

EVALUATION OF VARIATIONS IN PRINCIPAL INDICES OF THE CULINARY MEAT QUALITY OBTAINED FROM YOUNG BULLS OF VARIOUS BREEDS

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Background. Principal parameters determining meat nutritional value, its culinary and processing suitability and which jointly make up the concept of meat quality include basic composition, as well as meat pH value. The objective of the presented research project was to compare the slaughter value, basic composition and the course of pH changes in meat obtained from young bulls of four cattle breeds: Limousine, Hereford, and Polish Holstein-Frisian of Black and White variety and Polish Red.

Material and methods. In carcasses proportions of meat, fat and bones were determined using the dissection method. Chemical analyses were carried out on the *longissimus dorsi* muscle which was cut out from chilled carcasses. Samples were stored in vacuum bags for 10 days at 2°C.

Results. Higher slaughter values were obtained in the case of beef breeds in comparison with the native once. With the age, fat and protein content in meat increased, while the content of water decreased. Meat of Limousine and Polish Red breeds was characterised by the highest protein content in the muscle tissue in contrast to that of Hereford breed in which its concentration was the lowest and was accompanied by the highest fat content. The process of meat acidification in all examined animals was slow and in general the final pH value was low. However, in the case of the beef type cattle slightly higher final meat pH values were recorded.

Conclusions. The diversity of principal quality indices of culinary meat between compared breeds of young bulls was small, however often statistically significant. The analysis of the slaughter value revealed that the Polish Red cattle breed achieved dressing percentage similar to that of Hereford of beef type cattle. The Limousine bulls revealed the

highest dressing and meatiness from all analysed animals. The highest protein content was found in the Limousine and Polish Red breeds despite the fact that they do not belong to the same production types. The meat from bulls was characterised by the final pH value ranging from about 5.46 to 5.60 indicating the proper course of meat acidification as well as its good quality and suitability for culinary purposes.

Key words: slaughter value, basic composition of beef meat, pH value

INTRODUCTION

Meat chemical composition is frequently subject of detailed analysis, because it determines its nutritional value, culinary and processing suitability. Beef is very valuable nutritionally and the cattle provide it in large quantities, much of it for culinary purposes. There are a number of factors determining the quantity and quality of meat [Daszkiewicz et al. 2000, Litwińczuk 1996, Litwińczuk and Litwińczuk 1998, Papstein and Ender 1996]. In the case of beef production, the animal production type, breed, gender and age are crucial. Intensification of meat production makes it necessary to shorten production cycles which causes that the produced meat is obtained from young animals fattened intensively.

Large quantities of high quality culinary meat are obtained primarily from beef type cattle as well as from their hybrids. In Poland, the most popular beef type cattle include Limousine (L) and Hereford (H).

However, the most numerous cattle breed found in Poland is the Polish Holstein-Frisian of Black and White breed (BW) which belongs to the dual purpose breed. The above breed is used to obtain interspecific hybrids which are crosses of beef type cattle with dual purpose breed. Polish Red Cattle (PR) is a conservative breed and occurs in small quantities.

Principal parameters determining meat nutritional value, its culinary and processing suitability and which jointly make up the concept of meat quality include basic composition comprising, in particular: the content of protein, fat, water and dry matter as well as meat pH value. Analysing the course of the after-slaughter meat acidification, pH value is of special interest, both directly after slaughter and later, most frequently determined 48 hours after slaughter. The value of this parameter determines many physico-chemical traits of meat and exerts a significant impact on meat shelf-life.

AIM OF THE WORK

The objective of the research was to compare basic composition and the course of pH values changes in the meat obtained from the following four cattle breeds: L, H, BW and PR. Breed selection was performed bearing in mind the size of populations of individual cattle breeds in Poland as well as available information determining their slaughter value.

MATERIAL AND METHODS

Material

The experimental material comprised 78 carcasses and the *longissimus dorsi* muscle of bulls from four cattle breeds, namely BW, PR, H and L. The animals were slaughtered at the age of 6, 9 and 12 months. The number of bulls in individual groups taking into account the breed and age on the day of slaughter ranged from 5 to 12 animals. The *longissimus dorsi* muscle was excised after carcass chilling between the 7th thoracic and the last lumbar vertebrae, vacuum-packed and stored for 10 days at the temperature of 2°C.

