

## Cocoa Shells by-product: a natural source of functional ingredients

Pagliari S.<sup>1</sup>, R. Celano.<sup>2</sup>, Rastrelli L.<sup>2</sup>, Sacco E.<sup>1</sup>, Campone L.<sup>1</sup>

E-mail: [s.pagliari2@campus.unimib.it](mailto:s.pagliari2@campus.unimib.it)

<sup>1</sup> Department of Biotechnology and Biosciences, University of Milano-Bicocca, Piazza Della Scienza 2, 20126 Milan

<sup>2</sup> Department of Pharmacy, University of Salerno, Via Giovanni Paolo II Fisciano (SA) Italy

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Cocoa beans are one of the largest crops in the world and produce a large amount of by products that are left in the fields to rot. In particular cocoa shells are one of the main by-products obtained during the pre-roasting/roasting process. Several studies have demonstrated the antioxidant properties of cocoa shell extract due to high content of phenolic compounds, such as catechins, procyanidins, and its high content of alkaloids as caffeine (1,3,7-trimethylxanthine), theophylline (1,3-dimethylxanthine), and theobromine (3,7-dimethylxanthine). Therefore, a pressurised hot water extraction process was developed and optimised for the recovery of theobromine and caffeine from the cocoa by-product.

The extraction was performed using 15% (v/v) ethanol, and, and all parameters influencing the extraction efficiency were optimised by a chemometric approach. Theobromine and caffeine were quantified by UPLC-UV (283 nm), while antioxidant capacity was assessed by in vitro assays (ABTS). Applying PHWE under optimised conditions the extraction efficiency increased by theobromine and caffeine compared to the results obtained using ultrasound-assisted liquid extraction. The effect of PHWE extract on the cell viability of colorectal and breast cancer cell lines was also tested.

The application of PHWE for the selective recovery of theobromine and caffeine from cocoa shell by-products is a green, automated and rapid method that represents a viable alternative to conventional extraction methods for obtaining ingredients for the food industries.