VALORISATION OF APPLE PEEL THROUGH MODERN EXTRACTION TECHNIQUES

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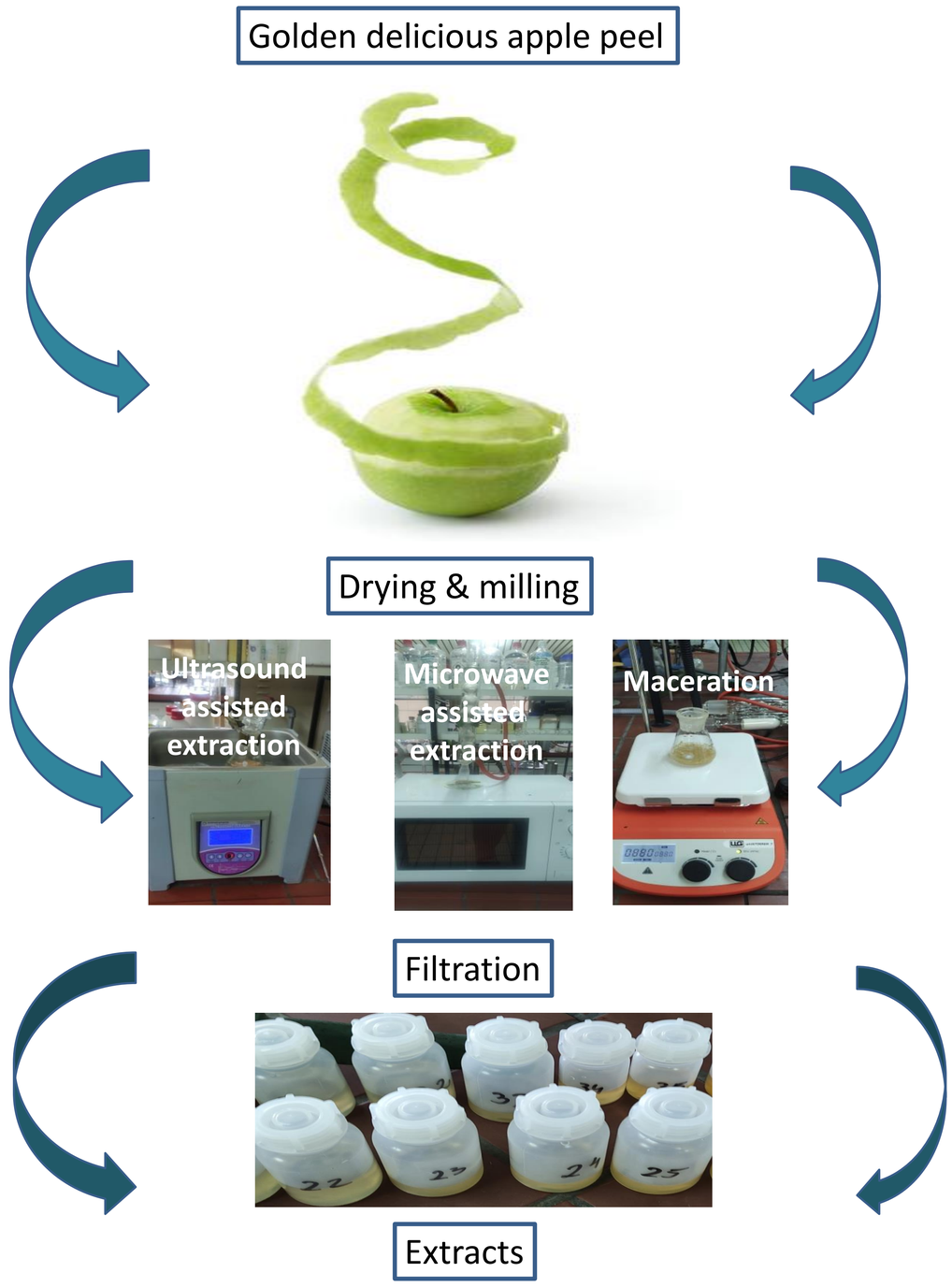
Introduction

The apple is one of the most consumed fruits in the world, and its utilization is high. A large proportion of the peel remains as waste during processing. Considering the richness of the apple peel in bioactive compounds, especially polyphenols, fibers, and minerals, this by-product is of great importance. In order to extract the bioactive compounds from the apple peel, the influence of various modern extraction techniques and solvents was investigated.

The water extracts were prepared by ultrasound (UAE) and microwave (MAE), while the NADES extracts were prepared by maceration with fructose-glycerol mixture 1:4 (MAC1) and choline chloride – glycerol mixture 1:2 (MAC2). The polyphenols in the extracts obtained were analyzed and their in vitro antioxidant activity tested. The total phenolic content (TPC) of the extracts was determined using the Follin-Ciocalteu method and expressed as chlorogenic acid equivalents (mg CAE/g).