Carcasses from animals slaughtered at the age of 12 months were dissected to determine the carcass composition i.e. the content of meat, fat and bones in it. The dissection was performed on the second day after slaughter and carcass chilling.

Dressing and valuable cuts percentage were analysed only in the case of 12-month old bulls.

Chemical analysis

The analysis of the basic composition of muscles was conducted after 48 hours of cold storage. The research comprised determination of content of water, fat, protein and dry matter. Fat content was determined by the Soxhlet method (according to the PN-ISO 1444: 2000 standard), protein content – by Kjeldahl method (according to the PN-A-04018:1975/Az3:2002 standard) and water content by drying a sample to constant weight (according to the PN-ISO 1442:2000 standard). The first measurement of the pH value was carried out 45 min after slaughter and then after 24, 48, 72, 96 and 240 h. pH values were measured using a Handylab 2 pH meter of the SCHOTT Company equipped with a combined electrode type Blue Line 21 (according to the PN-ISO 2917: 2001/Ap1:2002 standard).

Statistical analysis

The statistical calculations took into consideration arithmetic means (\bar{x}), as well as standard deviation (sd) for individual traits. Data were subjected to ANOVA one- and two-way analysis of variance using the STATISTICA 7.0 program. The significance of differences was demonstrated using the LSD Fisher's test at the level of significance $P \leq 0.05$.

RESULTS

Slaughter value and body weight gains

The primary parameter of carcass slaughter value is dressing percentage. However, this trait is described more accurately by proportions of basic carcass constituents, i.e. muscle tissue, fat and bones. Data concerning the above parameters are presented in Table 1.

Out of the four analysed cattle breeds, L bulls reached the highest dressing percentage (60.68%) and this value was significantly different in comparison with the remaining

Table 1. Dressing percentage of young slaughtered bulls, as well as the proportion of valuable cuts, %

Breed	Dressing percentage, %	Meat, %	Fat, %	Bones, %
Polish Holstein-Frisian of Black and White variety	50.68 ^a ±3.38	40.15 ^a ±3.53	6.69 ^{bc} ±0.89	12.08 ^b ±0.68
Hereford	53.93 ^b ±1.44	38.25 ^a ±6.85	7.32 ^c ±2.16	10.98 ^a ±1.30
Limousine	60.68 ^c ±1.22	53.15 ^b ±6.87	4.56 ^a ±1.32	10.37 ^a ±1.16
Polish Red	53.80 ^b ±1.83	38.05 ^a ±4.20	5.60 ^{ab} ±1.03	10.03 ^a ±0.96
Average	54.27 ±4.42	42.24 ±7.78	6.03 ±1.57	10.99 ±1.28

^{a, b, c} Values designated with various letters differ significantly at the level of $P \leq 0.05$; the comparisons take into account breed impact.

three breeds (Table 1). Carcasses of H bulls were characterised by a lower dressing percentage (53.93%), which was similar to value determined for PR bulls (53.80%). Significantly lowest dressing percentage was found for the carcasses of BW bulls (50.68%). The above relationship confirm the fact that the slaughter value of the PR breed, despite the fact that it is considered to belong to dairy cattle, is similar to that of the beef type cattle, the H breed.

In general, dressing percentage index often finds its expression in the carcass meat content, although there are exceptions (BW breed) – Table 1. Bulls of the L meat breed with their highest dressing percentage were also characterised by the highest, and significantly different from the remaining breeds, proportion of meat (53.15%) and the lowest fat content (4.56%) in the carcass. A reverse situation was observed for H cattle. In spite of relatively high dressing percentage, the proportion of meat in their carcasses reached only 38.25%, similarly to the PR breed. This may have resulted from the fact that this breed, in comparison with the L cattle, is characterised by a higher capability to accumulate fat in carcasses which was also confirmed in this study (7.32%). The fat content determined in the H cattle was the highest of all the examined breeds and significantly different in comparison with the PR and L breeds. The examined BW cattle, despite the lowest dressing percentage, contained a higher proportion of meat in the carcass than the meat of H cattle (by 1.9 percent unit) as well as the highest proportion of bones in the carcass (12.08%) which was significantly different in comparison with the remaining breeds (Table 1).

