IN VIVO PREDICTION OF CARCASS COMPOSITON OF FATTENING YOUNG STOCK USING X-RAY COMPUTER TOMOGRAPHY IN CALVES

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Background

For a long time cattle-breeders and animal scientists have had a strong desire to find methods for in vivo estimation of body and/or carcass composition in animals after slaughter without the need for complete dissection. Recently, various methods: ultrasonic (Denoyelle et al., 1995), video image analysis (Allen &Finnerty, 2000), TOBEC (Allen &Fallon, 1996) were trialed for this purpose. Their usefulness in practice and accuracy may differ largely. Digital cross-section imaging techniques such as X-ray computer tomography (CT) have been applied with success in human medicine for diagnostic purposes for decades. Hungarian animal scientists have been experimenting with CT technology in the last 12 years. The results of experiments carried out in species such as swine, sheep, poultry and rabbit reveal that, these in vivo techniques are suitable to predict body composition with high level of accuracy (Repa et al., 2001). Due to the size of adult cattle, use of CT-technique cannot be used for the time being, this technique is limited to small sized calves only.

Objectives

The aim of this study was to analyse (1) the relationship between body composition of calves estimated by CT and carcass composition determined at slaughter of them as fattening was finished using tissue separation, and (2) establish level of accuracy in prediction with tissues of entire carcass on the basis of in vivo CT examination in calves.

Methods

In vivo CT examinations were carried out in 12 Holstein-Friesian (HF) paternal half sib calves at an average age and in live weight of 56.5±13 days and 82±12.07 kg, respectively. Prior to CT examination calves were anaesthetised by intramuscular administration of Xylasine preparation (o.15 mg/LW kg Rometar 2 % ad. us. vet. – Spofa). For tomography SIEMENS SOMATOM DRG CT-equipment was used at the Institute of Diagnostic Imaging and Radiation Oncology of the University of Kaposvár. The scans were made of the whole body from the shoulder to the hock with 10 mm slice thickness and at 10 mm intervals. The cross section scans were assessed using CTPC-image analysis procedure. The volumes of connective and adipose tissue, moisture, muscle and bone were determined between the 11-13 ribs of right side of the body. The diet of calves consisted of compound feed, grass hay after 70 days milk feeding period. The animals were slaughtered at 206.5±17.7 days of age and in 262.75±13 kg The calves were slaughtered at 206.50±13 days of old, and 262.75±17.70 kg liveweight on the average. After slaughter lean meat, bone, fat, and tendons were separated. In addition samples were taken from 11-13th rib of the right half carcasses, the tissue composition of which were determined by the above-mentioned procedure using CT and then dissected. Using the figures registered, the tissue composition of entire carcasses was estimated by multiple regression analysis by software of the statistical computer package SPSS 8.0 for PC.

Results and discussion

The descriptive statistics of the experimental stock can be found in *Table 1*. During the growing period lasting for 150 days on the average, the muscle and moisture volume of the rib section obtained from CT-images was doubled, the bone content was grown more than 3,5 times, the fat content more than 4 times, and the connective tissue content more than 6,6 times. According to the results of previous study (Holló et al 1998), the tissue composition of rib sample determined at slaughter by CT and by dissection represent well the tissue composition of the carcass at 600 days of age. In *Table 2.* data on the relationship between slaughter records and tissue composition of dissected rib sample were summarised. The total weight of the rib sample is in a close association with all tissues of carcass at 206 days of age. Except for fat quantity in the rib sample, the amount of lean meat, bone and tendons showed significant relation with same characteristics of the carcass. It has to be noted that, the quantity of kidney fat closely correlated with the fat content of rib sample. In *Table 3.* correlation coefficients between the tissue composition of 11-13th ribs section determined by CT procedure in two occasions (in vivo at 56,5 days of age and at slaughter at 206,5 days of age, respectively) and the tissue composition of dissected rib sample as well as the tissue composition of carcass were shown. The weight of the rib sample and dressing percentage related to tissue volumes measured by CT. Between the quantity of lean meat in carcass and that of rib sample, and the muscle and fat volumes using CT technique a very close correlation can be seen at every age categories. Results of *Table 4.* reveal, that using the volume of muscle and connective tissue by in vivo CT examination of 11-13th rib section the dressing percentage and the lean meat content of carcass can be estimated with the same high level of accuracy. This shows that the volume of muscle tissue measured in vivo with CT in 11-13th ribs section specifies 70% out of the total variance of dressing percentage and lean meat. For estimating the fat content of carcass, the coefficients of determination were 0,98, when the equations included the volume of connective tissue and the moisture of 11-13th rib section measured by CT in calves.

