Department of Food Technology and Bioprocess Engineering

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MRI Max Rubner-Institut

Box-Behnken design based statistical modeling for ultrasound-assisted extraction of purple sweet potato valuable compounds

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Introduction

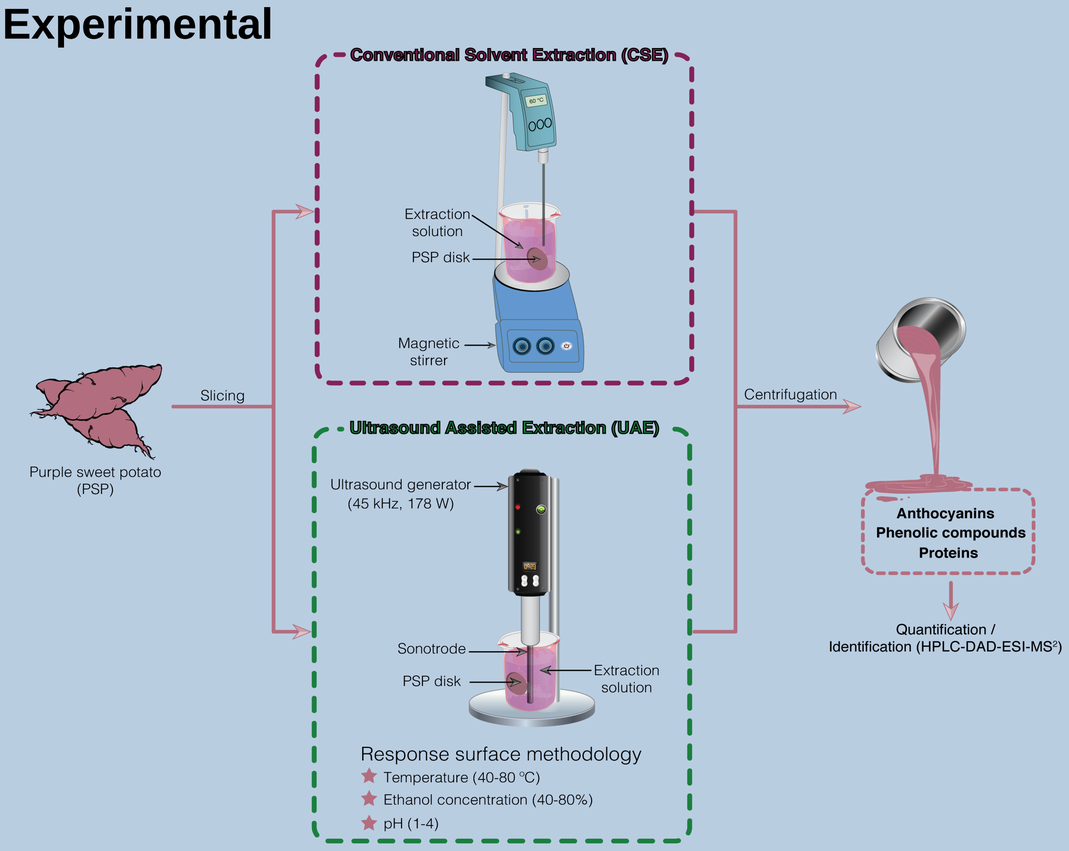
- Purple sweet potatoes (PSP) constitute an important natural source of dietary, fibers, minerals, vitamins, and antioxidants.
- It is of paramount importance to find novel methodologies to improve the extraction yield of PSP colorants.
- Although previous studies have evaluated the potential of ultrasound-assisted extraction (UAE) to extract total phenolic compounds (TPC) and total anthocyanins (TA) from PSP, there is a lack of information about the polyphenol profiles.

Research objectives

1. To evaluate and optimize ultrasound-assisted extraction (UAE) conditions, pH, and ethanol concentration in order to improve the recovery of polyphenols (especially anthocyanins) and proteins from purple sweet potatoes, compared to conventional solvent extraction (CSE).

