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THE ATTEMPT OF VIDEO IMAGE ANALYSIS USE FOR ESTIMATION OF MEAT QUALITY OF BEEF BREEDS BULLS

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ABSTRACT

The study based on use of VIA for estimation of beef quality from four beef breeds: Limousine, Charolaise, Angus, Hereford and cross-breed Black-and–White x Piemontese were performed. The average values of colour components R and G estimated with a VIA method differed statistically between the investigated breeds. The marbling of the MLD cross-section was for each beef breed significantly diversified. Many significant correlation between physical and chemical properties of meat were obtained, especially between colour components R, G, B, and marbling percentage. In our opinion VIA could be used as a fast and objective method for estimation of chemical composition, texture and technological quality of meat.

Key words: video image analysis, quality, beef meat, beef breeds.

INTRODUCTION

Video image analysis has belonged to the best developing methods in recent years. Modern very fast data processors and high quality of performed images give possibilities in systematisation and storage of information about investigated objects.

The experiments conducted in recent years proved usefulness of Video Image Analysis (VIA) for estimation of animal breeding value [4, 6]. The positive correlation has been stated between area of right side body profile, area of MLD cross-section measured between 10 and 11 ribs and cold carcass weight and weight of valuable cuts. The analysis of MLD cross-section could give us, not only the data about slaughter performance of animal, but also additional information about some chemical and physical characters of meat. The colour and marbling of meat are very important and well correlated with water holding capacity, cooking loss, pH and tenderness which decide about class of meat and its further processing [1, 10, 17]. In their works Reppel and al. [14] and Winkel and co. [19] show the need of development of objective analytical method for colour estimation of meat a quality characters indicator. There has been no such European standard until today [8].

Cross et al. [3, 4] supposed, that the best systems which fulfilled the requirements mentioned above, could be the VIA and ultrasonic carcass measurements.

PROJECT OBJECTIVES

The aim of the research was an attempt to use VIA in estimation of quality of cooled beef from following breeds: Limousine, Charolaise, Angus, Hereford, Black-and-White and Piemontese crossbred.

MATERIALS AND METHODS

The research materials were the meat probes taken from MLD (Roastbef) of beef breeds. The slaughter weight of investigated bulls varied from 450 to 500 kg. The probes were taken from 60 animals (12 bulls per each breed). The bulls were kept in a tied barn and fed ad libitum until the 15th month of life with total mixed ration (TMR), consisted of corn silage (65% of dry matter), hay (5% DM) and concentrate (30% DM). One kilogram of TMR dry matter contained 106 g crude protein, 71 g microbial protein supplied from rumen-degraded protein (PDIN), 93 g microbial protein supplied from rumen-fermented organic matter (PDIE) and 90 Feed Unit for maintenance and meat production (UFV). PDIN consisted of protein digested in the small intestine, which is not digestible in rumen forage protein (PDIA) and protein digested in the small intestine (PDI).

The carcasses after 24 h cooled till 4°C were divided into cuts and deboned. Physical and chemical analyses of meat were performed 48 h after slaughter.

Two slices performed from MLD (m. Longissimus dorsi) were taken to the texture testing and colour measurements by reflecting method. The colour components a*, b*, L* were determined by Minolta CR-200 spectrophotometer. The texture of meat after heating treatment (the slice of meat was dived in 1-% salt solution for 24 h and next warmed in water in 72±2°C for 2 h) was measured using ZWICKI type 1120. The force of pressure, penetration and shear was examined. The force of pressure test was conducted on meat probe 20×20×13 mm and located between two parallel discs. The velocity of the plunger was 50 mm/min. The probe was tested against muscle fibres. The force of pressure was read after the move of the plunger up to 7 mm after the initial tension of the fibres appeared. The penetration test was conducted with a plunger of 13 mm diameter crosswise the muscle fibres of meat probe 20×40×15 mm large. The velocity of the plunger was 50 mm/min. The force of penetration was measured after the gauge plunger, which was moved up to 10 mm depth after the initial tension of the fibres appeared. The measurement of the shear force was conducted with a use of shear element of Warner-Bratzler type. The maximum of shear force was read by plunger move of 50 mm/min. The meat probes 20×40×20 mm large were investigated. The shear force was tested against muscle fibres.

