

MARBLING OF MEAT I. CHEMICAL AND PHYSICO-TECHNOLOGICAL PARAMETERS OF COWS' MEAT

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ABSTRACT

The aim of the research work was to compare the quality of slaughtered cows of two age categories, depending on the degree of marbling of meat. Marbling degree in meat of slaughter cows was compared in two age categories: Category 1 – cows up to 4 years old; Category 2 – cows over 4 years old. Samples from *musculus longissimus dorsi* on the level of 9th – 11th ribs were evaluated. We used 10 points scale to estimate the marbling degree (degree 1 – very abundant marbling, degree 10 – practically devoid of marbling). Besides the marbling degree we evaluated the quantitative parameters of meat (fat, water, proteins, pH, colour L, water holding capacity and grilling losses) as well as some parameters of slaughter value (age at slaughter, carcass weight, class of conformation). We found no significant difference between both categories on the basis of marbling degree in meat. We noticed highly significant differences in the parameter age at slaughter in all marbling degrees of meat. Significant differences were found only in marbling degree 6 with the parameters carcass weight and meatiness.

Key words: cows; marbling; beef quality

INTRODUCTION

In Slovakia cows represent more than a half of all slaughter animals slaughtered during the last three years. Therefore cow's meat is offered more and more in the trade network. However, such meat is criticised as being of no good quality, coming from old animals, being very fat and not suitable as meat for sale (Steinhauser, 2000). Jedlička (1988) recommended distribution of cow's meat from animals up to three years of animal's age into trade network. In some countries the distribution of cow's meat into the trade network is prohibited. Galli *et al.* (2008) recommends using cow's meat for meat products or tinned meat. In spite of this beef is an important raw material in food chain. The consumer takes into account colour, amount of fat and other properties at purchase. Minchin *et al.* (2008) reported that the age, mainly the difference between young and old animals, can influence quality of beef.

The amount of intramuscular fat, the so called marbling, is the decisive criterion at selection of beef. According to Zaujec *et al.* (2006) and Yamazaki *et al.* (1989) the marbling degree can influence some qualitative parameters in meat. Johnson *et al.* (1989) stated that marbling does not influence the quality of meat. Vestergaard *et al.* (2000) found higher weight losses in cooked meat at lower content of intramuscular fat. Yang *et al.* (1999) did not find linear decrease or increase of average values in meat colour at individual marbling degrees. Page *et al.* (2001) reported similar results with pH value.

The objective of this work was to compare meat quality between two categories depending on marbling, and to test the hypothesis if the meat quality is worse in cows of higher age category than those of lower age category.

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MATERIAL AND METHODS

Animals

In the experiment slaughter aged cows of various breeds were used that were divided into two groups.

Group I – slaughter cows up to the age 4 years (n=53)

Group II – slaughter cows over 4 years of age (n=103)

The animals came from different farms and they were slaughtered at different slaughter houses in Slovakia. The carcasses were classified by the SEUROP system (regulation of the Ministry of Agriculture of the Slovak Republic SK No. 206/2007). We replaced the letters by numbers: P – 1. O – 2. R – 3. U – 4. E – 5, to calculate the average meat class. The carcass weight and age at slaughter were recorded as well. Basic characteristics of the set are given in table 1.

Chemical analyses

Meat samples were taken from the right side of half carcasses, between the 9th and 10th rib, at the slaughter house 48 hours after slaughtering. Meat samples were wrapped into thin plastic foils, stored in a portable cooling

box at 4°C during the transport lasting approximately 1 hour. The samples were tempered to the temperature 20°C after the transport and parameters of meat were assessed subsequently. Marbling was determined at fresh cut of meat. Marbling degree was assessed on the basis of 10 point American scale (USDA 1997): 1 – very abundant marbling; 10 – traces or devoid of marbling in meat. Percentage contents of protein, fat and total water were assessed in 100 g minced meat sample in the apparatus Infratec 1265 Meat Analyser. Combined glass electrode with portable pH meter (type 3071) was used to measure the pH₄₈ value. The value of meat colour (L) was measured on cutting area of *m. longissimus dorsi* by the apparatus Mini Scan E Plus (Hunter Lab., USA). Grau-Hamm method (modified by Palanská and Hašek, 1976) was used to assess the water holding capacity. Grilling losses were measured in a sample of grilled meat on day 7 after killing. Meat sample (2.5 cm thick slice of *m. longissimus dorsi*) was grilled at a temperature 200°C for 4 minutes in a contact grill – model PM-1015 (RM Gastro, Czech Republic). Grilling losses were calculated after grilling by the formula:

$$\text{Grilling losses in \%} = \frac{\text{weight of sample before grilling} - \text{weight of sample after grilling}}{\text{weight of sample before grilling}} \times 100$$