2. To identify the polyphenols' composition in both extracts (with and without UAE), using HPLC-DAD-ESI-MS^2.

Experimental



Key findings

Specific energy consumption (SEC)

- The lowest value of SEC was observed when UAE was applied for 40 min and a supplementary diffusion at 80 °C for up to 120 min, pH 2.5, and ethanol concentration of 40%.
- The highest SEC was observed under UAE (10 min) and supplementary extraction at 40 °C for up to 120 min, pH 2.5, and ethanol concentration of 80%.

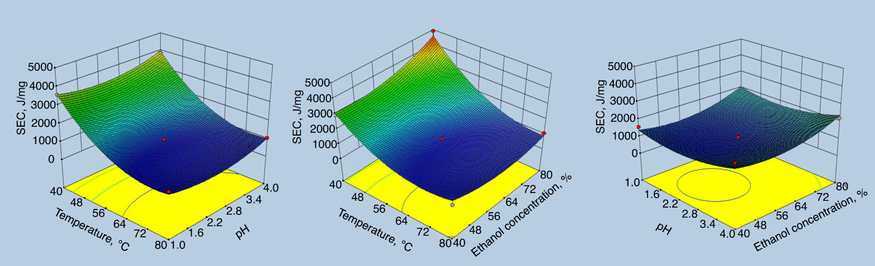


Figure 1. Response surface plots for specific energy consumption showing the combined effects of process variables: temperature and pH (ethanol concentration was set at 60%), temperature and ethanol concentration (pH was set at 2.5), and pH and ethanol concentration (temperature was set at 60 C).

Optimization of UAE conditions

- The highest values of polyphenols and anthocyanins were obtained when UAE was used for 40 min with a supplementary extraction at 80 °C for up to 120 min, pH 2.5, and ethanol concentration of 80%.
- The highest value of proteins was obtained when UAE was used for 40 min with a supplementary extraction at 80 °C for up to 120 min, pH 2.5, and ethanol concentration of 40%.

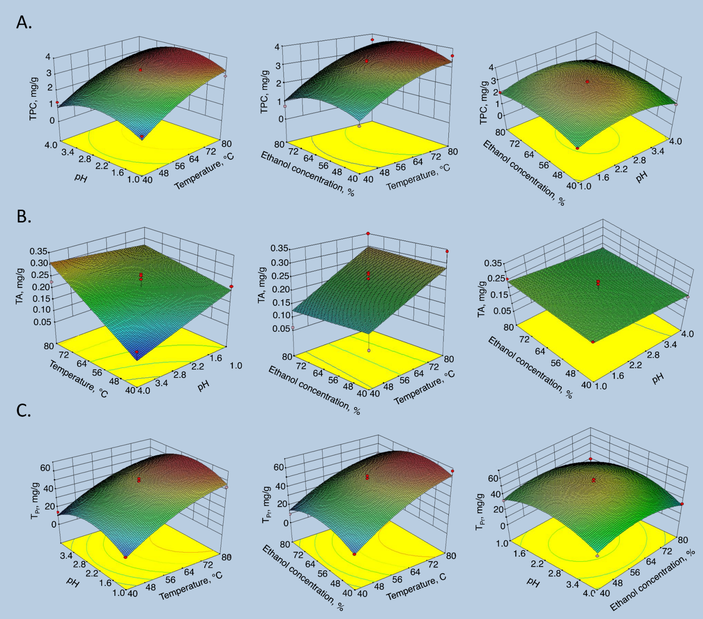


Figure 2. Response surface plots for TP (A), TA (B), and TPr (C) contents showing the combined effects of process variables: temperature and pH (ethanol concentration was set at 60%), temperature and ethanol concentration (pH was set at 2.5), and pH and ethanol concentration (temperature was set at 60 C).

Recovery of total polyphenols, anthocyanins, and proteins by conventional solvent extraction (CSE) under optimized UAE conditions

- In compared to the CSE method, application of UAE gave the better extraction results of total polyphenols (TP), anthocyanins (TA), and proteins (TPr).

