CLASSIFICATION OF PORK NECK BASED ON THE PH THROUGH VIS-NIR HYPERSPECTRAL IMAGE ANALYSIS

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I. INTRODUCTION

Consumer awareness of meat quality has increased and they want more certified meat. In the industry, there is a need for rapid and accurate analysis of the meat quality to satisfy the consumers' demands. Among various characteristics indicating the meat quality, pH is an important factor that can affect the final meat quality such as color, water holding capacity, and texture [1]. However, the traditional pH measurement method requires sample destruction and is time-consuming, so it is far from the required method in the meat industry. Therefore, there is a necessity for rapid analysis methods of meat quality in a non-destructive.

Hyperspectral image analysis is a novel technology that has the advantage to obtain multivariable data from samples in a non-destructive and non-invasively. A hyperspectral image is a combination of imaging technology and spectroscopy, so it can provide spatial information and spectrum information from the sample region being imaged. Therefore, hyperspectral imaging can be suitably used to judge and classify the quality of meat by identifying the external and chemical characteristics [2]. The aim of this study was to confirm the accuracy of predicting the grade according to the pH of pork neck by the hyperspectral image data of pork neck obtained at 4 and 24 h postmortem.

II. MATERIALS AND METHODS

The 70 pig carcasses were transported to the laboratory and the pork necks were separated from the right side carcasses at 4 h postmortem. Hyperspectral images were taken at the *Semipinalis capitis* muscle of pork neck. Pork necks were stored at 4 °C and at 24 h postmortem, hyperspectral images were taken. The *Semipinalis capitis* muscle was separated from pork neck and pH was measured.

Hyperspectral image system was snapshot-type and consisted of a cubert ultris X20 plus camera (Cubert GmbH, Germany), four halogen lamps for illumination, and data collection software (CUVIS, Cubert GmbH, Germany). The spectral images were obtained in the reflectance mode, and the wavelength range of 350-1002 nm with 4 nm intervals between bands, thus a total of 164 bands. The region of interest (ROI) selected *Semipinalis capitis* muscle of pork neck using perClass software (perClass Mira, Nederlands), and the mean reflectance spectral value was obtained. Pre-processing of the spectral data was performed by combining Savitzky-Golay smoothing (SG smoothing), baseline offset, standard normal variate (SNV), multiplicative signal correction (MSC), and first or second derivative (Der1, Der2).

The pork necks were divided into three grades according to the pH frequency of 70 samples; A (n=22, pH above 6.5), B (n=26, pH range of 6.2-6.4), and C (n=22, pH under 6.1). Soft independent modeling of class analogies (SIMCA) was performed to predict the classification of grade according to the pH by hyperspectral data. The prediction accuracy of SIMCA was determined by the correct classification rate.

III. RESULTS AND DISCUSSION

The pre-processing was performed to correct the influence of undesirable interference and to highlight the differences between the spectra. It was confirmed that some models with the combination of several pre-processing methods improved the correct classification rate (CC) compared to the model using raw data (Table 1). In the SIMCA model using the spectrum of neck at 4 h postmortem, the CC of pre-processing with MSC was 71.43%, which improved predictive ability compared to raw data (65.71%). In the SIMCA model using the spectrum at 24 h postmortem, the model pre-processing with MSC and Der2 had the highest prediction accuracy at 91.3%. MSC is a pre-processing method for minimizing the effect of light scattering that occurs when measuring spectral data, especially NIR spectra, and derivatives (Der1 or 2) can emphasize the differences between the spectra [3].

Table 1 The correct classification rate (CC%) of pH grade of pork neck using SIMCA

Independent variable	Pre-processing method	Number of components (Class A-B-C)[1]	CC%
Spectrum of neck at 4 h	-	5-6-6	65.71
	MSC	9-10-9	71.43
	Der2	10-12-10	68.57
	Offset, MSC	9-10-9	71.43
	MSC, Der1	10-11-10	71.43
Spectrum of neck at 24 h	-	8-7-6	82.61
	MSC	10-9-9	88.41
	Der2	10-6-7	89.86
	Offset, Der2	10-6-7	89.86
	MSC, Der2	10-6-4	91.3

[1] The number of model components for each class (A, B, and C)

In classification models using spectral data obtained from hyperspectral images at 4 h or 24 h postmortem, the models using spectrum at 24 h tended to have a higher correct classification rate for predicting the grade according to pH of pork neck. In this study, pork was graded according to the pH measured at 24 h postmortem. During the conversion of muscle to meat, the pH gradually decreases through metabolic processes after slaughter and then reaches an ultimate pH at 24 h postmortem [1]. Because the postmortem metabolism is in progress, it might be difficult for the spectral data obtained from the hyperspectral image at 4 h postmortem to reflect the ultimate pH. Therefore, it is suggested that the use of hyperspectral image data obtained at 24 h postmortem can enhance the correct classification rate of the classification model for predicting grade according to pork neck pH.

IV. CONCLUSION

In the SIMCA model for predicting the pH grade of the pork neck using the spectrum of neck 4 h postmortem, MSC pre-processing improved the prediction accuracy. In the model using the spectrum of neck 24 h postmortem, the pre-processing with MSC and Der2 improved the prediction accuracy. Using spectrum data obtained at 24 h postmortem from pork neck hyperspectral images has a higher correct classification rate than using data obtained at 4 h postmortem. Therefore, it is possible to non-destructively predict and classify the grade according to the pH of the pork neck by hyperspectral image analysis. In addition, hyperspectral image data obtained 24 h postmortem from pork neck can be considered to be more suitable for pH grade prediction.

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