PREDICTION OF BEEF TENDERNESS USING NEAR-INFRARED REFLECTANCE SPECTRUM ANALYSIS

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ABSTRACT

Nearinfra-red(NIR) reflectance NIR a spectra (400 to 2,100 ㎚) were collected on 32 beef samples to find feasibility of predicting beef tenderness . The study to predict beef tenderness was accomplished with the stepwise second differential data of the collected NIR spectra. Beef tenderness was measured by Warner-Bratzler(WB) shear force using a Universal Testing Machine(UTM). After modeling the relation between Warner-Bratzler shear force and NIR spectrum of 19 samples among the 32 beef samples, the verification was carried out through predicting the other 13 samples. The SEC and R^2 values in the prediction equation were 9.07(N) and 0.6463, respectively. The SEP and R^2 were 14.8(N) and 0.7082 (wave length 552 ㎚, 1988 ㎚) respectively. The result implied that it was possible to predict the beef tenderness using NIR spectrum and that the tenderness could be predicted non-destructively in real time.

Keywords : Beef, Tenderness, NIR spectrum, Reflectance

INTRODUCTION

Inconsistency in meat tenderness has been identified as one of the major problems facing the beef industry. Some beef processors are implementing that technology, but others have been reluctant to implement that technology because it is destructive. If possible, it is preferable to develop an accurate, nondestructive method to objectively predict meat tenderness.

Given that a variation in the rate of aging causes most of the variation in tenderness of longissimus steaks from the carcasses of young, grain-fed cattle (Whipple et al., 1990; Shackelford et al., 1991), NIR spectroscopy may be able to predict variation in tenderness of longissimus steaks. Recent work by Hildrum et al. (1995) on the use of NIR for the prediction of beef sensory properties achieved promising results using spectral data between 1100 and 2500nm

The objective of this study was to determine the relationship between NIR spectra and

Warner-Bratzler shear force, and to predict the beef tenderness nondestructively.

MATERIALS AND METHODS

Sirloin pot of 45 carcasses, which were just slaughtered, was selected for this experiment. The thickness of samples was about 20mm. Two samples per each carcasses were prepared using core whose diameter was 25mm, one for measuring Warner-Bratzler shear force the other for measuring NIR reflectance spectrum.

1. Measurement of Warner-bratzler shear force

After melt at 4℃ for 24 hours , samples were put in the vinyl bag, and heated at 70℃ in the constant temperature water tank for 1 hour. Each sample was cut into 10× 10× 20mm and placed on a plate, with the direction of muscle's fiber perpendicular to that of Warner-Bratzler blade. Next, Warnet-Bratzler shear force was measured using a Universal Testing Machine(UTM, Stable Micro System, USA, Figure 1). Driving speed of the UTM was 100mm/min.