Material and Methods



Results and discussion

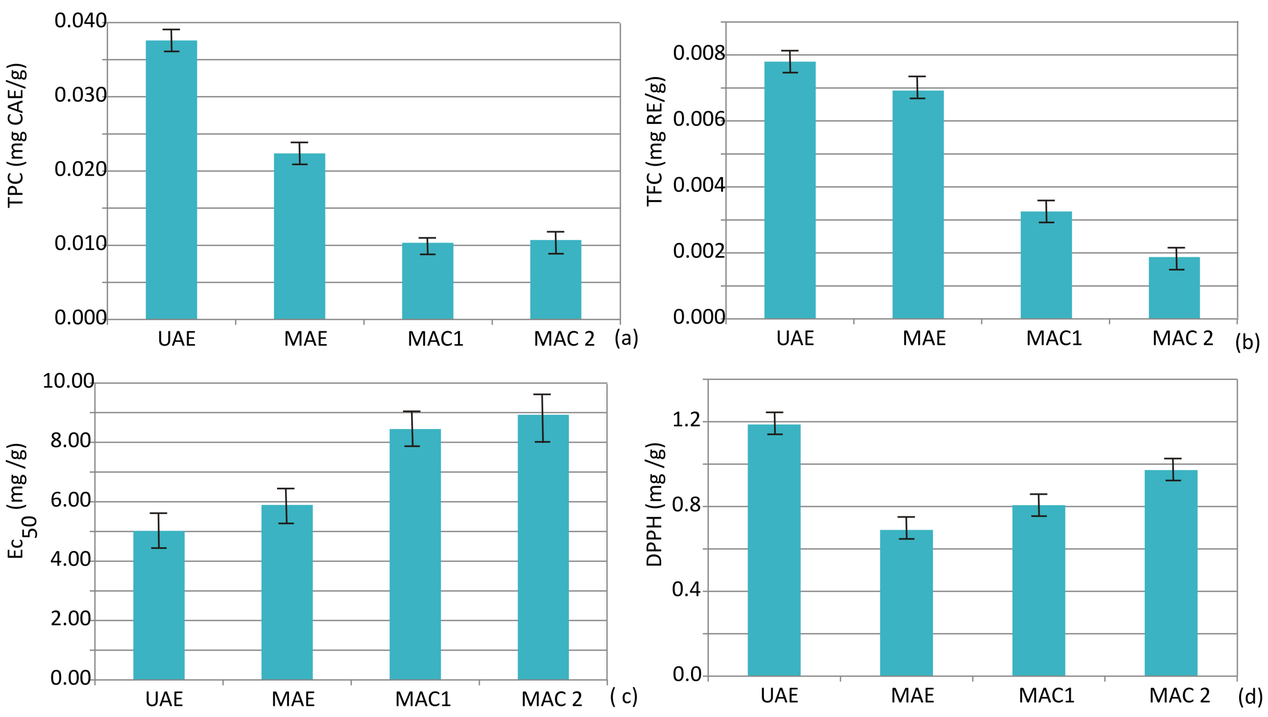


Figure 1. Apple peel extracts:a) total fenolic content, b)total flavonoid content, c) reducing power, and d) antiradical ability

The UAE provided the highest TPC content (0.038 mg CAE/g) while MAC1 had the lowest phenolic content (0.010 mg CAE/g). The same situation was observed for the total flavonoid content (TFC) which was determined by a spectrophotometric method based on the $AlCl_3$ reaction and expressed as rutin equivalents (mg RE/g). In the UAE extracts the TFC was 0.008 mg RE/g, while in MAC2 it had a value of 0.002 mg RE/g. LC-MS analysis confirmed the presence of phenolic acids, flavonoids and phloretin derivatives.

Table 1. UV and MS data as well as assignments of the compounds identified in the extracts by LC-MS analysis

UV data	MS data	Assignment
λmax [nm]	[m/z]	
280	441.1 $[M-H]^-$; 288.9	Epicatechine gallate
282	881.1 $[M-H]^-$; 729.9; 577.2; 425.1	Procyanidine trimer
326	353.1 $[M-H]^-$; 191.1	Chlorogenic acid
280	577.2 $[M-H]^-$; 425.1; 289.0	Procyanidine dimer
330	517.2 $[M-H]^-$; 385.1	Phenolic acid pentoside
280	865.2 $[M-H]^-$; 713.2; 577.1	Procyanidine trimer
354	463.1 $[M-H]^-$; 301,0	Hyperoside
354	463.1 $[M-H]^-$; 301,0	Isoquercitrin
284	567.2 $[M-H]^-$; 273.1; 167.1	Phloretin dihexoside
284	567.2 $[M-H]^-$; 273.0	Phloretin dihexoside isomer
282	609.2 $[M-H]^-$; 301.1; 286.0	Hesperidin
350	433.1 $[M-H]^-$; 301.1	Avicularin
254; 260; 350	447.1 $[M-H]^-$; 301.0	Quercitrin
282	435.1 $[M-H]^-$; 273.1; 167.1	Phlorizin

Conclusions

UAE, MAE, and MAC showed significant anti-radical DPPH ability and the IC_{50} values were in the range of 0.69-1.187 mg/g. The reducing power test showed remarkable activity, with EC_{50} values ranging from 5.02 to 8.93 mg /g. The results were highly variable depending on the extraction method, emphasising the importance of extract preparation for the overall nutritional profile of apple peels, transforming them from waste to a valuable resource.

Acknowledgements

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