Near-Infrared transmission spectroscopy for the prediction of intramuscular fat percentage from young Holstein bulls fed high-concentrate diets

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Abstract

The objective of this study was to validate the potential of Near –Infrared Transmission (NIT) spectroscopy spectrum for the prediction of *Longissimus Thoracis* (LT) intramuscular fat (IMF) percentage from young Holstein bulls. Samples from LT muscle (7-9 ribs) were removed from 52 Holstein bulls (443 ± 4.2 kg) at 24 h *post-mortem* for NIT and official ether extract (EE) method analysis. The intramuscular fat content was predicted using the NIT spectroscopy spectrum in the region 800-1,000 nm (Infratec 1265 Meat Analyzer, Tecator AB, Uppsala) calibrated for pork from 0 to 8% of fat range. A linear regression analyses was conducted between the NIT and official EE method values. The average intramuscular fat contents determined by NIT and official EE method were 2.26 ± 0.623% and 2.63 ± 0.793%, respectively. The regression coefficient of determination (R^2) was 0.84 ($P < 0.001$), the root mean squared error (RMSE) and the RMSE of prediction (RMSEP) were 0.33 and 0.35%, respectively, and the difference between the official EE method data and predicted values (bias) was 0.37. Therefore, present study supports that prediction NIT equation of pork IMF percentage might be a useful an accurate tool to determinate the LT IMF percentage from young Holstein bulls.

Introduction

The IMF percentage of meat, also assessed as marbling of meat, represents an important beef quality trait (Clark and Short, 1994). The official EE method analysis for determining IMF percentage is extremely time consuming, expensive, and generates toxic and hazardous waste (Windham et al., 2003). In contrast, the NIT spectroscopy is a rapid and accurate method for determining IMF percentage without requiring extensive sample preparation, and without leading chemical waste (Windham et al., 2003). Near-infrared measurements are based on the principle that major organic sample components have absorption characteristics (due to vibrations arising from the stretching and bending of H associated with C, o, and N) in the near-infrared region that are specific to the component. These absorption characteristics give the means for assessing composition (Windham et al., 2003). In addition, the NIT spectroscopy analysis enables a rapid assessment of several parameters simultaneously (i. e. fat, water and protein). Although, the NIT has been used extensively to analyze the chemical composition of pork meat (Lanza, 1983; Gispert et al., 1997; Valero et al., 2007), little information has been published on the evaluation of beef meat fat percentage by spectroscopic methods (Clark and Short, 1994). Thereafter, the objective of present study was to validate the NIT prediction equation of pork IMF percentage for the prediction of the IMF percentage in young Holstein bulls LT by comparing results with official EE method.

Materials and methods

The LT from the 6th to the 8th ribs was dissected from 52 Holstein bulls (443 ± 4.2 kg) at 24 h post-mortem, and a 300-g sample was frozen at -20ºC until NIT and official EE method analysis of fat content. The LM sample of 50 g was used to determine by Soxhlet with a previous acid hydrolysis (AOAC, 1995), and a sample of 250 g was ground using a food processor (Robot coupe Blixer3, Montceau Les Mines, France) for NIT analysis. Meat samples were presented in cylindrical sample cells (internal diameter, 130 mm; depth, 10 mm) with a clear plastic bottom and an open top surface, and scanned in the region 800-1,000 nm in 2-nm increments in a NIT spectroscopy (Infratec 1265 Meat Analyzer, Tecator AB, Uppsala) calibrated for pork from 0 to 8% of fat range (Valero et al., 2007). Intramuscular fat percentage data were expressed as g of fat/100 g of muscle.

A linear regression analyses was conducted between the NIT and official EE method values. Model performance was reported as the coefficient of determination (R^2), the prediction error expressed as the root mean squared error (RMSE), and the RMSE of prediction (RMSEP). The model was also validated by prediction of fat by calculating the bias (the average difference between official EE method and NIT values) corrected prediction error, expressed as the standard error of prediction (SEP). Thus, SEP is a measure of the

bias corrected difference between the predicted value and the reference value for each sample in absolute terms, averaged over all samples.

