Non-destructive Evaluation of Fruit Texture and Microstructure using Laser Scattering

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The texture of food greatly affects its perceived palatability. However, most of the methods used to measure food texture are destructive, meaning that the food cannot be eaten after measurement. This talk introduces a simple yet effective method for evaluating food texture and microstructure: laser scattering. This method estimates food texture by measuring and analyzing light scattering, a phenomenon that occurs when light enters a turbid medium. Since light scattering properties are affected by the microstructure of the material, it is possible to extract information from the light scattered image to estimate microstructure and related texture.

Laser scattering is a technique for quantifying the spatial distribution of backscattered light (the light that is scattered in the direction of the incoming light) which is captured using a monochrome camera. It is a non-contact, non-destructive technology and can be operated at low cost since its basic configuration is based on a monochrome camera and several single-wavelength laser sources. Laser scattering simultaneously acquires information related to both the absorption coefficient and the reduced scattering coefficient of the measured object, which are related to its chemical and physical properties, respectively. However, it is possible to focus on the physical properties of the object by selecting illumination wavelengths in which the effect of absorption is small. Compared to similar technologies that utilize backscattered light, laser scattering has an advantage of acquiring information from a large area of the sample. This is achieved by creating high-dynamic-range images: images that are synthesized by combining multiple images acquired at different exposure times.

In this talk, we show how the textural and microstructural changes of apples during storage can be estimated by laser scattering. Firmness is a textural attribute that is generally associated with fresh apples, while mealiness is a powdery texture that is associated with lower quality and palatability. The firmness and mealiness of apples during storage were measured by conventional methods, using a firmness tester and the fruit disk shaking method for firmness and mealiness measurement, respectively. These values were estimated by analyzing the laser scattering image. Multiple features were extracted from the laser scattering image, such as coefficients of fitted functions and image texture parameters. By using machine learning methods such as support vector machine (SVM), artificial neural networks (ANN), and ensemble methods that combine multiple algorithms, laser scattering image parameters were related to the texture values, and the textures of apples were estimated with practical accuracy.

The quality of fruits has conventionally been evaluated by chemical attributes such as sweetness and sourness, as well as the physical appearance. The laser scattering method may be used to add a third parameter to fruit quality evaluation: texture, and this is expected to lead to a more wholesome evaluation of agricultural products.

【Introduction of the speaker】

Mito Kokawa obtained her PhD in agriculture from the University of Tokyo in 2014. After working as a visiting researcher at KU Leuven, Belgium and as a JSPS postdoctoral researcher at the National Agriculture and Food Research Organization (NARO), Japan, she was appointed as assistant professor at the University of Tsukuba. Her research interests are in non-destructive food evaluation and food processing. Current research themes in her lab include Raman spectroscopy and imaging, spice processing, and alternative protein production using filamentous fungi.