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Bioactive Compounds Extraction from Natural Fruit by Ultrasonic Irradiation
超音波照射による天然果実からの生物活性化合物の抽出

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1. Introduction

Naturally occurring bioactive compounds can be obtained from fruit, plant and oil sources. Carbon dioxide is used as a method of extracting bioactive compounds instead of harmful organic solvents [1] [2]. Carbon dioxide is safe extraction solvent which is nontoxic and nonflammable. Carbon dioxide extraction is a flexible process due to the possibility of adjustment of the solvent power or selectivity of the carbon dioxide [2]. However, carbon dioxide extraction has the disadvantages of low extraction efficiency and long extraction time. In order to solve these disadvantages, we proposed a new extraction method that combines high-pressure carbon dioxide and ultrasound. Ultrasound can be expected to increase extraction efficiency and shorten extraction time [3].

In this study, high-pressure carbon dioxide extraction combined with ultrasonic irradiation was used to extract crocin contained in Gardenia jasminoides Ellis fruit pulp and compared with the conventional method. Since crocin is a polar component, aqueous ethanol was used as a co-solvent. The effects of temperature, pressure and ultrasonic irradiation time on the extraction yield were examined single-factor experiment.

2. Experiments

The dried gardenia fruit was powdered with freezed crushing machine. Fig.1 show a schematic of an experimental device. Gardenia fruit powder (10 mg), water (2 ml) and ethanol (8 ml) were placed in a high-pressure cell at predetermined temperature (5~25 °C), pressurize to predetermined pressure (8~14 MPa) and extracted for 60 minutes. The ultrasound was irradiated for predetermined time (0~250 s) after reaching a predetermined pressure. After 60 minutes, the liquid extract was collected and the concentration of crocin in the liquid extract was measured by high performance liquid chromatography (HPLC).

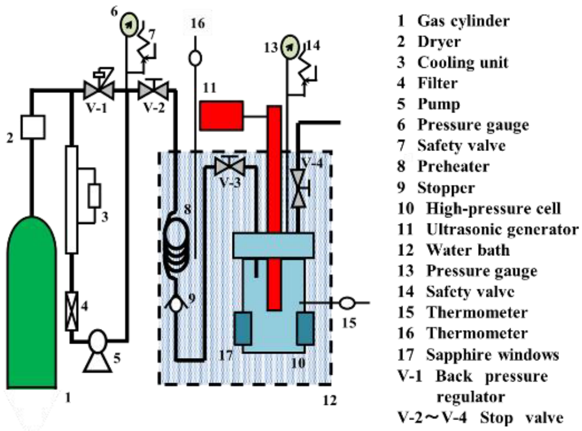

Fig.1 Schematic of an experimental device

3. Results and discussion

Fig.2 shows the extraction yield of crocin extracted by the solvent extraction and liquid carbon dioxide extraction at 25 °C and 10 MPa with and without ultrasound. As shown in Fig.2, the extraction yield of crocin was increased by using liquid carbon dioxide extraction compared to the solvent extraction. Furthermore, the extraction yield of crocin increased by irradiating the solvent extraction and the liquid carbon dioxide extraction with ultrasound, respectively. Fig.3 shows a schematic diagram of the extraction mechanism of crocin by ultrasonic irradiation. Cavitation bubbles are generated near cells surface by ultrasound irradiation. The cavitation bubble bursts and a shock wave are generated. As a result, the cell surface is destroyed and the components are released into the solvent.

Fig.4 shows effect of temperature on the extraction yields of crocin by liquid carbon dioxide extraction with 80% ethanol at various temperatures (5, 20, and 25 ℃) at a constant pressure (10 MPa) with and without ultrasound irradiation. As shown in Fig.4, the extraction yields of crocin increased with increasing temperature from 5 to 25 ℃. As the

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temperature increases, the viscosity of the solvent decreases. Therefore, penetration into the matrix was promoted and the extraction yield was improved.

Fig.5 shows effect of pressure on the extraction yields of crocin by liquid carbon dioxide extraction with 80% ethanol at various pressures (8, 10, and 14 MPa) at a constant temperature (25 °C) with and without ultrasound irradiation. As shown in Fig.5, the extraction yields of crocin was constant with increasing pressure from 8 to 14 MPa. Generally, increasing pressure increases the density of a liquid carbon dioxide extraction system be increased in solubility. However, the extraction yield was constant because the density changes of liquid carbon dioxide between 8 MPa and 14 MPa was little.