Rates of body weight gain measurements of bulls provided interesting information associated with their slaughter utilization (Table 2). Usually faster body weight gains are connected with more intense fat deposition in the carcass which, in turn, finds its expression in the rate of animal maturation.

From among the analysed beef breeds of animals, the highest gains between the 6th and 12th months of life were recorded in the case of the H breed (171.80 kg), while the lowest – for the L cattle (159.88 kg). This can explain differences between these breeds with regard to the amount of fat gathered in the carcass (Table 1). The examined native cattle breeds – PR and BW – revealed similar body weight gains during the research period with slightly higher values (by 0.72%) for the BW breed. Polish Holstein-Frisian

Table 2. Rates of body weight gains of young bulls between the 6th and 12th months of life, kg

Breed	Weight of animals, kg			Body weight gain 6-12 months* kg	Body weight gain 6-12 months** %
	6 months	9 months	12 months		
Polish Holstein-Frisian of Black and White variety	197.57 ^b ±16.49	281.33 ^a ±33.98	389.83 ^b ±30.31	192.26	97.31
Hereford	173.00 ^a ±12.86	223.80 ^b ±44.73	344.80 ^a ±52.69	171.80	99.31
Limousine	191.40 ^{ab} ±22.14	287.80 ^a ±7.29	351.28 ^a ±46.77	159.88	83.53
Polish Red	166.50 ^a ±24.55	284.50 ^a ±13.43	327.33 ^a ±33.51	160.83	96.59
Average	184.33 ±21.74	267.50 ±40.22	357.79 ±45.11	173.46	94.10

^{a, b, c} Values designated with various letters differ significantly at the level of $P \leq 0.05$, comparisons take into account breed impact.

*Body weight gain expressed in kg of the mass was calculated by the deduction of the 6 month-old bulls mass from of the 12 month-old bulls.

**Body weight gain was calculated by dividing the difference in the weight of 12 and 6 month-old bulls by the mass of 6 month-old animals and expressed in percent.

of Black and White bulls had the highest body weight at the 6th and 12th month of slaughter, while the PR bulls – the lowest (Table 2). The recorded differences between them were statistically significant. At the age of 9 months, L bulls showed the highest body weight at slaughter, while H bulls turned out to be the lightest and these weights differed from each other significantly (Table 2).

Basic composition of meat

Average protein content in beef ranged from 20.48% for 6-month old H bull to 22.03% found in the L cattle also slaughtered at the same age (Table 3). Similar protein content (about 21.77%) calculated for analysed breeds independently from the age of bulls was determined for the PR and L breed despite the fact that they represented different production type (Fig. 1). Significantly lower mean values were determined for the BW and H cattle (21.33% and 21.06% respectively; Fig. 1). Age of the bulls has not influenced the meat protein content. The determined mean values ranged from about 21.4% in animals slaughtered at the age of 6 and 9 months of age to 21.59% in the animals slaughtered at the age of 12 months (Fig. 2).

The determined average intramuscular fat content ranged from 0.27% in the L cattle to 1.32% in the PR cattle (Table 3). Its highest level was recorded in the meat of animals at 9th month of life, although differences between the 9th and 12th months were statistically non-significant (Table 1). At the age of 6 months, the highest percentage of fat was found in the meat of the H breed (0.66%), while the lowest – in L (0.27%). In addition, the meat of L cattle contained the lowest fat levels in the remaining age groups, as well. This caused that the mean fat content in the meat of this beef breed was the lowest (0.42%) of all the experimental animals (Fig. 1). Statistically significant differences were found between the content of this component in the meat of the L breed in relation to the PR breed (1.05%) as well as between the above two breeds and BW and H breeds.

