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TECHNICAL NOTE

Dependence of Camomile Flower Solubility on Carbon Dioxide Density at Supercritical Extraction

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ABSTRACT

The solubility of camomile flowers in supercritical carbon dioxide as it depends on pressure (80–160 bar) and temperature (313–353 K) changes has been determined by using a dynamic procedure. The solubilities obtained were correlated with the density of carbon dioxide by using Chrastil's equation. This equation allows the calculation of the solubility of a complex system.

INTRODUCTION

Chrastil (1) derived a semiempirical equation which functionally connects the solubility (S) of the extracted substance under supercritical conditions to the solvent density (d). This equation can be presented as

$$\ln S = a + b/T + c \ln d \tag{1}$$

where a and b = constants related to the corresponding thermal effect (a) and the molecular masses of the extracted substance and solvent (b)

c = association number, i.e., the number of solvent molecules which make a complex with the substance molecule in supercritical extraction

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T = absolute temperature

S and d are expressed in g·dm^{-3} and T in K.

Chrastil's equation, although derived for supercritical extraction of two independent components, has found application for such multicomponent systems as edible oils (2) and shale oil (3). This prompted us to investigate the possibility of applying this approximate approach to camomile flower extraction with supercritical carbon dioxide.

EXPERIMENTAL

The solubility of camomile flowers in supercritical carbon dioxide in the 80–160 bar pressure range and temperatures of 313–353 K was determined by a dynamic method. On the basis of the extraction yield obtained and the carbon dioxide flow rate, the camomile flower solubility was calculated.

All investigations were carried out on camomile flowers (*Chamomillae flos*) obtained from the Institute for Hop, Broomcorn and Medicinal Plants (Backi Petrovac, Yugoslavia, 1992). There was 0.4352 g essential oil per 100 g material. Commercial carbon dioxide was used as the extracting agent.

The extraction was carried out in a laboratory-scale high pressure extraction plant (NOVA-SWISS, Switzerland), described previously (4, 5).

The samples for extraction (50 g) were milled (the ratio of the fraction between the sieves with 0.5 and 0.315 mm openings was 96.2%, whereas the remainer was 3.8%). The samples were extracted for 2 hours at a carbon dioxide flow rate of 53.5 dm^3/h (expressed under normal conditions) and at different combinations of pressure and temperature. Deviation of the flow rate, as well as of the pressure and temperature, did not exceed ± 3 and $\pm 2\%$.

To determine the extraction yield, the extract obtained in the separator was quantitatively dissolved in petroleum ether (bp 40–60°C) and the solvent was removed by the procedure used for the determination of camomile essential oil (see Ref. 6).

RESULTS AND DISCUSSION

The dependence of experimental data of camomile flower solubility on carbon dioxide density (7) for different temperatures is given in Fig. 1.

Starting from the values of T, d, and S from Fig. 1, the parameters in Eq. (1) were determined using the minimum square-root method. This equation for the investigated system is

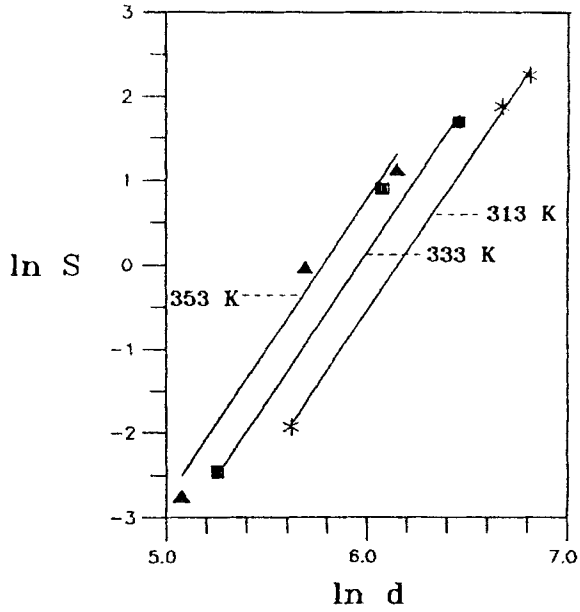

FIG. 1 Plots of ln S vs ln d.

$$\ln S = -10.11 - 3697/T + 3.56 \ln d \quad (2)$$

where the standard deviation of solubility is ± 0.609 g·dm^{-3}.

The isotherms for 313, 333, and 353 K, derived from Eq. (2), together with the experimental points, are given in Fig. 1. A rather good fit of the experimental results is obtained.

In this way a contribution to the use of Chrastil's equation for the camomile flowers–supercritical carbon dioxide complex system is given. This allows the calculation, i.e., the prediction, of camomile flower solubility on the temperature and density of carbon dioxide in supercritical extraction.

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