Poster SCF24

Solubility of Carotenoids in Supercritical Fluids: Data and Modeling

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Carotenoids are an important group of functional compounds which action on cardiovascular disease and prevention of other illness. These compounds are precursors of vitamin A and as antioxidants, and are also responsible for the color of many foods. The extraction of carotenoids is usually made using organic solvents, however several studies have demonstrate the use of supercritical fluids (SCFs) on the recovery of these compounds. The success of the extraction using SCF has been demonstrated on the extraction of compounds like β-carotene, lycopene, astaxanthin, canthaxanthin, capsanthin, lutein, and zeaxanthin. In order to facilitate the industrial applications and to decrease costs associated with number of experiments to obtain solubility data many predictive equations have been proposed. Basically, these models can be classified in three segments:
i) a density-based approach, based on the effect of SFC density of the solubility of different compounds,
ii) a solubility parameter approach based on regular solution theory and the activity coefficient of solute in SFC; and
iii) equations of state (EOS), where the solvent is treated as a pressured gas. The objective of this study was to correlate and to simulate the solubility data of carotenoids in supercritical CO_2. Experimental solubility data of carotenoids in supercritical CO_2 have been collected from the literature. The Peng-Robinson equation of state was used as thermodynamic model. The binary interaction parameters, especially estimated for the attractive term, were based on the series of the literature data. The required critical properties were determined by the group contribution methods. Charistil and Scratchard-Hildebrand equations were used to compare the results obtained by Peng-Robinson equation of state. The results were consistent with experimental data indicating these equations can descript the solubility of carotenoids in supercritical fluids reliably.