of valueless crop remains (especially plant aerial parts) [1], whose insertion in the value chain needs to be promoted and investigated to ensure the efficient use and circularity of these natural resources. Moreover, while the fruits of these species are well characterized for their nutritional value [2], the residual biomass of these crops remain unexplored, and little is known about their composition in bioactive constituents.

Fig. 1. Bell pepper (left) and eggplant (right) fruits and aerial parts.

Therefore, this work aimed at characterizing the phenolic compounds of bell pepper and eggplant crop by-products and evaluating the antioxidant and antimicrobial activities, in order to find possible industrial applications and a way to re-insert these by-products in the agri-food value chain.

Materials and methods

Bell pepper and eggplant aerial parts (mostly leaves and stems) were supplied by local famers from Bragança, Portugal. The hydroethanolic extracts of both plant materials were obtained by dynamic maceration. The freeze-dried extract were redissolved, filtered and analyzed in a HPLC-DAD/ESI-MS^n system [3]. Compounds from the obtained chromatograms were identified with commercial standards and based on the MS data from the literature.

Antioxidant activity was evaluated *in vitro* through two different biological assays: i) oxidative hemolysis inhibition assay (OxHLIA), in which the used substrate was a red blood cell (RBC) solution, and the results were represented as IC_{50} (µg/mL) for a Δt of 60 min, which means the concentration capable of keeping intact 50% of the RBC population for 60 min; and ii) thiobarbituric acid reactive substances (TBARS) formation inhibition assay, where the used substrate was a porcine brain cell solution, and the results were expressed as IC_{50} (µg/mL), which means the concentration that produces 50% of antioxidant effect.

Antimicrobial activity was tested against foodborne fungi and bacteria by serial microdilution methods [3]. The extracts were tested against 3 Gram-positive and 3 Gram-negative bacteria, and 6 fungi strains.

Results

Both extracts contain phenolic compounds such as phenolic acids and flavonoids. The bell pepper by-product extract showed a qualitative predominance of flavonoids. In turn, phenolic acids stood out as main compounds in the eggplant by-product extract (**Fig. 2**).

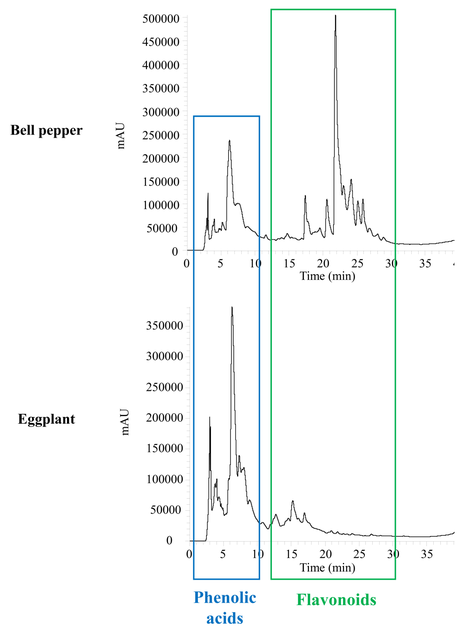

Fig. 2. Chromatograms of bell pepper and eggplant by-products hydroethanolic extracts. Both extracts were dissolved in MeOH/$H_2$0 20:80 (*v/v*) and eluted with the same chromatographic gradient.

Luteolin-*O*-malonyl-pentoside-hexoside was an abundant flavonoid in bell pepper by-product, and 3-*O*-caffeoylquinic acid was a predominant phenolic acid in eggplant by-product. Regarding antioxidant activity, the OxHLIA assay showed that bell pepper by-product extract presents a higher capacity to inhibit oxidative hemolysis for 60 min, and the TBARS assay revealed that this extract has also a greater capacity for inhibiting lipidic peroxidation in porcine brain cells (**Fig. 3**).

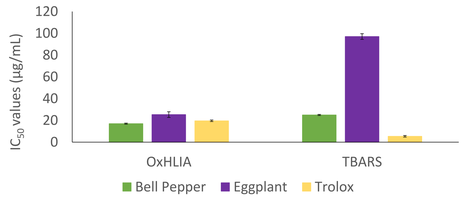

Fig. 3. Results of the OxHLIA and TBARS assays for bell pepper and eggplant by-product extracts.

The bell pepper by-product extract showed greater antifungal activity than the eggplant by-product extract. It presented activity against fungi from the genera *Aspergillus*, *Penicillium* and *Trichoderma*. On the other hand, the eggplant by-product extract exhibited antibacterial activity against more bacteria stains, including *Staphylococcus aureus*, *Listeria monocytogenes*, *Salmonella* Typhimurium, and *Enterobacter cloacae*.

Conclusion

The obtained extracts seemed to be promising natural ingredients for application in the food and nutraceutical industries, among other sectors, given their high potential to be used as preservative ingredients.

Recommendations

[1] FAOSTAT online database. FAO, 2021. ttps://www.fao.org/faostat/en/#data

[2] Jaiswal AK in: Nutritional Composition and Antioxidant Properties of Fruits and Vegetables. (1st Ed.). Academic Press. (2020). (ISBN: 9780128127803).

[3] Añibarro-Ortega M, Pinela J, Ćirić A, et al. Valorisation of table tomato crop by-products: Phenolic profiles and in vitro antioxidant and antimicrobial activities. Food Bioprod Process. 2020, 124 307-319. https://doi.org/10.1016/j.fbp.2020.09.006

[4] Añibarro-Ortega M, Pinela J, Barros L, et al. Compositional features and bioactive properties of Aloe vera leaf (fillet, mucilage, and rind) and flower. Antioxidants. 2019, 444. https://doi.org/10.3390/antiox8100444

Acknowledgements

To the Foundation for Science and Technology (FCT, Portugal) for the financial support to CIMO (UIDB/00690/2020) through national funds FCT/MCTES; to FCT for the PhD studentship granted to M. Añibarro-Ortega (2020.06297.BD) and the contracts of J. Pinela (CEECIND/01011/2018) and M.I. Dias and L. Barros (institutional scientific employment program-contract). To the Ministry of Education, Science and Technological Development of Republic of Serbia (451-03-9/2021-14/200007). Work financially supported by the European Regional Development Fund (FEDER)-Interreg España-Portugal programme through the project TRANSCoLAB 0612_TRANS_CO_LAB_2_P and by FEDER through the Regional Operational Program North 2020, within the scope of the Project GreenHealth - Norte-01-0145-FEDER-000042.