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SOME CARCASS/MEAT QUALITY TRAITS RELATION TO THE MEASUREMENTS OF NOVEL (CT, MR) TECHNIQUES

G. Holló, J. Seregi, I. Holló, I. Repa

Summary

The aim of the study is to analyse the carcass/meat quality traits using non-invasive techniques. Young bulls (n=40) from Holstein-Friesian, Hungarian Grey were used. Besides slaughter data the right half carcasses were dissected samples taken between the 11-13th rib of which tissue composition were measured by X-ray computer tomography (CT). The crude fat, the intramuscular fat content and the relaxation times of longissimus were determined according to Hungarian Standard, Magnetic Resonance Imaging (MRI) and ^{+}H NMR spectroscopy, respectively. Correlation coefficients calculated among parameters (SPSS 10.0). Closest correlation was found for amount and percentage of carcass fat and fat content of rib samples using CT (r=0.93. r=0.84 P<0.001). Coefficients of amount of bone and muscle in carcass and that of in rib samples were r=0.81, r=0.88 (P<0.001). The relationship of the fat of longissimus determined by MRI to crude fat of longissimus showed r=0.52, and to fat amount of rib samples analysed by CT r=0.53. Based on the results of multiexponencial analysis of relaxation times obtained by spectroscopy a negative relationship between biexponencial T_2 fast (%) component and pH_{45} as well as colour (a*) r=-0.37, r=-0.39 (P<0.01) was established. Contrary tendencies were presented in case of T_2 slow (%) component. In conclusion, these novel techniques can be used for the slaughter value estimation and determination of some beef quality traits.

Introduction

Cattle-breeders and animal scientists have had strong desire to elaborate use methods for in vivo estimation of body and/or carcass composition in animals

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G. Holló, J. Seregi, I. Holló, I. Repa, University of Kaposvar, Faculty of Animal Sciences, Institute of Diagnostic Imaging and Radiation Oncology, Kaposvar, Hungary.

after slaughter without complete dissection for a long time. Recently, various methods from visual evaluation (assessing conformation) to instrumental techniques based on miscellaneous principles, ultrasonic-(Denoyelle et al., 1995), video image analysis (Allen & Finnerty, 2000), TOBEC (Allen & Fallon, 19%), were established for this purpose. Their use in practice and accuracy may differ largely. Digital cross-section imaging techniques such as computer- and magnetic resonance tomography have been applied with success in human medicine for diagnostic purposes for decades. Procedures listed, however have been commenced in Hungarian animal science since the late 13 years. Findings 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 animal in bovine species, this technique cannot be used the time being. Use of digital imaging techniques is limited to small sized calves only. In spite of the limits search for ways towards application of procedures in question may be justified for further development. Obvious possibility seems to present for estimation of tissue composition of carcass by tomography of samples taken from carcasses. Thus, it may make evaluation and qualification of cattle more objective after slaughter. Ample relevant literature resources (Küchenmeister et al. 1990) indicate that, tissue composition of several cuts may describe lean meat, fat and bone content, and percentage of intact carcass. From this point of view rib samples merit the highest attention.

The main object of this research was to clarify what for and in which fields digital imaging techniques (CT, MR) can be used in bovine species.

The following additional sub-aims were set:

- opportunity to determine tissue composition in rib sample by CT for estimating that of intact carcass,
- examination of intramuscular fat content of musculus longissimus using magnetic resonance imaging (MRI),
- analysis of relaxation times in longissimus muscle by means of ^{+}H NMR spectroscopy.

Materials and methods

Animal management, carcass handling and meat sampling

Holstein-Friesian (HF) and Hungarian Grey (HG) growing finishing bulls (n=40) were used. Two groups of each breed (n=10) were fattened with maize

silage, hay and concentrate without linseed supplementation whereby the bulls in other groups were fed with grass/grass silage and concentrate with linseed supplementation. The animals were slaughtered at the Zalahús abattoir after 24 h lairage. After 24h chilling the right half carcasses were dissected and the tissues (lean meat, fat bone and tendon) were separated simultaneously samples taken from the right half carcasses between the 11-13th ribs. The pH and the colour in the M. longissimus dorsi (LD) were measured.

The X-ray Computer Tomography (CT) examination

For the CT examination Siemens Somatom Plus CT equipment was used at the Institute of Diagnostic Imaging and Radiation Oncology of the University of Kaposvar. Volume as well as area of tissues of rib samples was determined in 10 mm sections in spiral mode. Records taken were analysed by Med-Image software, where the following tissues muscle, rat, bone and connective tissue as well as water like materials were separated on the bases of density.

