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Extraction of catechins from green tea using ultrasound

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1. Introduction

Recently, danger and the hazardous properties of the artificial synthetic things contained in foods and medicines have come to be indicated. Then, attention has been paid to the pharmacological actions of natural elements. Green tea transmitted from China, as a medicinal plant, had been drunk for a long time. Lots of catechins, poly-phenols, are contained in the tea. It is known that the catechins have a lot of actions such as antioxidative effect and antibacterial effect. The effective use of catechins in green tea is expected[1].

For extracting the green tea catechins, hot water extraction method and organic solvents method are used[1]. Though hot water extraction is safe, the heat causes changes in quality and losses of catechins. Extraction at low temperature is desirable, while the efficiency of the extraction is not good. In this paper, attempt is made to promote the extraction using ultrasonic irradiation in order to raise the efficiency by referring the results of our researches[2-5]. The effects of ultrasonic pressure and irradiation time on the amount of the catechins extracted from green tea are mainly examined.

2. Experimental

Figure 1 shows experimental setup. A Teflon vessel is put in a water tank made of stainless steel. Six BLT ultrasonic transducers of resonance frequency 28 kHz are bonded to the bottom of water tank. Distilled water is filled in the water tank. The Teflon vessel with 80 ml green tea is placed at 13 mm from the bottom of the water tank. The depth of water in the water tank is set at 67 mm. The reason why this depth was chosen is that the surface of green tea in the Teflon vessel and that of water in the tank is made at the same level. By adjusting the electric power of the oscillator fed to the ultrasonic transducers, ultrasonic pressure is controlled. The distribution of ultrasonic pressure in green tea is measured beforehand using sonic meter SM1000 (Shinka Industry Co.). Irradiation experiment is carried out with ultrasonic pressure as a parameter. Water in the water tank is circulated and regulated at a constant temperature with a circulation regulator unit to avoid both the effect of ambient temperature and the water temperature rise by ultrasonic irradiation. For the sake of comparison, green tea of no irradiation for the control is put in the similar Teflon vessel and is put in the same circulatory system as in the ultrasonic irradiation, in order to remove difference of the temperature between irradiation and no irradiation.

The tealeaves are crushed to powder of 160 μm or less. Specimens used in this experiment consist of 80 mg of the tea powder and 80 ml of pure water. The catechins extracted from green tea with ultrasonic irradiation are measured after removing the residue with a filter. Amount of extracted catechins is analyzed quantitatively using the colorimetric method with ferrous tartrate[6]. In this method, catechins are determined as follows. First, the green tea catechin is reacted with ferrous tartrate. Second, the absorbance of the liquid colored in dark blue is measured. Third, the absorbance is converted into the amount of gallic acid ethyl. At last, amount of the catechins is calculated by using the value of gallic acid ethyl.

3. Results

Figure 2 shows a measured distribution of ultrasonic pressure in the Teflon vessel in 25.1 kHz and 28℃ at 5 mm from the bottom. In this figure, ultrasonic pressure is depicted the pressure at the center (x, y = 0, 0) as reference. As shown, the

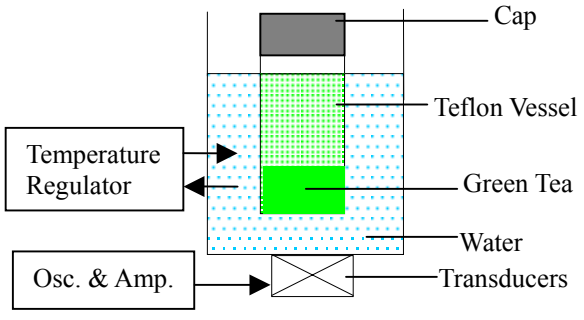

Fig. 1. Schematic of ultrasonic extraction of catechins

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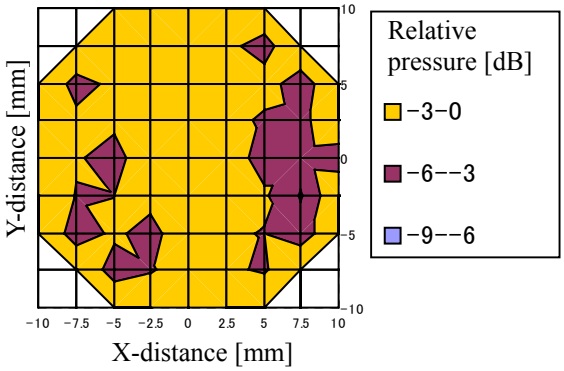

Fig.2. Ultrasonic field in the vessel

distribution of ultrasonic pressure in a Teflon vessel is within approximately ± 3 dB and almost uniform.

Figure 3 shows the extracted catechins versus exposure time at the ultrasonic pressure in Fig.2. Amount of extracted catechins with ultrasonic irradiation is larger than the amount of extracted catechins with no irradiation. **Figure 4** shows the increase of extracted catechins using ultrasound expressed as the ratio R from the graph of Fig.3. R [%] is determined by the following equation,

$$R = \frac{A - B}{B} \times 100 \quad [\%]$$

where A [mg] is the amount of catechins with ultrasonic irradiation, and B [mg] is the amount of catechins with no irradiation. As shown, R rapidly increases by 10% in ten minutes after ultrasonic irradiation begins. Afterwards, with keeping the irradiation, R increases and becomes about 15% for one hour. The effect of the ultrasonic irradiation continues and R gradually increases up to about 20%.

Figure 5 shows the amount of extracted catechins versus ultrasonic pressure in 25.1 kHz and 28℃ for 30 minutes. As shown, extracted catechins are proportional to the ultrasonic pressure.

4. Conclusions

Extraction promotion of the green tea catechins using ultrasound was attempted. It was found that the ultrasonic irradiation is effective to increase the amount of catechins extracted from green tea even in low temperature water extraction.

Further experiments will be made on the effect of ultrasonic irradiation in various kinds and sizes of tealeaves.

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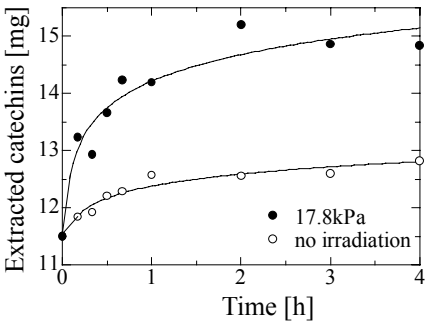

Fig.3. Extracted catechins versus time

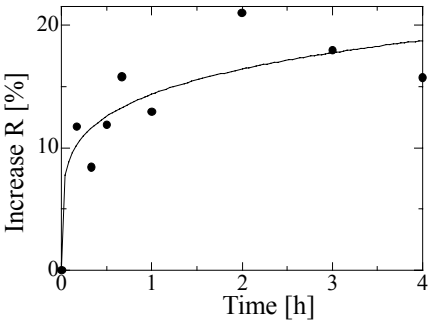

Fig.4. Ratio of increase of extracted catekins

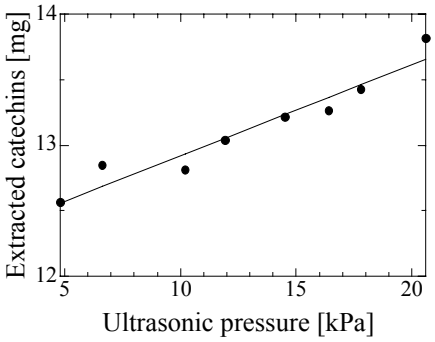

Fig.5. Extracted catechins versus ultrasonic pressure.

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