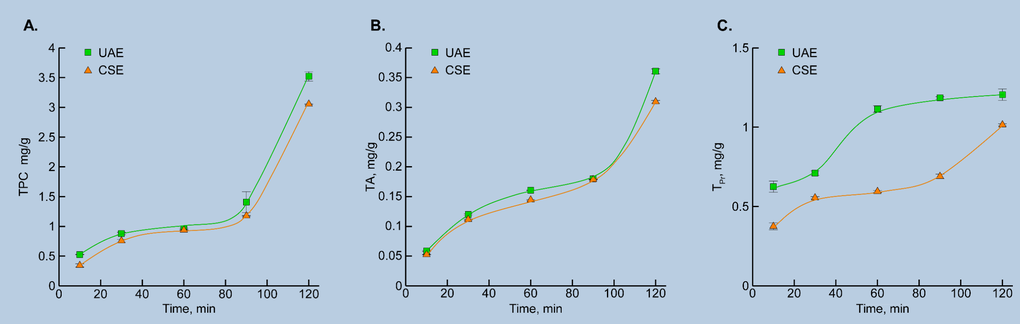


Figure 3. Comparison of TP (A), TA (B), and TPr (C) contents recovered using ultrasound-assisted and conventional solvent extraction.

HPLC-DAD-ESI-MS^2 analysis of purple sweet potato anthocyanins

- The major identified anthocyanins were peonidin-3-caffeoyl-p-hydroxybenzoyl sophoroside-5-glucoside, peonidin-3-(600-caffeoyl-6000-feruloyl sophoroside)-5-glucoside, cyanidin-3-caffeoyl-p-hydroxybenzoyl sophoroside-5-glucoside.
- The major identified non-anthocyanin molecules were quinic acid, chlorogenic acid, caffeic acid, and chlorogenic acid-3-glucose.

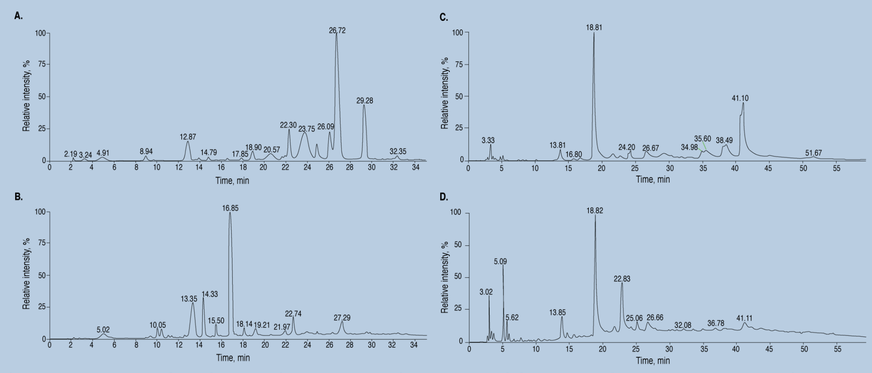


Figure 4. A-B) HPLC chromatograms of anthocyanin compounds extracted from purple sweet potatoes (PSP) using ultrasound-assisted extraction (UAE) (A) and conventional solvent extraction (CSE) (B). C-D) HPLC chromatograms of non-anthocyanin compounds extracted from PSP using ultrasound-assisted extraction (UAE) (C) and conventional solvent extraction (CSE) (D).

Conclusions

- Under optimum conditions (ultrasound time (40 min); supplementary hot extraction (80 °C) up to 120 min; pH: 2.5; ethanol concentration: 58%), the highest concentrations of polyphenols (3.877 mg/g), anthocyanins (0.293 mg/g), and proteins (0.753 mg/g) were found, with minimal specific energy consumption (8406 J/mg).
- The amount of the predominant anthocyanin and non-anthocyanin compounds from purple sweet potato extract obtained after ultrasound-assisted extraction was higher than that extracted after conventional solvent extraction.
- The results obtained in this work demonstrated the efficiency of ultrasound-assisted extraction for the recovery of anthocyanins from purple sweet potato.

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