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Fractionation of Passion fruit (Passiflora edulis) seed oil using adsorption process with zeolite NA13X

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Abstract

The lipid extraction of passion fruit by-products using supercritical CO2 (SFE-CO2) is capable of recovering phytochemicals with high efficiency, using a safe solvent. After extraction, supercritical fractionation by adsorption is an emerging technique that can separate and concentrate bioactive compounds. The objective of this work was to extract the oil from passion fruit by-products by SFE-CO2 and to fractionate it using NA13X zeolites as adsorbent material, varying the separation temperature and mass of zeolites and observing the influence of these process parameters on the final concentration of compounds. Analyses were carried out to characterize the raw material and the enriched extracts in terms of carotenoids. Statistics were applied using ANOVA and Tukey test at 5% significance level. The high molecular weight molecules of the carotenoids were retained in the zeolite pores due to a recovery of fractions with less intense staining.

Key words:

Bioactive compounds, adsorption, zeolites.

Introduction

The use of food industry by-products to recover bioactive compounds is an important mean to add value to food residues. Phytochemicals such as tocols, carotenoids and phytosterols are underexplored through safe extraction methods for further application in food and cosmetics. The extracts obtained using supercritical CO_2 have shown potential to be employed in food, once CO_2 is a safe and easier to be separated from the final product. The enhancement of the nutricional and economic value of extracts can be achieved by adding another step after extraction: fractionation. One of the different ways to concentrate extracts is supercritical adsorption in packed columns, which is based on the retention of particles of different sizes in the adsorbent material, leading to the concentration of some specific compounds[1]. The aim of this work was to explore different separation conditions (temperature and adsorbent mass) to concentrate bioactive compounds from passion fruit seed oil using a packed column filled with zeolite NA13X.

Results and Discussion

Supercritical CO_2 extraction was carried out at 40 °C and 35 MPa, since this condition in reported as optimum for obtaining high yields and low selectivity[2]. Table 1 shows some raw material characteristics, extraction parameters and yields.

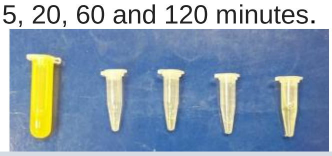
Table 1. Raw material composition, particle characterization and global yields.

Analysis	Result
Moisture (%)	7.9 ± 0.4
Real density (kg/m³)	1190 ± 10
Apparent density (kg/m³)	714 ± 59
Extraction global yield (%)	18.5
S/F (kg CO_2/ kg seeds)	46
Flow rate (kg/s)	1.75 x 10^{-4}
Fractionation average yield (g fraction/ 100 g extract)	90.6

The extracted oil was rich in unsaturated fatty acids as linoleic (68.5%) and oleic (15.8%), and palmitic (10.5%) among the saturated acids. Unsaponifiable matter was approximately 1.7%.

For the fractionation experiments, an exhaustive kinetics was performed observing that, from 180 minutes, the amount of recovered oil remained constant. The assays were conducted varying the mass of zeolites (5, 10 and 15 g) and temperature in the adsorption column (50, 60 and 70 °C) with the solubilization cell condition fixed at 40 °C and 35 MPa, simulating an integrated process for SFE-CO_2 + fractionation. The oil fractions were collected at predetermined time intervals and the content of carotenoids was analyzed in the fractions collected at the first 40 minutes and those of the remaining time. There were differences in the separation of compounds between the process conditions, and an evident fractionation of carotenoids could be visually verified (Figure 1).

Figure 1. From left to right: non-fractionated oil, fractions collected after 5, 20, 60 and 120 minutes.



Conclusions

The fractionation processes had an average yield of 90.6% with experiments lasting 180 minutes. Based on the results, it is possible that the high molecular weight molecules of the carotenoids were retained in the zeolite pores due to a recovery of fractions with less intense staining.

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