

Optimizing the extraction of isoflavones from okara using a choline chloride-based deep eutectic solvent

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Okara is a solid residue generated after obtaining soy extract and is rich in phytochemicals such as phenolic acids and, mainly, isoflavones. These compounds are phenolic compounds that are associated with several health effects, mainly in the relief of menopausal symptoms and prevention of breast and prostate cancer. This makes okara an interesting residue for extraction of antioxidants and application in products that promote human well-being. Aiming at the best use of this residue, in this work six soy isoflavones were extracted: daidzein, genistein, glycitein, daidzin, genistin, and glycitin. A deep eutectic solvent (DES) consisting of choline chloride (ChCl) and acetic acid (AA) (ChCl:AA, 1:2) was used for extraction. All compounds were quantified by UHPLC-MS. Initially, a screening of the variables temperature (°C), % water, solid-liquid ratio (mg/mL) and stirring speed (rpm) was performed applying a fractional design (24-1) followed by optimization applying a central composite rotational design (CCRD) ($2^2 + 2$ axial points + 4 repetitions at the center point). Total isoflavone content was used as the response variable. From the screening, statistically significant effects ($p < 0.05$) on isoflavone extraction were observed for the variables temperature and % water in DES and were therefore used for optimization. The effect of temperature was evaluated from 40-70 °C and that of % water from 40-100%. From the CCRD analysis only the water content showed significant effect at the levels studied, being the maximum extraction at 40°C, 500 rpm, liquid solid ratio of 10 mg/mL and 61.5 % water. In this condition, 116.61 ug of daidzein/g; 151.31 ug of genistein/g; 27.98 ug of glycitein/g; 52.0 ug of daidzin/g; 74.74 ug of genistin/g; and 28.26 ug of glycitin/g were extracted; totaling 450.9 ug of total isoflavones/g of dried okara. Thus, in this work, it was possible to maximize the extraction of isoflavones from okara using DES, making this mixture an interesting alternative for isoflavone extraction, replacing conventional solvents such as ethanol and methanol. And, an alternative to better use this residue, generating products with high added value.