別紙４－１（課程博士（英文））

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Abstract (Doctor)

Title of Thesis	Food product quality measurement and visualization using fluorescence fingerprint

Approx. 800 words

Public interest in food quality and production has increased in recent decades. This increase is probably related to the changes in eating habits, consumer behavior, and the development and increased industrialization of the food supply chains. The demand for high quality and safety in food production calls for high standards for quality and process control, which requires sensitive and rapid analytical tools to investigate the food. An excitation-emission matrix (EEM), also known as fluorescence fingerprint, has been widely applied for the nondestructive measurement of the physical and chemical properties of objects. Determination of the food quality using fluorescence measurements has been achieved with high accuracy in many previous studies. However, adopting fluorescence as a technique for determining the quality and authenticating food products is still limited due to the high cost involved. This thesis presents the novel imaging method using fluorescence and presents universal band-pass filters made suitable for their introduction in the food industry.

First, a novel fluorescence imaging method was developed by combining the excitation-emission matrix (EEM) and imaging techniques. This approach based on expanding the point estimation of EEM to the image, where each point in EEM corresponds to one image measured under a specific excitation-emission wavelength. An optimization method also proposed to reduce the dimensions of the EEM by selecting the most efficient excitation wavelength, which allows visualizing the target using only one excitation light. The proposed fluorescence imaging method was applied to visualize the spatial-temporal changes of the freshness indices (*K*-value) and taste component (IMP) content in frozen fish. The result showed that the distribution of *K*-value and IMP content could be visualized with an accuracy of R^2=0.78 and R^2=0.83, respectively. Furthermore, this innovative approach was applied to differentiate burnt meat, which is a type of abnormal meat found in many types of fish, and it was found that burnt meat could be detected even when in a frozen condition.

Next, the versatile band-pass filters for fluorescence imaging of food product for quality assessment was defined by simulation. In the first phase, 70 compounds related to food nutrition, freshness, and umami components were selected as samples for fluorescence spectra (EEM) measurement. From the obtained EEM, a synthetic EEM data-set was generated. Parallel factor analysis (PARAFAC) was applied to the generated synthetic EEM data-set in order to define the excitation-emission wavelength of the band-pass filters. In the second phase, the practicality of the proposed band-pass filters was verified by employing them to solve a real problem. The results showed that the proposed band-pass filters are able to reduce the number of variables in the prediction model, thereby reducing the measurement time and filter cost while having similar or practical accuracy in most of the cases such as estimating aflatoxin contamination in nutmeg, inosine 5'-monophosphate (IMP) of frozen fish and geographical origin of mango compared to the methods reported previously.

As a conclusion, this thesis proposed a novel method to apply fluorescence as a food quality assessment. The proposed fluorescence imaging method and versatile band-pass filters offer a more practical way of adopting fluorescence as a technique for determining the quality and authenticating food products instead of using point measurements or searching the target-dependent excitation-emission wavelength combinations.