Table 1: Basic composition of the set of two age groups of cows in dependence on marbling

Marbling degree	6					7				
	I. (n=8)		II. (n=13)		significance	I. (n=10)		II. (n=18)		significance
Parameter	\bar{x}	S \bar{x}	\bar{x}	S \bar{x}		\bar{x}	S \bar{x}	\bar{x}	S \bar{x}	
Age in days	1124.60	149.30	2645.30	231.49	+++	1183.80	75.29	2493.70	186.50	+++
Weight of carcass in kg	256.18	17.88	331.92	12.43	++	247.74	16.90	269.87	15.79	-
Conformation score	1.37	0.18	2.08	0.14	++	1.40	0.22	1.77	0.19	-
Fatness score	2.25	0.36	2.66	0.33	-	2.20	0.20	2.38	0.21	-
Marbling degree	8					9				
Group	I. (n=10)		II. (n=27)		significance	I. (n=25)		II. (n=45)		significance
Parameter	\bar{x}	S \bar{x}	\bar{x}	S \bar{x}		\bar{x}	S \bar{x}	\bar{x}	S \bar{x}	
Age in days	1064.70	92.12	2508.20	151.97	+++	1141.20	65.49	2471.20	96.28	+++
Weight of carcass in kg	222.76	17.00	244.56	8.87	-	207.14	9.60	236.12	7.79	+
Conformation score	1.30	0.15	1.29	0.08	-	1.12	0.08	1.24	0.06	-
Fatness score	1.70	0.11	1.90	0.17	-	1.28	0.10	1.35	0.08	-

- P > 0.05; + P ≤ 0.05; ++ P ≤ 0.01; +++ P ≤ 0.001

conformation score: 1- P (very poor conformation)... 5 – E (very good conformation)

fatness score: 1 – very lean ... 5 very fat

marbling degrees: 1 – very abundant ... 10 - traces or practically devoid

Statistics

The average (\bar{x}) and standard mean error ($S_{\bar{x}}$) were calculated with all results. Differences in averages between categories with individual parameters were tested by Two-Sample test, using the programme Statistix for Windows, version 8 (Analytical Software, Tallahassee, USA). Average values were statistically evaluated with significance of differences as $P < 0.05$.

RESULTS AND DISCUSSION

Basic slaughter parameters are presented in table 1. The table shows that the greatest differences between groups ($P \leq 0.001$) are in the parameter age in days with all marbling degrees. The greatest difference between groups was noticed at marbling degree 6 (1520.7 days), followed by marbling degree 8 (1443.5 days), marbling degree 9 (1330.0 days), and marbling degree 7 with the smallest differences in age (1309.9 days). We found significant differences between groups in marbling

degree 6 and 9 with carcass weight. With this parameter it is necessary to notice that the linear weight of carcass rose in both groups from marbling degree 9 to marbling degree 6. Higher carcass weights were noted in group II with cows over 4 years of age at all marbling degrees. Mojto *et al.* (2009) also noticed higher weight in the group of cows over 4 years of age. Zaujec *et al.* (2006) reported linear rise of carcass weight from marbling degree 9 to marbling degree 4. With the parameter conformation all carcasses were classified as O or P. The results show that the conformation class has no influence on classification of marbling degree. With the parameter fattiness the trend prevails that with decrease of marbling degree the carcasses were incorporated into classes with lower amount of subcutaneous fat. Higher amount of subcutaneous fat was detected in group II with all degrees of meat marbling. In this parameter linear increase of subcutaneous fat content from marbling degree 9 to marbling degree 6 was noted. Similar results were obtained by Zaujec *et al.* (2010) in cows at marbling degree 7.

