The influence of sample temperature on the determination of moisture and fat content in beef *longissimus* by near infrared spectroscopy

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Introduction

Some attempts have been made to investigate the influence of sample temperature on the estimation of protein and moisture in wheat[1], or on the status of water[2] by near infrared (NIR) spectroscopy. However, it is not clear whether differences of muscle temperature in NIR spectroscopy determination may cause problems or not. The purpose of this work was to investigate the influence of sample temperature on the determination of moisture and fat content in beef *longissimus* by NIR spectroscopy.

Materials and methods

Longissimus thoracis from 16 fattening cattle (ten Japanese Black and six Holstein) were used. A 5.5 cm diameter × 6 cm deep sample was cut from the muscle using a template cutter and placed in a polyethylene bag. The internal temperature of each sample was maintained at 5, 10, 15 or 20°C in the water bath using ice or warm water. At each temperature, the sample was placed in a specially designed sample cup to prevent interference from outside light. Then fibre optic spectra measurements (680 to 1235 nm) were performed by a Neotec Model 6250 Spectrophotometer. Scannings were performed twice on both sides of each sample to obtain the average value of individual beef cuts. Actual sample temperature was measured at each scanning using a thermometer. NIR data were recorded at 2 nm intervals and 50 scans / 25 s were averaged for every sample. Data obtained were saved as log 1/*Re*, where *Re* is the reflectance energy, then mathematically transformed to second derivatives to reduce the effects of differences in particle size and sample composition. A multiple linear regression with two wavelengths was used to find the equation which would best fit the data.

Each muscle sample was ground after NIR scanning. Moisture content was then determined by oven drying and fat content was determined by ether extraction.[3]

Results and discussion

Sample temperature and chemical data of beef *longissimus* muscles are presented in Table 1. The influence of sample temperature on selected wavelengths and calibration statistics for the determination of moisture and fat content in beef *longissimus* by NIR are presented in Table 2. High multiple correlation coefficients (*R*) for moisture and fat content were obtained at every sample temperature (*R* = 0.9494 to 0.9590, *SE* = 1.65 to 1.49% for moisture; *R* = 0.9503 to 0.9565, *SE* = 2.01 to 1.88% for fat). The first selected wavelengths for moisture and fat content at the sample temperature of 5 and

Table 1. Sample temperature and chemical data of beef *longissium* muscles.

Sample temperature (°C)[a]	Actual temperature (°C)			
	n	Mean	*SD*[b]	Range
5	16	4.96	0.34	4.35 – 5.58
10	16	9.98	0.44	9.20 – 11.03
15	16	14.93	0.25	14.33 – 15.30
20	16	20.06	0.35	19.35 – 20.75
Composition (%)	*n*	Mean	*SD*	Range
Moisture	16	64.4	4.9	55.1 – 71.7
Fat	16	14.5	6.0	5.4 – 26.4

[a]Internal temperature of sixteen samples was maintained at 5, 10, 15 or 20°C in a water bath using ice or warm water
[b]*SD*: Standard deviation

Table 2. The influence of sample temperature on selected wavelengths and calibration statistics for determination of moisture and fat contents in beef *longissimus* by NIR.

Content	Temperature (°C)	Selected wavelengths		Calibration	
		X_1[a]	X_2[a]	*R*[b]	*SE*[c] (%)
Moisture	5	1016 nm	854 nm	0.9590	1.49
	10	1017 nm	950 nm	0.9555	1.55
	15	1063 nm	763 nm	0.9511	1.62
	20	1067 nm	1035 nm	0.9494	1.65
Fat	5	1016 nm	854 nm	0.9565	1.88
	10	1017 nm	793 nm	0.9513	1.99
	15	1063 nm	763 nm	0.9503	2.01
	20	1066 nm	1035 nm	0.9527	1.96

[a]X_1 and X_2 refer to selected wavelengths for the linear calibration model
[b]*R*: Multiple correlation coefficient
[c]*SE*: Standard error

10°C (1016 nm and 1017 nm, respectively) were almost the same and another first wavelength for moisture and fat content at 15 and 20°C (1063 nm and 1067 or 1066 nm, respectively) were selected. This could partially explain the highly correlated moisture content ($r = –0.998$) with the fat content. Since different wavelengths were selected at the sample temperature between 5–10°C and 15–20°C, the moisture and fat status or muscle structure might be changed by the temperature. We then compared the second derivative spectra of beef *longissimus* muscles maintained at 5, 10, 15 or 20°C (Figure 1). Spectral differences between 5 and 10°C were very small. However, the spectral differences between 10 and 15°C or between 15 and 20°C were large, especially around 928 nm, which is the NIR absorption band for oil.[4] The peak spectrum around 928 nm shifted to a longer wavelength as the sam-

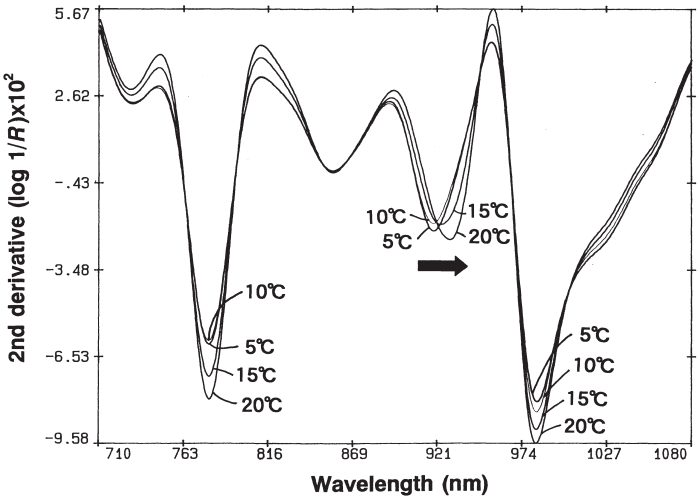

Figure 1. Changes in second derivative spectra of beef *longissimus* as affected by sample temperature. Each spectrum is the average for 16 samples.

ple temperature was increased from 10 to 20°C. The data indicated that higher temperature made intramuscular fat soft and that it shifted the absorption band for fat. Nádai[5] reported that a change in the sample temperature caused an almost parallel shift in the spectrum of homogenised beef and that 1°C caused a shift of about 5×10^{-3} in the log (1/*R*) value. Iwamoto *et al*.[2] reported that the absorption band of water shifted to a shorter wavelength in the optical density spectrum as temperature was increased from 30 to 60°C. However, they also reported that temperature had no influences on a shift of absorption bands in the second derivative spectrum, i.e. the position of the three absorption bands was independent of the temperature. Begley *et al*.[6] reported that the best calibration of NIR data for salt content in meat occurred at a point (1806 nm) in the second derivative spectrum where salt induced a shift in the water spectrum. We found in this study that the absorption band for beef intramuscular fat shifted to a longer wavelength in the second derivative spectrum as the sample temperature was increased from 10 to 20°C. NIR scanning for meat should be performed at a sample temperature of between 5 and 10°C to reduce errors due to the shift in the intramuscular fat spectrum caused by higher temperature.

References

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