The MLD cross-section was photographed under uniform lightening conditions with a digital camera Olympus 1400L. All influences of the varied lightening conditions (shadow, sun rays, lighting) in the slaughterhouse were eliminated. The MLD cut was taken between 10 and 11 thoracic vertebra and put into special photobox and then photographed. The result of digital image analyses of MLD cross-section were values of colour components R, G, B and marbling percentage.

The chemical composition of meat before heating treatment was investigated. Water content was measured on the base of PN-73/A-82110 with a dryer method. Total nitrogen was estimated with a Kjeldahl method based on PN-75/A-04018 and using 6.25 coefficient for protein calculation. Fat content was proved by Soxhlet method based on PN-73/A-82111, pH was measured with a PH-meter CP-315, cooking loss was stated measured after 30 minutes of heating of 30 g meat probe until 70±2°C in a glass container. The water holding capacity was checked with a filter paper method [13]. The Hornsey [11] method was used for estimation of a total pigment in meat after heating treatment.

The data was statistically analysed using one-way analyse of variance, correlation analysis and NIR test for significance level $\alpha = 0.05$.

RESULTS AND DISCUSSION

The results of basic chemical composition, technological properties, textures and colour measured were presented and discussed in detail in a paper [15]. In this paper we would like to concentrate only an assestment of use of VIA for evaluation of meat quality.

The average values of colour components R and G, estimated with a video image analysis method, were statistically significant between beef breeds. Meat of Hereford breed differ significantly in R component from meat of Charolaise, Limousine and Angus breeds. There was not significant difference between beef breeds in found colour component B (Fig. 1, Table 1).

Fig. 1. The influence of beef breed on colour componnets R, G and B estimated with a help of VIA method

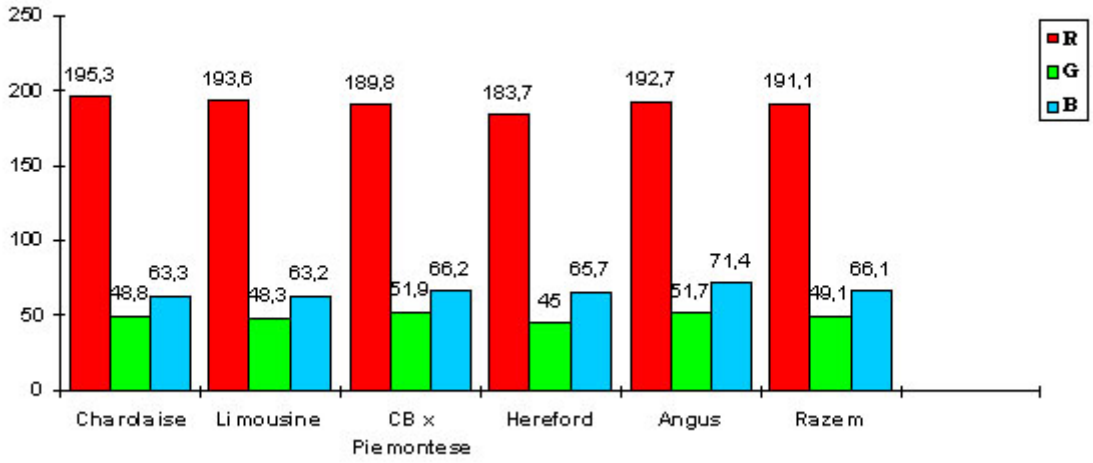


Table 1. Statistic analysis of the influence of beef breed on colour components R, G, B and marbling of meat. One way analysis of variance

Indicators	$F_{emp.}$	NIR	$F_{tab.}$ α=0.05;ν=60
R	**10.13***	5 3 3 4 2 1	$F_{tab.\nu=60}$=3.16
G	**3.99***	5 2 2 1 1 4 3	
B	1.90	2 1 5 5 3 3 4	
Marbling percentage	**12.48***	3 2 1 4 5	

The average values are in ascending order and their positioning in the one column means homogenic group. There is no difference in the estimated character). Significance level p = 0.05.
Beef breed - 1 Charolaise. 2 Limousine. 3 CB x Piemontese. 4 Angus. 5 Hereford.

