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Effect of ultrasound on the extraction of saccharides from roselle seeds

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1. Introduction

Roselle (Hibiscus Sabdariffa L.) belonging to the Malvacea family is one of the most common flower plants originated from India, Malaysia, and Africa. Roselle has much applications in food, medicine, fiber and animal feed industries.[1] For example, roselle calyces are used in commercial products of beverages, jam, jellied confectionaries, flavoring agents. However, in some places, roselle seeds are regarded as waste biomass. Recently, we found that roselle seeds include various useful chemicals such as oil, vitamin E, saccharides, etc. In this study, we investigated the effect of ultrasound on the extraction of saccharides from roselle seeds. In addition, the results were compared with those obtained by a conventional mixing method instead of ultrasound.

2. Experimental

Roselle seeds were collected after the harvest of roselle calyces from Vietnam. They were packed in paper bags and stored in a dark and dry place at room temperature until use. Before using for experiments, the seeds were ground using an electrical mill-Wonder Blender. In this study, water soluble components of sucrose, glucose, and fructose extracted from roselle seeds were analyzed. As a preliminary experiment, the effect of extraction time was investigated at first: 1.2 g of seed powders was added in 30 g of water and then stirred at 27°C under mixing condition at 300 rpm. At the designated extraction time, the sample was withdrawn by a syringe and then filtered by a membrane filter. The filtrate was analyzed by HPLC-RID with Inert Sustain NH2 column (5 μm, 4.6 x 250 mm). Eluent was 85 vol% acetonitrile and 15 vol% water. For comparison, ultrasound assisted extraction was performed with Quava mini (Kaijo 30110, QR-001, frequency: 26 kHz, power: 50 W).

2.1 Effect of extraction temperature under conventional mixing condition

1.2 g of seed powders was added in 30 g of water and then stirred at 27, 70, 80, 90°C under mixing condition at 300 rpm. At the designated extraction time, the sample was withdrawn by a syringe and then filtered by a membrane filter. The filtrate was analyzed by HPLC-RID.

2.2 Effect of standing time of extracted solution

1.2 g of seed powders was added in 30 g of water and then stirred at 27°C under mixing condition at 300 rpm. For comparison, ultrasound assisted extraction was performed with Quava mini (Kaijo 30110, QR-001, frequency: 26 kHz, power: 50 W). At 20 min of extraction time, the sample was withdrawn by a syringe and then filtered by a membrane filter. The filtrate was stand at 20°C for the designated time and then analyzed by HPLC-RID.

2.3 Effect of extraction time, mixing rate and ultrasound frequency

1.2 g of seed powders was added in 30 g of water and then stirred at 27°C under mixing condition at 100, 200, or 300 rpm. For comparison, ultrasound assisted extraction was performed with Quava mini with different ultrasound frequency (Kaijo 30110, QR-001, frequency: 26, 78, or 130 kHz, power: 50 W). At the designated extraction time, the sample was withdrawn by a syringe and then filtered by a membrane filter. The filtrate was stand at 90°C before HPLC-RID analysis to avoid the enzymatic reaction of sucrose to fructose and glucose.

3. Results and discussion

As a preliminary experiment, the effect of extraction time was investigated. **Figures 1, 2,** and **3** show the changes in concentration of sucrose, fructose and glucose as a function of extraction time under mixing or ultrasound irradiation. When an extraction experiment was performed at 27°C under both conditions, the concentration of sucrose in water increased with increasing extraction time and reached a maximum value and then decreased (Figure 1). On the other hand, the concentration of glucose and fructose in water increased with increasing extraction time (Figures 2 and 3).

2.1 Effect of extraction temperature under conventional mixing condition

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When an extraction experiment was performed at 70, 80, and 90°C under mixing condition at 300 rpm, the concentration of sucrose in water increased with increasing extraction time and reached a maximum value, but it did not decrease with increasing further extraction time. In addition, the concentration of glucose and fructose was almost the constant or the zero even with increasing extraction time. This reason was considered as the enzyme in roselle seeds is inactive at upper 70°C to hydrolyze sucrose to glucose and fructose.

