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Supercritical CO_2 extraction of glycyrrhizic acid from licorice root: optimization of extraction conditions using RSM (response surface metodology)

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Abstract

Extraction of HA from licorice roots was carried out by SC-CO_2 with ethanol, as a solvent. Experiments and modeling were denoted by RSM. Licorice root extract was analyzed by chromatography and AAS. The RSM design was used to optimize the variables of the CCE and the GC output. The maximum yield of HA is observed under conditions of 10 MPa, 90.8 and 48.2 °C, 92 minutes and a flow of 1.70 and 1.50 ml/min of CO_2 using RSM, respectively. According to RSM, R2 and the modified R2 model are 96.1% and 93.2%, respectively. The accuracy of the GC output model is confirmed by triplet experiments, giving an average extraction yield of 52.2±1.2%, respectively, for RSM. The difference of this study from the data known in the literature lies in the design of experiments on modeling and optimization of the extraction yield. An innovation is the optimization of process parameters via RSM, where the maximum yield is achieved by optimizing the extraction conditions. Estimated optimal yield under specific conditions is confirmed by triple experiments (CHIP) in this study.

Notation: P (MPa) – extraction pressure, φ (ml/мин) – CO_2 flow rate, R (%) – yield, t (мин) – extraction duration, E (^oC) – extraction temperature.

RSM is a polynomial model of the 2nd order, to explain the variation in the rate of extraction of GC depending on the variables. The linear terms of temperature, pressure and dynamic time, the quadratic terms of dynamic time and pressure with $P \leq 0.001$ are highly reliable. The linear term of the CO_2 stream, the quadratic term of temperature, and the terms of interaction t – p and r – the dynamic time with $0.001 < p < 0.01$ are significant, while variables with $p > 0.01$ are insignificant. By applying multiple regression analysis to experimental data, one can obtain second-order polynomial equations.

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