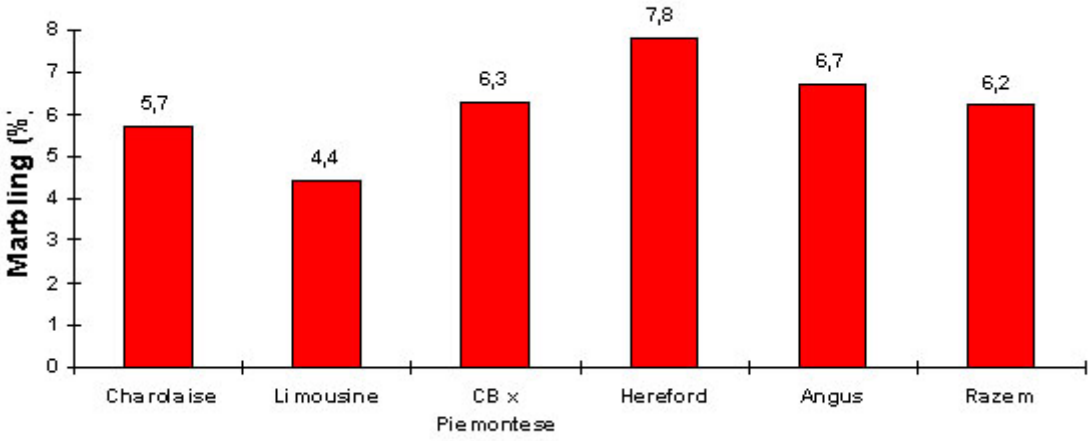
The similar results for colour components R, G and B to those obtained in our experiment were referred for young, beef and dual purpose cattle by other researchers [7, 18].

The differences in pigment content and pH of meat probes could influence the value level of colour components. The colour of meat and the same R, G and B components resulted from breed, age, pH, fat and water content and connective tissue.

The Hereford meat was significantly higher marbled in comparison to the other beef breeds (Fig. 2 Table 1). Lower marbling score were estimated in experiments on Black-and-White cattle and their commercial crossbreeds conducted by Chrobot [2] and Dasiewicz et al. [7]. Results presented by Walasek [18] were close to obtained in our experiment.

The marbling score of the MLD cross-section of beef breed bulls differed significantly depending on breed. This could be a result of individual variability or of different collagen content, which wasn't measured in our experiment.

Fig. 2. The influence of beef breed on marbling percentage of meat, estimated with a help of VIA method



The R, G and B components were correlated with a marbling percentage and chemical and physical characters of beef meat to prove the possibility of use VIA to estimation of meat quality. The correlation coefficient between colour components R, G, B, marbling and chemical content of meat was showed in Table 2. All examined beef breeds had significant correlation between fat content in meat and marbling percentage, which was consistent with results of Gerrard et al. [9], Dasiewicz et al. [7] and Chrobot [2].

Searching for any factors influencing results of marbling estimation of meat, there should also be collagen content in muscle taken into account. Computer software performs its estimations without differentiated fat and connective tissues. Both tissues have almost the same image, hardly differentiated for standard PC Video equipment. The experiments conducted by Seideman [16] and Kołczak et al. [12] show that collagen content in muscles is highly correlated with their tenderness sensorial estimated. It could also be connected with age of animal, muscle type or breed. The meat of Limousine breed with a lowest fat content (3,2%) was highly correlated between fat content and marbling ($r = 0.73$).