Pertinent literature

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Table 1 Mean and standard deviation of variables recorded

n=12		Traits	Mean	SD
Slaughter records		Dressing percentage %	50.79	0.70
		Lean meat weight kg	78.82	4.74
		Bone weight kg	30.90	0.68
		Fat weight kg	4.64	0.27
		Tendon weight kg	4.10	0.22
		Kidney fat weight kg	3.70	0.50
Tissue composition of rib sample		Total weight of rib g	1699.25	217.75
		Lean meat weight g	974.50	171.55
		Fat weight g	130.50	18.23
		Tendon weight g	150.75	19.78
		Bone weight g	443.50	86.54
Tissue composition of CT-determined rib sample	In vivo (82 kg)	Muscle volume cm^3	479.64	112.22
		Fat volume cm^3	29.21	10.05
		Bone volume cm^3	63.36	5.79
		Moisture volume cm^3	37.37	9.98
		Connective tissue volume cm^3	11.31	1.69
	After slaughter (263 kg)	Muscle volume cm^3	968.58	145.60
		Fat volume cm^3	126.47	8.45
		Bone volume cm^3	231.52	36.66
		Moisture volume cm^3	72.53	8.39
		Connective tissue volume cm^3	73.19	6.86

Table 2. The coefficients of correlation (r) between tissue composition of carcass and rib sample

Carcass (kg)	**Rib sample (g)**				
	Total weight	Meat	Fat	Tendon	Bone
Lean meat	0.99	**0.93**	0.78	0.90	0.66
Bone	0.74	0.56	0.76	0.64	**0.73**
Fat	0.49		**0.48**		
Kidney fat	0.68	0.74	**0.93**	0.56	
Tendon	0.75	0.75	0.87	**0.59**	

Coefficients of correlation are significant at 0.05 level of probability.

Table 3. Relationships between the in vivo, or at slaughter CT-determined tissue volume (V) of rib sample and tissue composition of dissected rib sample as well as tissue composition of carcass

CT-examination		**Rib sample**				**Carcass**			
		Dissection							
		T. weight	Meat	Fat	Bone	Dressing %	Meat	Fat	Bone
V Muscle	in vivo	**0.91**	**0.91**		----	**0.85**	**0.83**		
	at slaughter	**0.97**	**0.99**		----	**0.92**	**0.92**		
V Fat	in vivo	**0.87**	0.87		----	0.82	0.79		
	at slaughter	**0.97**	0.92		----	0.94	0.93		
V Bone	in vivo	**0.81**	----		----	0.77	0.73		
	at slaughter	**0.65**	----		**0.91**	0.75	0.75		**0.78**
V Moisture	in vivo	-----	0.77		----	----	------		
	at slaughter	**0.94**	0.98		----	0.90	0.88		
V Connective tissue	in vivo	-----	-----		----	----	-------	0.63	
	at slaughter	**0.94**	0.60	0.60	----	0.88	0.89		

Coefficients of correlation are significant at 0.05 level of probability.

Table 4. Results of regression analysis ($P<0.001$)

R	R^2	$R^{2'}$	SEE	Regression equations
Dressing percentage %				
0.85	0.73	0.70	0.39	$Y_1=48.22+0.005\times Vmuscle_{in\ vivo}$
0.94	0.88	0.85	0.28	$Y_1=45.33+0.007\times V\ muscle_{in\ vivo}+0.19\times V\ connective\ tissue_{in\ vivo}$
Lean meat kg				
0.84	0.70	0.70	2.74	$Y_2=22.52+0.035\times V\ muscle_{in\ vivo}$
0.94	0.89	0.85	1.76	$Y_2=0.38+0.05\times V\ muscle_{in\ vivo}+1.5\times V\ connective\ tissue_{in\ vivo}$
Fat kg				
0.99	0.98	0.98	0.04	$Y_3=-3.4+0.35\times V\ connective\ tissue_{in\ vivo}+0.05\times V\ moisture_{in\ vivo}$