Table 2: Chemical and physico-technological parameters of cow's meat in two age groups in dependence on marbling degree in meat

Marbling degree	6				significance	7				significance
	I. (n=8)		II. (n=13)			I. (n=10)		II. (n=18)		
Group	\bar{x}	$S_{\bar{x}}$	\bar{x}	$S_{\bar{x}}$		\bar{x}	$S_{\bar{x}}$	\bar{x}	$S_{\bar{x}}$	
Parameter										
Total water (g.100 g ⁻¹)	74.75	0.61	73.16	0.63	-	75.02	0.30	74.38	0.36	-
Proteins (g.100 g ⁻¹)	19.68	0.33	20.38	0.24	-	20.11	0.29	20.28	0.24	-
Fat (g.100 g ⁻¹)	4.55	0.53	5.43	0.58	-	3.96	0.32	4.31	0.40	-
pH ₄₈	6.03	0.11	5.80	0.18	-	5.90	0.11	5.94	0.08	-
Colour lightness L	29.22	1.35	29.88	1.13	-	28.82	1.09	30.13	0.83	-
Water holding capacity (g.100 g ⁻¹)	30.84	1.40	29.26	1.28	-	28.13	1.39	27.84	1.23	-
Grilling losses (g.100 g ⁻¹)	8.85	0.60	10.21	1.09	-	10.32	0.65	11.37	1.21	-

Marbling degree	8				significance	9				significance
	I. (n=10)		II. (n=27)			I. (n=25)		II. (n=45)		
Group	\bar{x}	$S_{\bar{x}}$	\bar{x}	$S_{\bar{x}}$		\bar{x}	$S_{\bar{x}}$	\bar{x}	$S_{\bar{x}}$	
Parameter										
Total water (g.100 g ⁻¹)	75.70	0.64	75.22	0.32	-	76.70	0.27	76.50	0.19	-
Proteins (g.100 g ⁻¹)	20.18	0.29	20.55	0.16	-	20.42	0.16	20.56	0.11	-
Fat (g.100 g ⁻¹)	3.03	0.44	3.20	0.31	-	1.87	0.20	1.92	0.17	-
pH ₄₈	5.87	0.05	5.79	0.04	-	5.88	0.06	5.90	0.07	-
Colour lightness L	29.91	0.97	29.38	0.58	-	31.63	0.69	29.48	0.51	-
Water holding capacity (g.100 g ⁻¹)	31.54	1.44	28.87	1.17	-	29.54	0.73	27.72	1.08	-
Grilling losses (g.100 g ⁻¹)	8.45	1.03	11.36	0.86	-	9.80	0.79	11.02	0.67	-