Table 2. The correlation coefficients between colour components R, G, B, marbling percentage and content of choosen chemical indicators of beef

Chemical content Indicators estimated with VIA method	Water	Protein	Fat	Haeme content
Charolaise bulls				
R	-0.18	-0.01	0.17	-0.22
G	-0.27	0.14	0.07	-0.23
B	-0.23	0.02	0.16	-0.08
Marbling	0.02	0.40 *	0.71 *	0.45 *
Limousine bulls				
R	-0.11	-0.32 *	0.56 *	0.30
G	-0.17	-0.25	0.58 *	0.28
B	-0.26	0.16	0.27	-0.17
Marbling	0.23	0.37 *	0.73 *	-0.25
Black-and-White x Piemontese bulls				
R	0.25	-0.60 *	-0.01	0.10
G	0.24	-0.67 *	-0.29	0.19
B	0.61 *	-0.53 *	-0.29	0.14
Marbling	-0.14	0.38 *	0.85 *	-0.49 *
Hereford bulls				
R	0.02	-0.06	0.07	0.20
G	-0.05	-0.09	-0.05	0.28
B	0.09	-0.25	-0.07	0.03
Marbling	0.35 *	0.21	0.55 *	-0.24
Angus bulls				
R	-0.17	-0.49 *	0.34 *	-0.16
G	0.19	-0.63 *	0.19	-0.01
B	0.06	-0.20	0.01	0.01
Marbling	-0.26	0.70 *	0.82 *	-0.44 *
All bulls summarized				
R	0.22	-0.18	-0.16	-0.04
G	-0.04	-0.35*	0.16	0.16
B	-0.11	-0.39*	0.29	-0.07
Marbling	-0.57 *	-0.24	0.70 *	-0.24

* significance of the coefficient at p = 0.05

Beside fat, in every investigated beef breed, also protein content was highly correlated with R colour component and marbling. For meat probes taken from Limousine, the correlation was apparently (r = - 0.32 and r = 0.37), crossbreeds Black-and-White with Piemontese (r = - 0-60 and r = 0.38) and Angus (r = - 0.49 and r = 0.70). Negative correlation shows that R parameter decline with a protein content increase. On the other hand, positive correlation between protein content in meat and its marbling (the meat probes of every investigated breed without Hereford) proves that with an increase of protein content in MLD also higher marbling percentage is expected.

The correlation analyses between technological properties, textures parameters of meat and marbling and colour components R, G, B show also many interesting dependencies (Table 3). The pH of charolaise meat is significantly correlated with all factors measured with a help of VIA. Significant correlation was also stated between water holding capacity and colour components R and G for Angus meat probes, colour component B and marbling for hereford and crossbreeds Black-and-White and Piemontese meat and marbling of Charolaise meat. The biggest number of statistically significant correlation coefficients were found between cooking loss and quality indicators measured with VIA for Angus and Charolaise bulls. Otherwise it were not found any statistically significant correlation coefficients between technological meat indicators and quality indicators measured with VIA for Limousine bulls.

Table 3. The correlation coefficients between colour components R,G, B, marbling percentage and technological properties and texture parameters of beef

Technological indicators of meat quality Indicators of meat estimated with VIA method	pH	Water content	Cooking loss	Shear force	Pressure force	Penetration force
Charolaise bulls						
R	0.35*	-0.19	-0.48*	0.06	-0.41*	-0.28
G	0.34*	-0.03	-0.45*	0.19	0.13	-0.17
B	0.40*	-0.14	0.12	0.00	0.00	-0.01
Marbling	0.32*	-0.66*	-0.03	-0.15	-0.37*	-0.49*
Limousine bulls						
R	-0.29	-0.28	-0.18	-0.38*	0.34*	-0.43*
G	-0.24	-0.21	-0.20	-0.45*	0.28	-0.55*
B	-0.22	0.02	-0.29	-0.76*	0.35*	-0.61*
Marbling	-0.07	-0.02	-0.19	-0.02	-0.21	0.50*
Black-and-White x Piemontese bulls						
R	-0.10	0.25	-0.10	0.17	-0.22	-0.31
G	-0.05	0.18	-0.03	0.09	-0.35*	-0.38*
B	-0.03	0.51*	-0.32*	0.08	-0.20	-0.19
Marbling	0.24	-0.51*	-0.06	-0.38*	-0.41*	-0.06
Hereford bulls						
R	-0.08	-0.25	0.05	0.30	-0.01	-0.32*
G	-0.43*	-0.30	-0.19	0.00	-0.12	-0.49*
B	-0.48*	0.32*	-0.17	-0.14	-0.37*	-0.02
Marbling	0.05	-0.53*	-0.11	-0.03	0.14	-0.36*
Angus bulls						
R	-0.10	-0.57*	-0.52*	0.67*	-0.34*	0.50*
G	-0.16	-0.51*	-0.58*	0.72*	-0.41*	0.65*
B	0.20	0.04	-0.05	0.21	0.15	0.15
Marbling	-0.04	0.16	-0.41*	0.01	-0.16	-0.15
All bulls summarized						
R	0.05	0.19	-0.06	0.11	0.29*	-0.07
G	-0.15	-0.13	-0.29*	0.16	0.28*	0.02
B	-0.14	-0.10	0.03	0.13	0.28*	-0.13
Marbling	0.03	-0.28*	0.13	-0.14	-0.10	-0.18

