ESTIMATION OF LEAN MEAT AND FAT CONTENT IN RIB SAMPLES FROM BEEF CARCASSES USING DIGITAL IMAGING TECHNIQUES (CT, MRI)

Gabriella Hollo[1], Gábor Bajzik[1], János Tőzsér[2], Endre Szűcs[2] and Imre Repa[1]

[1]Kaposvár University, Faculty of Animal Science, H-7400 Kaposvár, Guba S. u. 40.
[2]Szent István University, Faculty of Agricultural and Environmental Sciences, H-2103 Gödöllő, Páter K. u. 1., Hungary

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Background

Information of lean meat and fat content of whole carcasses has always been in the focus of attention, that one in particular cuts may have interest for meat industry as well. First evidence on opportunity of estimation of carcass composition from samples taken from 9-10 or 11-12 ribs was published by Hankins and Howe (1946). In one our previous studies (Holló et al., 1998) it was concluded that lean meat percentage of carcass can easily be estimated by X-ray computer tomography. Nowadays quite a lot methods are available to analyse the fat content in meat. One of them, the magnetic resonance imaging (Högberg et al., 2000) made possible to determine the intramuscular fat content in meat and differentiate among fat, connective tissue, and meat using discriminance analysis.

Objective

The aim of this study was to estimate lean meat and fat content in rib samples using X-ray computer tomography and tissue composition of M. longissimus dorsi in rib samples by magnetic resonance imaging (MRI).

Methods

Altogether 30 Holstein-Friesian female cattle were slaughtered after 24 h lairage. Right half carcasses were dissected and the tissues (muscle, bone and fat) were separated after 24 h chilling. Simultaneously, samples were taken from loin between the 11-13th rib and volume as well as area of tissues were determined in 10 mm sections by SIEMENS SOMATOM DRG CT equipment. Records were analysed by CTPC image software on the bases of density values. Muscle and intramuscular content in samples were analysed by SIEMENS MAGNETOM SP 63 1.5 Tesla magnetic resonance imaging (MRI) whole body scanner. After MRI scanning rib samples were dissected and the tissues were separated. From all the MRI-images were taken T_1- (TR: 600 (TR: time repetition), TE: 15 (TE: time between echoes)) and T_2- (TR: 3200, TE: 93) weighted sequences. MRI images were analysed by MRPC software. Images provided histograms which were used to classify tissue categories muscle, fat and connective tissue by k-mean cluster analysis. These variables were included into stepwise multiple regression model for prediction of fat and lean meat content in rib samples. Data processing and statistical analysis was made by softwares of SPSS 8.0 program package.

Results, discussion

Average slaughter weight and weight of rib sample were 562.7±67.4 kg, and 3147.1±617.4 g, respectively. Figures of descriptive statistics are presented in Table 1, whereas coefficients of correlation are summarised in Table 2. CT determined fat tissue area and volume of rib samples showed close and positive correlations with fat percentage and muscle cluster of M. longissimus dorsi in T_1-weighted sequence of MRI image. Significant correlations were calculated among lean meat percentage in rib sample and all the parameters determined by CT or T_2-weighted sequence of MRI image. The results of stepwise multiple regression analysis are presented in Table 3. Coefficients of determination for regression equations were R^2=0.97 in both cases. In relevant literature accuracy of CT data in predicting fat and lean percentage for pig carcasses were R^2=0.98; R^2=0.68-0.89 and R^2=0.55-0.87 calculated by Skjervold et al., (1981) i. e. Sehested and Vangen (1989), respectively. Using figures range of coefficient of determination from MRI analysis (Baulain, 1997) were R^2=0.68-0.89 and 0.55-087, respectively. Residual standard deviation of fat and lean percentage in rib samples were 1.35 and 0.92, respectively. Predicted values of fat percentage and lean met percentage in rib sample were 20.12±8.29 and 53.8±5.02 %, respectively.

Conclusions

Image processing parameters obtained from tissue composition of CT analysed rib sample and that of obtained using MRI can be combined in multiple regression model to estimate fat and lean meat content of rib sample in cattle.

References

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Table 1. Means and standard deviations (SD) for carcass traits and tissue composition of rib samples

		Mean	S.D.
Carcass	Lean meat (kg)	189.71	24.63
	Lean meat (%)	63.96	3.05
	Fat (kg)	51.13	19.41
	Fat (%)	16.69	4.80
Rib sample	Lean meat (g)	1690.00	349.54
	Lean meat (%)	53.80	5.10
	Fat (g)	659.33	347.97
	Fat (%)	20.12	8.40

Table 2. Relation of independent variables with the fat (y_1), lean meat (y_2) percentage of rib sample

Fat (%) in rib sample		r	P
Rib sample	Fat tissue area	0.89	0.001
	Muscle tissue area	0.08	-
	Fat tissue volume	0.87	0.001
	Muscle tissue volume	0.15	-
m. L.D.	Fat cluster (T_1)	-0.12	-
	Muscle cluster (T_1)	0.59	0.001
Lean meat (%) in rib sample			
Rib sample	Fat tissue area	-0.60	0.001
	Muscle tissue area	0.49	0.05
	Fat tissue volume	-0.57	0.001
	Muscle tissue volume	0.43	0.05
m. L.D.	Fat-cluster (T_2)	-0.45	0.05
	Muscle-cluster (T_2)	0.64	0.001

Table 3. Estimation of fat, lean content in rib samples using multiple regression equation

		Fat (%) in rib sample (y_1)	Lean (%) in rib sample (y_2)
Multiple coefficient of correlation	R	0.98***	0.98***
Coefficient of determination	R^2	0.97	0.97
Adjusted coefficient in determination	$R^{2,}$	0.97	0.96
Standard error of the estimate	SEE	1.68	0.99

*** P<0.001

Regression equations: Dependent variable: fat percentage in rib sample (y_1)

	Coefficients of regression	P
Intercept	16.25	0.000
Independent variable		
Fat tissue area in rib sample	0.57	0.000
Muscle tissue area in rib sample	-0.01	0.000
Muscle-cluster in m. l. dorsi (T_1)	0.83	0.000

Dependent variable: lean meat percentage in rib sample (y_2)

	Coefficients of regression	P
Intercept	37.07	0.000
Independent variable		
Muscle-cluster in m. l. dorsi (T_2)	0.13	0.000
Fat tissue area in rib sample	-0.32	0.000
Muscle tissue volume in rib sample	0.02	0.000
Fat-cluster in m. l. dorsi (T_2)	0.19	0.001