Effect of operating parameters on supercritical fluid extraction of vegetable oil

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Abstract

The present study concerns the application of a green process namely the supercritical carbon dioxide extraction of oil from some local vegetable matrix, such as olives which represent one of the major sources in the world. The effects of pressure and temperature on the extraction yield were investigated. The results showed that the yield increased markedly with pressure, contrary to temperature.

Keywords: *Supercritical Carbon Dioxide; Olive Oil; Pressure; Temperature.*

I. Introduction

Supercritical fluid extraction has been applied in the food and pharmaceutical areas [1]. Recent breakthroughs in supercritical technology are nutraceutical extracts (natural extracts from plants or natural products that exhibit physiological or health benefits). One of the most popular and successful applications of SFE is the extraction of fats and oils, such as olive oil [2]. This latter plays a major role in health preservation through its beneficial effects on lipid metabolism, blood pressure, diabetes etc. [3]. The present work focused on the supercritical Carbone Dioxide extraction of olive oil and the investigation of the effect of different parameters such as temperature and pressure on the process performance.

II. Experimental Process

Initially the olive fruits were collected from a local region during the harvest period. Then, they were dried at 40 °C in an oven to eliminate the moisture content. Supercritical carbon dioxide extraction was carried out in a 2 Liters extraction vessel of the machine supplied by Separex (France).

A mass of 50 grams of olives was introduced in the extraction vessel. The CO_2 was continuously pumped into extractor with a fixed mass flow rate of 50 g/min. Two separators receiving the supercritical phase provided a pressure drop so that the CO_2 separated from the transported olive oil which was collected in vials at the outlet of extractors. The yield was calculated by dividing the mass of the resulting oil to the initial mass of olive fruits. The operating conditions were 50 and 60 °C for temperature and 200 and 300 bar for pressure.

III. Results and discussion

Experimental results are presented in Table 1 and they showed an effective extraction process of the olive oil with supercritical Carbone Dioxide.

A. Pressure effect

The effect of pressure on oil extraction was investigated by plotting the obtained yield at different time and pressure, while the temperature was maintained constant.

Figure1 presents the accumulation of olive oil extracted in different periods of time at a constant temperature of 50°C. From this figure it can be seen

that the yield increased. At a pressure of 200 bar, the variation of the extracting yield was the same in the different periods, with an accumulation of 2% in the olive oil production. This was not the case at 300 bar where the accumulation differed from the first 15 min to the second period by approximatively 5% and 2%, respectively. In Figure 2 and at a temperature of 60°C, the production of olive oil was approximatively the same during the first 30 min and this more than doubled in the second period at 60 minute. Similar results by Salgin et al [4] and Roy et al [5], found that increasing the pressure increased the extraction yield at constant temperature whatever the different period of time. This was due to the solubility of oil in supercritical CO_2 which increased with the increase of SC-CO_2 density and hence its solvency.

B. Temperature effect

Using the same methodology, the effect of temperature on oil extraction was also studied by plotting the obtained yield at different time and temperature. The pressure was maintained constant. From Figure 3, the yield of oil increased with temperature during the first half of extraction time, as confirmed by Ray et al [6]. After that an inverse behaviour was the observed with a decrease of the extraction yield when the temperature increased from 50 °C to 60 °C.

Working at high pressure (300 bar) as shown in Figure 4, the decrease in temperature condition from 60 °C to 50 °C, the extraction yield remained higher during all the extraction time. This was due to a retrograde effect between solubility and density at different temperatures in the extraction process.

IV. Conclusion

This study showed that the yield of olive oil increased markedly with pressure, suggesting that a resulting increase in fluid density accounts for better solvent power and thus for a higher oil solubility. Temperature seemed to be a less significant variable where in a certain temperature range, the yield decreased with increasing temperature, whereas in another range an increase in yield for an increase in temperature was observed for the lower temperature. On the other hand, the contact time had an important effect on the yield of olive oil.

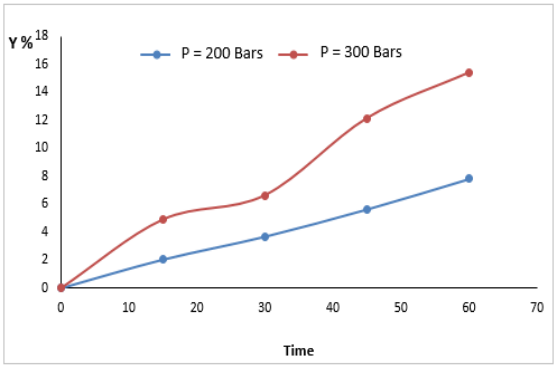

Figure 1: Pressure effect on oil yield at T=50 °C.

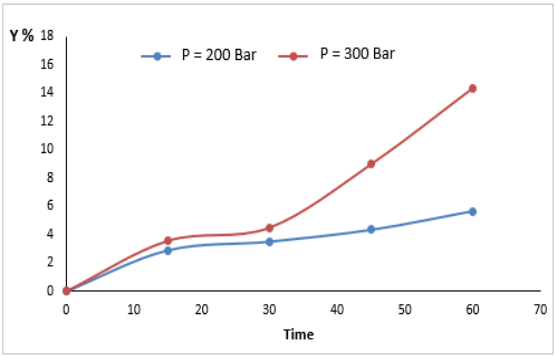

Figure 2: Pressure effect on yield at T=60 °C.

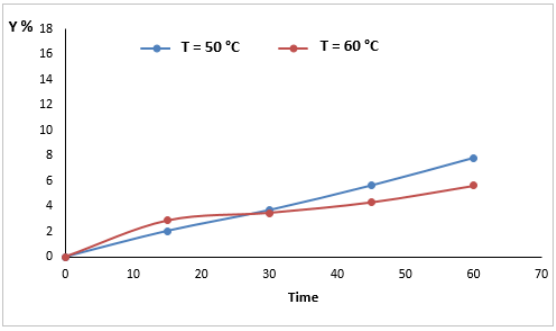

Figure 3: Temperature effect on oil yield at P= 200 bar.

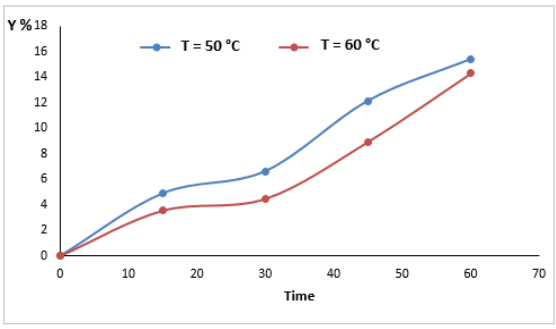

Figure 4: Temperature effect on oil yield at P=300 bar.

Table 1: Oil yield in one hour at different conditions of temperature and pressure

Experiments	Pressure (Bar)	Temperature (°C)	Yield (%)
1	200	50	7.83
2	200	60	5.63
3	300	50	15.41
4	300	60	14.32

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