Results and discussion

Table 1 shows the basic statistics of the IMF percentage determined by NIT and official EE method analysis. The average IMF percentages determined by NIT and official EE method were 2.26 ± 0.623% and 2.63 ± 0.793%, respectively. When the official EE method was predicted by the NIT measurements, the regression coefficient of determination (R^2) was 0.84 ($P < 0.001$), indicating that IMF percentage was relatively well predicted (Figure 1). The parameters of that equation are showed in Table 2. The intercept did not have a significant effect. Furthermore, the confidence interval for the intercept included the zero and the confidence interval for the slope included the 1, indicating a good prediction. For that reason when the intercept was forced to be zero, the slope was 1.164 (Table 2), in agreement to the 1.2 coefficient reported by Wood (1990), comparing IMF percentage with hydrolysis and without hydrolysis. In contrast to present result, Togersen et al. (1999) reported a relatively better predicted IMF fat percentage of beef ground meat in on-line applications, with correlation coefficients between 0.92 and 0.98. In addition in the current study, the root mean squared error (RMSE) and the RMSE of prediction (RMSEP) of models were 0.33 and 0.35%, respectively. The mean difference between the official EE method data and predicted values (bias) was 0.37, and the standard error of prediction was 0.28. In agreement to present results, Hildrum et al. (1995) reported that NIT standard error of prediction for beef IMF percentage ranged between 0.27 and 0.81%.

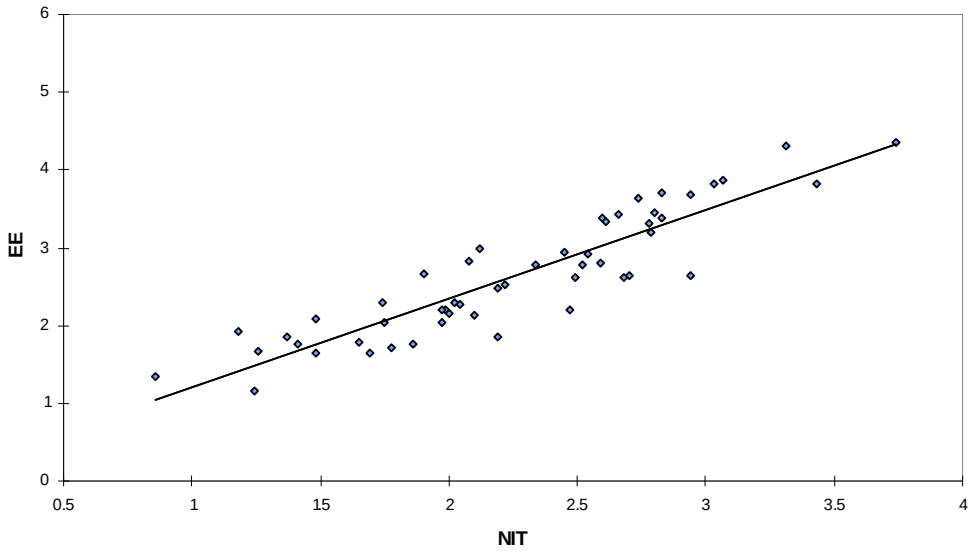

Figure 1. Official EE method determined fat versus Near-Infrared Transmission (NIT) predicted fat.

Table 1. Mean, standard deviation (SD), minimum and maximum intramuscular fat percentage measured with NIT and official EE method

	N	Mean	SD	Minimun	Maximum
NIT	52	2.26	0.62	0.86	3.74
EE	52	2.63	0.79	1.16	4.35

Table 2. Parameters of the regression equation of NIT prediction intramuscular fat percentage (independent variable) versus official EE method intramuscular fat percentage (dependent variable)

Source	Value	Deviation	Significance	Low confidence interval (95%)	High confidence interval (95%)
Intercept	0.049	0.175	0.781	-0.303	0.401
Slope (NIT)	1.144	0.075	< 0.0001	0.994	1.294
If intercept=0					
Slope (NIT)	1.164	0.020	< 0.0001	1.125	1.204

Conclusion

Present study supports that the present prediction equation of NIT for the prediction of the intramuscular fat of pork might be a useful an accurate tool to predict as well the LT intramuscular fat percentage from young Holstein bulls.

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