The Magnetic Resonance Imaging (MRI) examination

The muscle and intramuscular fat content of LD of rib samples were analysed by Siemens Magnetom Vision Plus magnetic resonance imaging (MRI) whole body scanner (1.5 T) in the Institute of Diagnostic Imaging and Radiation Oncology (Kaposvar). The MRI images were analysed by Osiris software, all the scans provided histograms which were used to classify tissue categories muscle and fat by k-means cluster analyses (SPSS 10.0).

The ^{+}H Nuclear Magnetic Resonance (NMR) spectroscopy

From all the LD muscles 2-3 g muscle samples were taken in a subsequent trial for proton pulse NMR spectroscopy analysis. The examination was carried out in the Institute of Diagnostic Imaging and Radiation Oncology of the University of Kaposvar. The proton relaxation times were measured with a MINISPECT PC 140 NMR system (operating frequency: 40 MHz, 1 Tesla). A T_1 relaxation time was determined by an inversion recovery method with eight different time intervals between the 180° and 90° pulses. Repetition time was 5 times T_1. The transverse relaxation, T_2, was measured using the Carr-Purcell-Meilboom-Gill (CPMG) sequence: the echo time was 1 ms, the number of echos detected was 1000. Multiexponential behaviour of T_2 curves was analysed by least squares statistical procedure. Water content of muscle samples was determined gravimetrically. Fresh muscle samples were weighted

before and after drying at 104 °C for 48 h, the water content was expressed in percent of wet weight.

Chemical analysis and determination of the fatty acid composition

After the digital cross section imaging examinations the tissues of rib samples were separated by dissection and chemical composition of tissue homogenates was analysed using conventional procedures. The determination of fatty acid composition in samples was analysed simultaneously using Chrompack CP 900 gas chromatography. When analysing the fatty acid content the results relating to the unknown sample were given as the relative mass percentage of the fetty acid methyl esters.

Statistical analysis

For statistical analysis software of SPSS 10.0 computer package were used. Coefficients of correlation were calculated between the slaughter records and the tissue composition of rib samples determined by the above-mentioned procedures.

Results and discussion

The animals were slaughtered at 548.5 ± 70.40 days of age and in 479.20 ± 57.65 kg live weight on the average. The treatments mean values are presented in Table 1. The perinephric fat and the trimmed fat content were significantly higher in the intensive groups. It was observed from the slaughter results, that the extensive feeding resulted as less fat deposition and more lean meat in the animal body.

Table 1. - THE SLAUGHTER AND DRESSING DATA

Traits	Intensive		Extensive	
	HF	HG	HF	HG
Slaughter weight, kg	*564*	*546*	*473*	*467*
Internal fat, %	1.1	1.4	0.7	0.7
Kidney fat, %	2.9	3.1	2.0	2.1
Trimmed fet, %	9.2	10.6	4.2	4.8

In Table 2. can be seen the results of the correlation analysis between the slaughter data and the tissue composition of rib samples determined both by tissue separation and CT. From the data it can be established, that the tissue composition of rib samples closely correlated with the amount of lean meat, bone and fat content in the carcass. Between the same tissues close correlation of coefficients r=0.84-0.90 was calculated. The question is, whether the complete dissection of rib samples can be substituted by a CT-examination of the rib sample. The results of the correlation calculations confirmed the close relationship between the rib tissue composition using X-ray computer tomography and the lean, bone and fat content of dissected rib samples. This involves that, the complete dissection at the slaughterhouse, can be replaced by CT examination of rib samples.

Table 2. - THE RELATIONSHIPS BETWEEN THE CARCASS AND THE TISSUE COMPOSITION OF THE RIB SAMPLE (P<0.001)

Carcass	Rib sample	
Lean meat	Lean meat	0.90
Fat	Fat	0.84
Bone	Bone	0.80
CT-examination	**Carcass**	
Muscle tissue	Lean meat	0.88
Fat tissue	Fat	0.93
Bone tissue	Bone	0.81
CT-examination	**Rib sample**	
Muscle tissue	Lean meat	0.88
Fat tissue	Fat	0.93
Bone tissue	Bone	0.81

Contrary to CT, MRI provided various density-values. In addition to MRI scans do not seem to allow clear differentiation of tissues, the contrast of them however, may reflect of their water, fat and protein content Clusters obtained were correlated with reference information including CT-determined tissue composition and the chemical composition data of LD. Based on the results (Table 3.) obtained from MRI pictures further development of the procedure may provide opportunity for analysis of intramuscular fat content and composition.