Table 3. Basic composition of *m. longissimus lumborum* & *thoracis* from bulls of different genotype and age, %

Breed	Protein, %			Fat, %			Water, %			Dry matter, %		
	6 months	9 months	12 months	6 months	9 months	12 months	6 months	9 months	12 months	6 months	9 months	12 months
Polish Holstein-Frisian of Black and White variety												
n	7	8	12	7	8	12	7	8	12	7	8	12
x	21.38 ^{bc}	21.05 ^{ab}	21.45 ^{bc}	0.42 ^a	0.55 ^a	1.13 ^{bc}	77.15 ^{cd}	77.02 ^{bed}	76.50 ^b	22.43 ^{bed}	22.44 ^{bed}	22.53 ^{bc}
sd	±0.69	±1.11	±0.57	±0.15	±0.28	±0.34	±0.40	±0.39	±0.52	±0.39	±0.37	±0.43
Hereford												
n	5	5	5	5	5	5	5	5	5	5	5	5
x	20.48 ^a	21.41 ^{bc}	21.29 ^{abc}	0.66 ^a	0.76 ^{ab}	0.69 ^a	77.49 ^d	77.04 ^{bed}	76.42 ^{ab}	21.85 ^a	22.00 ^{ab}	22.54 ^{bcd}
sd	±0.42	±1.50	±0.35	±0.26	±0.22	±0.37	±0.91	±0.55	±0.89	±0.71	±0.79	±0.48
Limousine												
n	5	5	7	5	5	7	5	5	7	5	5	7
x	22.03 ^c	21.61 ^{bc}	21.69 ^{bc}	0.27 ^a	0.44 ^a	0.51 ^a	76.85 ^{bed}	76.83 ^{bed}	76.97 ^{bed}	22.89 ^{de}	22.73 ^{cde}	22.53 ^{bcd}
sd	±0.46	±0.41	±0.28	±0.15	±0.28	±0.30	±0.31	±0.45	±0.42	±0.20	±0.40	±0.43
Polish Red Cattle												
n	5	5	9	5	5	9	5	5	9	5	5	9
x	21.69 ^{bc}	21.68 ^{bc}	21.88 ^c	0.39 ^a	1.32 ^c	1.27 ^c	76.69 ^{bc}	75.80 ^a	75.85 ^a	22.92 ^{de}	22.90 ^{de}	23.01 ^e
sd	±0.36	±0.27	±0.59	±0.34	±0.60	±0.70	±0.91	±0.25	±0.88	±0.60	±0.56	±0.27

a, b, c, d, e Values designated with various letters differ significantly at the level of $P \leq 0.05$; the comparisons take into account the influence of age and breed.

x – mean value, sd – standard deviation, n – number of experimental animals.

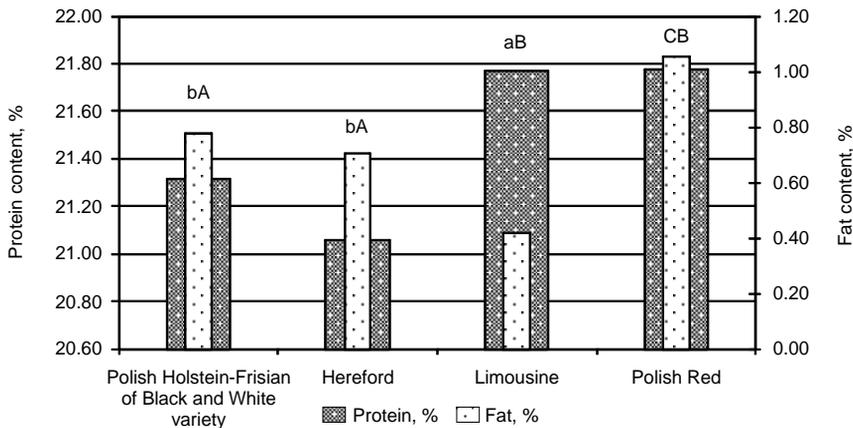


Fig. 1. The percentage share of protein and fat in the meat of bulls depending on their genotype: a, b, c – columns designated with various letters differ significantly at the level of $P \leq 0.05$, comparisons take into account the influence of breed for fat content; A, B, C – columns designated with different letters differ significantly at the level of $P \leq 0.05$, comparisons take into account the influence of breed for protein content

Mean fat content was found to increase along with the age of the examined animals (Fig. 2) and it differed significantly in individual animal age groups ($P \leq 0.05$).

