Real-Time Infrared Spectroscopic Monitoring of Fermentation Process to Support Sensory Evaluation

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Ⅰ. Abstract

Fermented foods that we eat contain a vast variety of ingredients, which are produced through complex fermentation processes. Among them, the production of sake uses an advanced fermentation method that is unparalleled in the world, where two chemical reactions are carried out simultaneously by using two types of microorganisms. Therefore, the crucial importance of quality control during fermentation requires the use of highly versatile sensory evaluation and measurement devices tailored to the ingredients to be measured (Li et al., 2009). In this context, we propose a method of quality control by quantitative measurement of fermented foods using a one-shot infrared Fourier spectrometer (Sato et al., 2016). Because this spectroscopic method uses Fourier spectroscopy it can measure multiple components simultaneously, while its small size allows it to be installed at the production site so that quality information can be confirmed in real time. This instrumentation makes it possible to measure and quantify important information in the fermentation process, such as microorganisms that act in the fermentation, compounds like glutamic acid that affect the taste of fermented foods, and volatile components that produce aroma. In this paper, we describe the feasibility of quality control in fermented food production by using a one-shot infrared Fourier spectrometer.

Ⅱ. Quantitative measurement of ethanol and glucose

Ethanol and glucose, which are the main components of fermented foods such as soy sauce and sake, were specifically selected for the measurement using a one-shot Fourier spectrometer. An IR light source (manufacturer: HAWKEYEY, model number: IR-Si217) was used to irradiate the samples with mid-infrared light by critical illumination at an applied voltage of 24 V. The experimental optical system is shown in Fig. 1. Ethanol (1, 2, 3, 4 mg/dL) and glucose (1, 5, 10, 20 g/dL) were sealed in a liquid cell with an optical path length of 25 μm, respectively. As shown in Fig. 2, the absorption peaks of ethanol and glucose were detected at 9.33 μm and 9.60 μm, respectively, and high correlation coefficients between concentration and absorbance were observed. These results demonstrate the feasibility of ethanol and glucose measurements using our proposed one-shot infrared Fourier spectrometer.

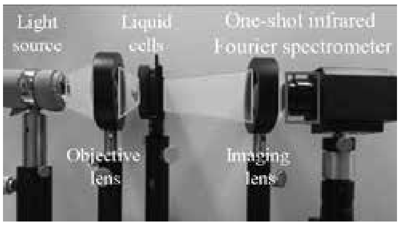

Fig 1. Optical configuration of one-shot-type spectroscopy for ethanol and glucose in liquid cell.

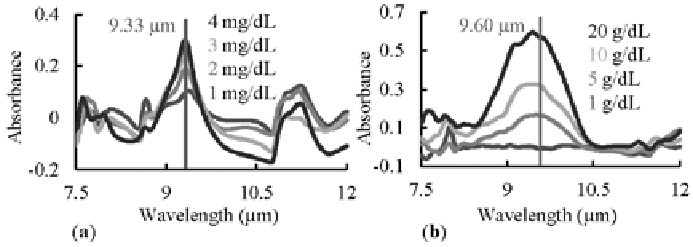

Fig 2. Spectral absorbance of ethanol (a) and glucose (b).

Ⅲ. Conclusion

Quantitative measurement of ethanol and glucose concentrations in fermented foods was carried out using a oneshot infrared Fourier spectrometer. From the experimental results, we confirmed the intrinsic absorption peaks of ethanol and glucose, and found high correlations between concentration and absorbance, which demonstrated the feasibility of quantitative measurement of the target analytes using this method. In the future, we will use the oneshot infrared Fourier spectrometer to broaden the range of measurement targets, such as microorganisms acting on fermentation and flavor components, with the aim of commercializing a compact measurement device that can provide quality control during fermented food production.

Ⅳ. References

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