- $P > 0.05$

marbling degrees: 1 – very abundant ... 10 - traces or practically devoid

Table 2 presents some chemical-physical parameters of cow's meat quality. At first sight it is obvious that there are no statistically significant differences between groups at individual marbling degrees. It means that meat quality between the groups is almost the same at individual marbling degrees. Closer analyses show the differences between groups at individual marbling degrees of meat. In water content, a linear rise was noticed from marbling degree 6 to marbling degree 9, higher content of water being noticed in group I at all marbling degrees of meat. Significant differences in water content between the groups were found at marbling degree 6 ($1.59 \text{ g} \cdot 100 \text{ g}^{-1}$), followed by marbling degree 7 ($0.64 \text{ g} \cdot 100 \text{ g}^{-1}$) and marbling degree 8 ($0.48 \text{ g} \cdot 100 \text{ g}^{-1}$); the smallest differences between the groups were noticed at marbling degree 9 ($0.2 \text{ g} \cdot 100 \text{ g}^{-1}$). Linear rise of protein content was noted from marbling degree 6 to marbling degree 9. The greatest differences between groups were noticed at marbling degree 6 ($0.7 \text{ g} \cdot 100 \text{ g}^{-1}$) and the smallest ones at the marbling degree 9 ($0.14 \text{ g} \cdot 100 \text{ g}^{-1}$). Zaujec *et al.* (2006) also reported linear rise in content of water and proteins in bulls. Zaujec *et al.* (2010) and Gondeková *et al.* (2008) reported approximately the same results in cows with the parameter content of water and proteins as we did. Our results correspond also with the results of Galli *et al.* (2008). In intramuscular fat content we noticed opposite tendency than with the first two parameters. Content of intramuscular fat decreased linearly with incorporation of animals into the lower marbling degree. The highest content of intramuscular fat was found at the marbling degree 6. The greatest differences between groups ($0.88 \text{ g} \cdot 100 \text{ g}^{-1}$) were detected at this degree as well. The differences between groups reduced with incorporation into lower degree of marbling. At the marbling degree 9 the difference between the groups was only $0.05 \text{ g} \cdot 100 \text{ g}^{-1}$. We found higher measured values in group II with this parameter. These results suggest that the incorporation of meat samples into marbling degrees was correct. Similar results were found by Gondeková *et al.* (2008) and Zaujec (2010) at marbling degree 7. Galli *et al.* (2008) on the other hand found the same results, as detected by us in this study, at marbling degree 8. There prevails an opinion that the higher content of intramuscular fat in meat, i.e. the more marbling in meat, the paler the meat. In meat colour we did not find the influence of this parameter between groups on meat paleness in marbling degrees. We found the greatest difference in meat colour between groups in marbling degree 9, followed by marbling degrees 7, 6 and 8. With this parameter we did not find linear decrease or increase of measured values in marbling degrees in both groups. Galli *et al.* (2008) and Kim *et al.* (2003) also obtained similar results. On the other hand, Mojto *et al.* (2009) found lower value for meat colour in cows over 4 years old. With the parameter

water holding capacity we did not notice its linear influence on meat marbling between the groups either. However, the results show that higher water holding capacity was recorded in group I at all marbling degrees of meat. It is logical as younger animals have more water in body than the older ones. Paradoxically, with the parameter grilling losses we detected higher losses in group II at all marbling degrees in spite of lower values of loose water in group II. Significant differences between groups were noted at marbling degree 8 (2.67 kg), followed by marbling degree 9 (1.22 kg), marbling degree 6 (1.36 kg), and significant differences in grilling losses were observed at marbling degree 7 (1.05 kg). Mojto *et al.* (2009) found higher losses at grilling in meat of cows over 4 years old. Similar results were obtained by Gondeková *et al.* (2008) and Zaujec *et al.* (2010) at marbling degree 7.

CONCLUSION

In conclusion we can say that there were no large differences between the groups in the marbled meat, which could indicate the poorer quality of animals at higher age at slaughter. More favourable results were found in group I animals slaughtered at an earlier age. Effect of marbling was reflected in the indicators of total water at level of marbling 6, where the differences between groups were the greatest ($74.75 \text{ g} \cdot 100 \text{ g}^{-1}$ in group I and $73.16 \text{ g} \cdot 100 \text{ g}^{-1}$ in group II) and degree of marbling 9, where the difference between the groups were the smallest ($76.70 \text{ g} \cdot 100 \text{ g}^{-1}$ in group I and $76.50 \text{ g} \cdot 100 \text{ g}^{-1}$ in group II.). Similar results were seen in indicator proteins also in the degree of marbling 6, where the differences between groups were the highest ($19.68 \text{ g} \cdot 100 \text{ g}^{-1}$ in group I and $20.38 \text{ g} \cdot 100 \text{ g}^{-1}$ in group II) and degree of marbling 9, where differences between groups were the smallest ($20.42 \text{ g} \cdot 100 \text{ g}^{-1}$ in group I and $20.56 \text{ g} \cdot 100 \text{ g}^{-1}$ in group II). Also, for fat contents the highest differences were seen in the marbling degree 6 between groups ($4.55 \text{ g} \cdot 100 \text{ g}^{-1}$ in group I and $5.80 \text{ g} \cdot 100 \text{ g}^{-1}$ in group II), while the smallest differences between groups were in the marbling degree 9 ($1.87 \text{ g} \cdot 100 \text{ g}^{-1}$ in group I. and $1.92 \text{ g} \cdot 100 \text{ g}^{-1}$ in group II.). In total water and proteins we found that with decreasing content of intramuscular fat, i.e. less marbling in meat, linear values increased from higher degree of marbling to the lower degree, and on the contrary, the content of intramuscular fat decreased.

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