Table 3. - THE RELATIONSHIPS BETWEEN THE RESULT OF CLUSTER ANALYSIS OBTAINED BY MRI-SCANS AND THE CHEMICAL COMPOSITION OF LD (P<0.01)

Biexponential T_2, % (fast)	pH_{45}	-0.37
	Colour, a*	-0.39
	SAFA	0.63
	MUFA	-0.65
Biexponential T_2, % (slow)	pH_{45}	0.37
	Colour, a*	0.39
	SAFA	-0.63
	MUFA	0.65

We tried to separate the water fractions (both bound, and loose) of different mobility by ^{+}H NMR spectroscopic examination, according to which we can deduce to the water holding capacity of meat. The results of this are shown in Table 4. As a pah of the evaluation we have to mention that fast component characteristics the bound whereas the slow component the free water fraction. Moderate correlation of coefficients was established between the biexponential analysis of T_2 relaxation time of LD samples and pH as well as colour measurements. An examination was carried out between the tatty acid composition of muscle samples and the relaxation time could be assumed, that the differences in fatty acid composition cause alterations in the relaxation time or in the proportion of components with fast or slow relaxation components.

Table 4. - THE RELATIONSHIPS BETWEEN THE RESULT OF SPECTROSCOPY EXAMINATION AND PH, COLOUR MEASUREMENTS AS WELL AS THE FATTY ACID COMPOSITION OF LD (P<0.01)

Cluster	LD	r
Muscle	Crude protein	0.43
	Fat content determined by CT	0.53
	Crude fat	0.52
Fat	SAFA	0.51
	MUFA	0.59
	PUFA	-0.69

Conclusions

The digital cross sectional equipments can be used for the estimation of slaughter value and the determination of the meat quality parameters in cattle species.

Close relationships were established between the rib tissue composition using X-ray computer tomography and the lean, bone and fat content of dissected rib samples and carcass. This involves that, the complete dissection at the slaughterhouse, can be replaced by CT examination of rib samples.

The tissue composition on the MR-scans seems to be able to be solved by the purification of the method and in the course of parameters of meat quality can be estimated such as the intramuscular fat content.

Finding reveal that the differences in fatty acid composition of muscle samples cause alterations in the relaxation time measured by ^{+}H NMR spectroscopy.

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NEKE ZNAČAJKE KAKVOĆE TRUPOVA/MESA U ODNOSU NA NOVE (CT, MR) TEHNIKE MJERENJA

Sažetak

Cilj ovog rada je analizirati značajke kakvoće trupova/mesa primjenom neinvazivnih tehnika. Upotrijebljeni su mladi bikovi (n=40) holstein-frizijske i mađarske sive pasmine. Osim klaoničkih podataka secirane su desne polovice te uzeti uzorci između 11. i 13. rebra čiji je sastav tkiva mjeren rentgenskom kompjutorskom tomografijom (CT). Sirova masnoća, sadržaj intramuskulaturne masnoće i vrijeme opuštanja longisimussa određeni su prema mađarskim standardima, odnosno imaging magnetske rezonance (MRI) i ^{+}H NMR mikroskopijom. Izračunati su koeficijenti među parametrima (SPSS 10.O). Najbliža korelacija nađena je za količinu i postotak masnoće trupla i sadržaj masnoće uzoraka rebara primjenom CT-a (r=0.93, r=0.84 P<0.001). Koeficijenti količine kostiju i mišića u truplu i u uzorcima rebara bili su r=0.81, r=0.88 (P<0.001). Odnos masnoće longisimussa određen MRI-om i sirove masnoće longisimussa bio je r=0.52 i

količine masnoće uzoraka rebara analiziranih CT-om bio je r=0.53. Na temelju rezultata multieksponencijalne analize vremena opuštanja dobivenih spektroskopijom ustanovljen je negativan odnos između biekspоnencijalne T_2 brze (%) komponente i pH_{45} kao i boje (a^*) r=0.037, r=0.39 /P<0.01/. Suprotne su se tendencije pokazale u slučaju T_2 polagane (%) komponente. U zaključku, ove se nove tehnike mogu primijeniti za procjenu klaoničke vrijednosti i određivanje nekih značajki kakvoće govedine.

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