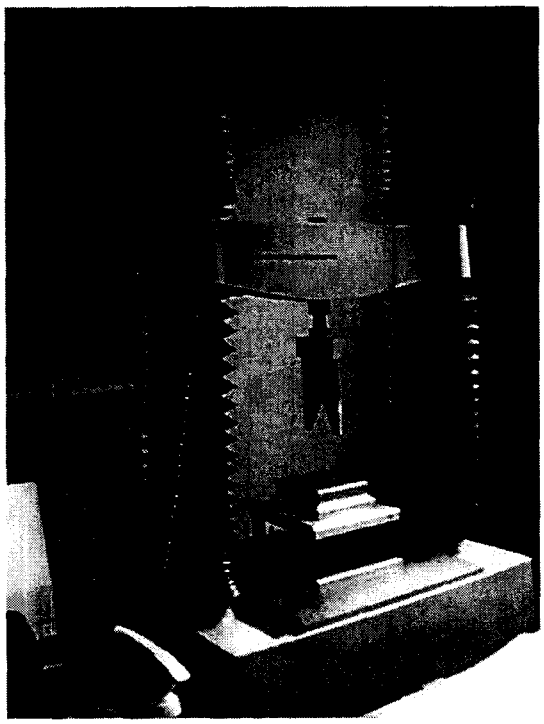


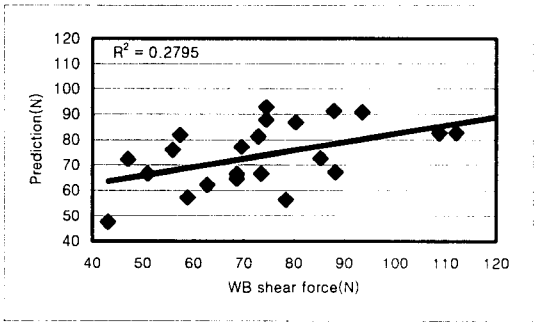
Fig. 1 The UTM used for the tenderness measurement.

2. Measurement of NIR spectrum

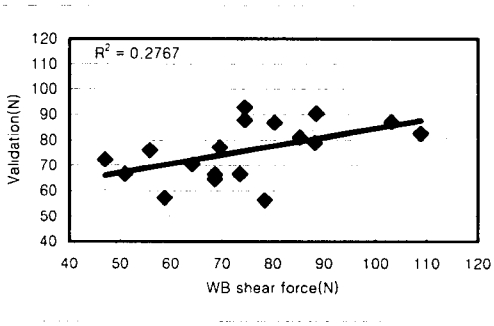
After being melted for 24 hours at 2℃, the samples were measured on the core, which had 30mm hole made fit for the size of probe of a NIR spectrometer, covered with a slide glass. The NIR spectroscopy was Spectrometer(NIR System Inc., USA). Bandwidth of wavelength was in a visual/NIR region(400～2,500 ㎚, 2nm interval). Acquired spectra were analyzed with NIRS2(Infrasoft International, USA) software for the reflectance.

RESULTS AND DISCUSSIONS

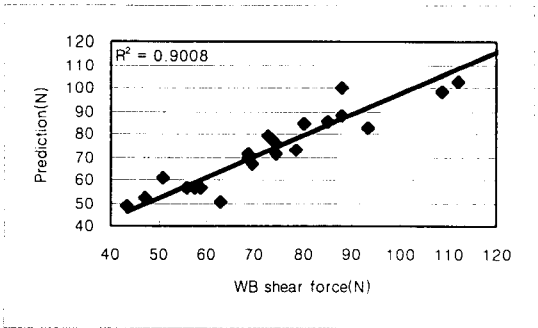
WB(Warner-Bratzler) shear force prediction model was developed using 25 samples, which were randomly selected among 45 samples. Stepwise regression, PCR(Principle Component Regression), PLS(Partial Least Square) and modified PLS methods were applied, and a model using 2nd derivative of the NIR spectra showed best prediction result. Figure 2 represents prediction and validation results of 45 samples by the developed model.



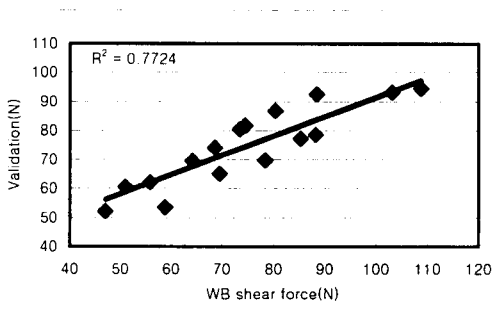
1st derivative(prediction)



1st derivative(validation)



2nd derivative(prediction)



2nd derivative(validation)

Fig. 2 Prediction and validation results using PLS method.

The relation between NIR spectrum and Warner-Bratzler shear force was modeled at R^2 = 0.901, $\frac{SEC}{\bar{y}}$ = 8.0 %, which was obtained with 25 samples among 45 samples. The prediction model was validated with other 20 samples. The model was validated at R^2 = 0.772, $\frac{SEP}{\bar{y}}$ = 10.2%.

CONCLUSIONS

As shown in the result, it was feasible to predict tenderness of beef nondestructively using the NIR spectrum. The beef might be classified into 2 ~ 3 grades using the prediction model.

Color and marbling were used as main quality factors in the conventional beef grading process. Nondestructive tenderness measurement using the NIR spectrum might also be used for the quality grading process.

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