The highest correlation coefficients were found between colour components R, G, B, marbling and texture parameters for Limousine and Angus bulls. The lowest coefficients were estimated for charolaise bulls (Table 3). The correlation analysis indicated significant dependence between quality parameters measured with VIA and colour parameters measured with reflecting method (a*, b*, L*). The table 4 shows, that the most significant correlation coefficients were stated for Hereford and Charolaise breeds and lowest number was for meat of Angus and crossbreeds Black-and-White and Piemontese.

Table 4. Tab. 4. The correlation coefficients between colour components R,G, B, marbling percentage of beef and its colour parameters a*, b*, L* measured with a reflection method

Colour parameters Indicators estimated with VIA method	a*	b*	L*
Charolaise bulls			
R	-0.58*	-0.27	0.70*
G	-0.30	-0.42*	0.48*
B	-0.14	-0.29	0.52*
Marbling	0.36*	0.67*	0.04*
Limousine bulls			
R	-0.32*	0.23*	0.67*
G	-0.26	-0.29	0.64*
B	0.14	0.41*	0.48*
Marbling	0.14	0.06	-0.24
Black-and-White x Piemontese bulls			
R	0.15	-0.16	-0.08
G	0.19	-0.23	-0.04
B	0.13	-0.28	0.20
Marbling	0.43*	-0.16	-0.55*
Hereford bulls			
R	-0.79*	-0.38*	0.37*
G	-0.32*	-0.02	0.53*
B	0.60*	0.49*	0.03
Marbling	-0.56*	-0.27	0.26
Angus bulls			
R	-0.32*	-0.31	0.39*
G	-0.25	-0.29	0.42*
B	0.30	-0.01	-0.30
Marbling	0.01	0.08	-0.07
All bulls summarized			
R	0.27*	0.01	0.14
G	-0.11	-0.19	0.16
B	-0.37*	0.11	0.22
Marbling	-0.03	-0.07	-0.18

In order to verify whether the VIA can be used as a method for quality assessment of meat of beef bulls, without indication the breed of investigated meat probes, the results of the quality measurements were treated as only one group.

The statistical analysis showed significant correlation ($\alpha = 0.05$) between marbling and water and fat content in meat (correlation coefficients apparently $r = -0.57$, $r = 0.70$ in Table 2) and between marbling and water holding capacity ($r = -0.28$). Moreover, there was stated statistically significant correlation between colour components R, G, B and pressure force measured with Zwiki apparatus.

CONLUSIONS

In the described experiment many significant dependencies between investigated physical and chemical characters of meat, colour components R, G, B and marbling were obtained. This allow to assume that:

1. Many significant correlations between marbling and protein, fat content show the possibility of use of VIA to measure chemical content in beef meat.
2. Many significant correlations between marbling and chemical content and quality carcass properties (pH, texture, colour components a*, b*, L) show the possibility of use of VIA to measure surface of fat covered beef carcass. This also needs further investigations.

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