2.2 Effect of standing time of extracted solution

From the result of section 2.1, it was suggested that an enzymatic reaction proceeds at room temperature before HPLC analysis. To confirm this, we investigated the effect of standing time of extracted solution after filtration on the concentration of sucrose, fructose and glucose in water. It was confirmed that the changes in these saccharide concentrations occurred both in the mixing and ultrasound extracted solutions: the concentration of sucrose decreased and the concentration of glucose and fructose increased with increasing standing time.

2.3 Effect of extraction time, mixing rate and ultrasound frequency

From the results obtained above, to analyze all saccharide concentrations correctly, in this study, the extracted samples were kept in a 90°C water bath to avoid an enzymatic reaction before HPLC analysis. Here, the effect of mixing rate or ultrasound frequency was investigated. It was confirmed that the concentration of sucrose has peaks at around 20 to 80 min of the extraction time. The concentration of glucose and fructose increased almost linearly with increasing extraction time. The total extracted amounts of saccharides were almost the same between mixing and ultrasound methods. This may be because the solubility of saccharides in water is very high so that physical effect of ultrasound cavitation may be not effective for the saccharide extraction. On the other hand, it was observed that the enzymatic reaction under ultrasound was higher than that under mixing.

Reference

1. I. Da-Costa-Rocha et al., Food Chem. 165 (2014) 424–443.

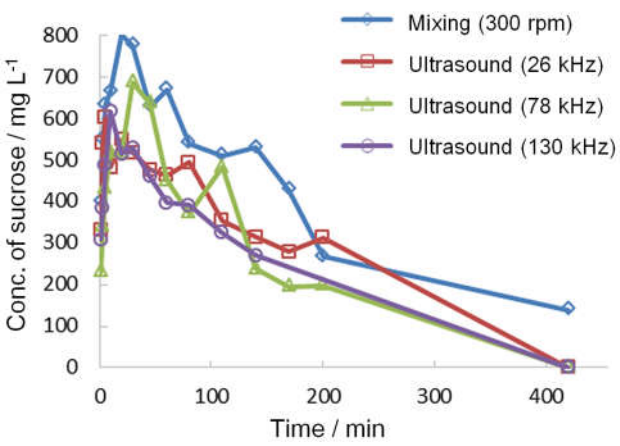

Fig. 1 Changes in concentration of sucrose as a function of extract time under mixing or ultrasound conditions.

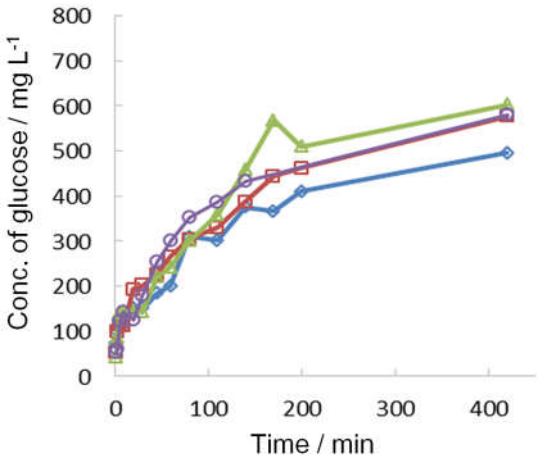

Fig. 2 Changes in concentration of glucose as a function of extract time under mixing or ultrasound conditions. Symbols are the same as Fig.1.

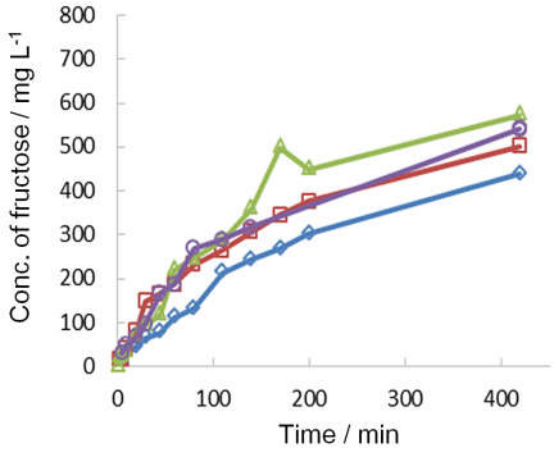

Fig. 3 Changes in concentration of fructose as a function of extract time under mixing or ultrasound conditions. Symbols are the same as Fig.1.