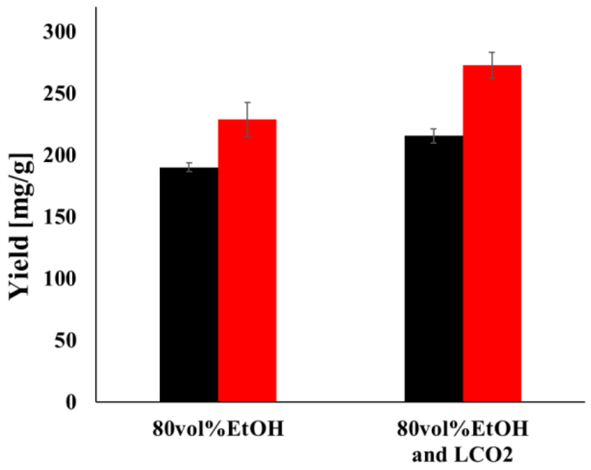

Fig.2 The extraction yield of crocin extracted by the solvent extraction (80% ethanol) and liquid carbon dioxide (LCO_2) extraction with 80% ethanol at 25 °C and 10 MPa with (red) and without (black) ultrasound.

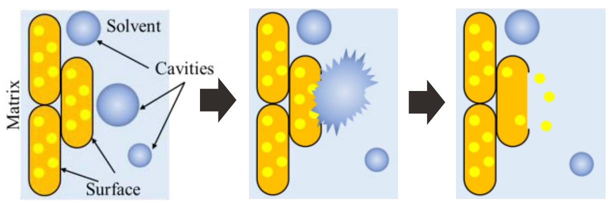

Fig.3 Schematic diagram of the extraction mechanism of crocin by ultrasonic irradiation

4. Conclusion

Bioactive compound (crocin) was successfully extracted from *Gardenia Jasminoides* Ellis using liquid carbon dioxide and ultrasound. 80% ethanol was used as a cosolvent. The extraction yield of crocin was higher using liquid carbon dioxide extraction than with the solvent extraction. The extraction yield of crocin was further increased by ultrasonic irradiation. Optimum temperature and pressure conditions were examined by liquid carbon dioxide extraction with 80% ethanol as a cosolvent and with or without ultrasound. As a result, the optimal conditions for extraction were liquid carbon dioxide extraction using ultrasound at 25 °C and 10 MPa.

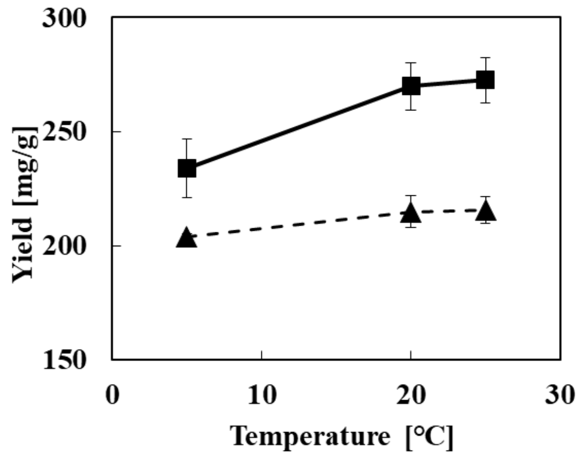

Fig.4 Effect of temperature on the extraction yield of crocin by liquid carbon dioxide extraction with 80% ethanol at various temperatures (5, 20, and 25 °C) at a constant pressure (10 MPa) with (■) and without (▲) ultrasound irradiation.

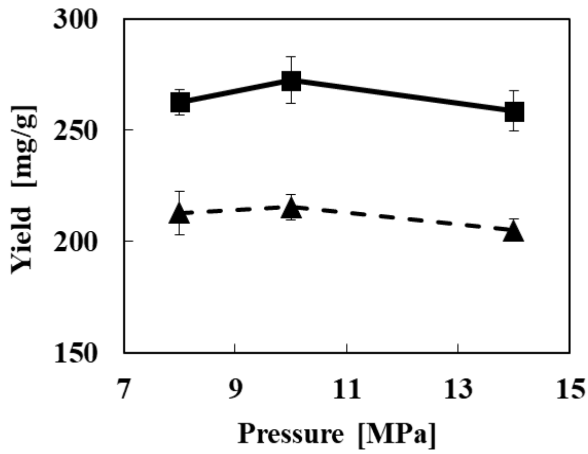

Fig.5 Effect of pressure on the extraction yield of crocin by liquid carbon dioxide extraction with 80% ethanol at various pressures (8, 10, and 14 MPa) at a constant temperature (25 °C) with (■) and without (▲) ultrasound irradiation.

References

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