Water content also differed significantly ($P \leq 0.05$) among the four experimental animal breeds (Table 3). The greatest differences were observed between the meat of the PR cattle (in the 9th month) in which water content was the lowest and H in the 6th month of life (Table 3). It is worth emphasising that the meat of the PR cattle was characterised by the lowest mean water content in all age groups (Fig. 3). The content of

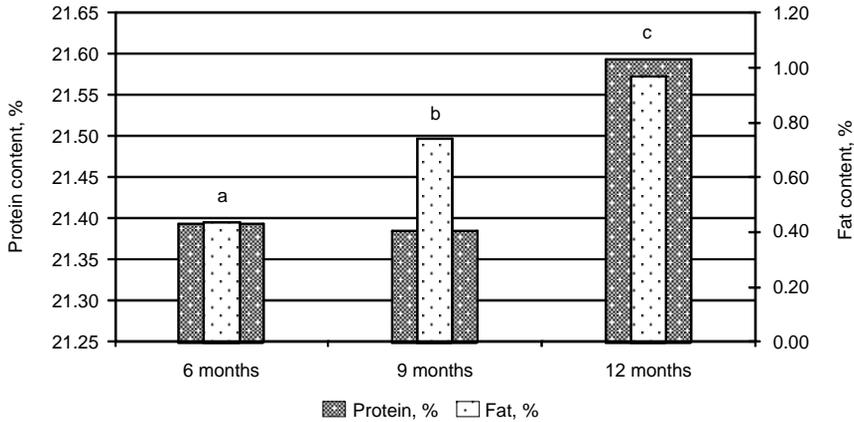


Fig. 2. The percentage share of protein and fat in the meat of bulls depending on their age: a, b, c – columns designated with various letters differ significantly at the level of $P \leq 0.05$, comparisons take into account the influence of age for fat content

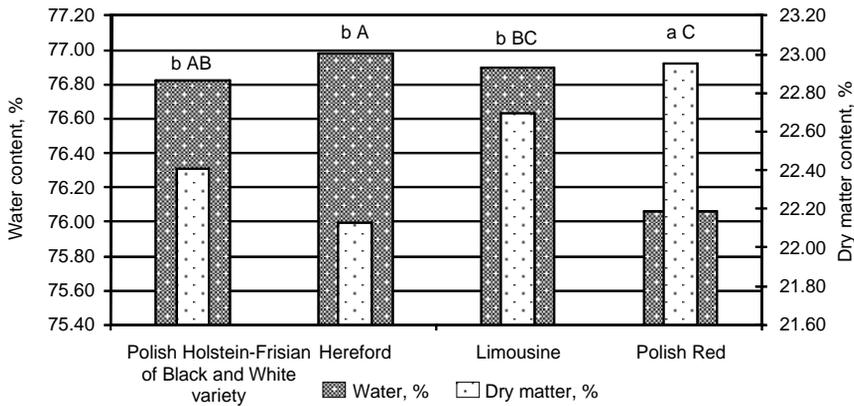


Fig. 3. The percentage share of water and dry matter in the meat of bulls depending on their genotype: a, b, c – columns designated with various letters differ significantly at the level of $P \leq 0.05$, comparisons take into account the influence of breed for water content; A, B, C – columns designated with different letters differ significantly at the level of $P \leq 0.05$, comparisons take into account the influence of breed for dry matter

water in the BW, H and L breeds was at the similar levels (Fig. 3). In the analysed groups of experimental animals, significant differences in the content of this component were found between bulls slaughtered at 6 months – on average 77.06% and those slaughtered at 12th month of life – 76.41% (Fig. 4).

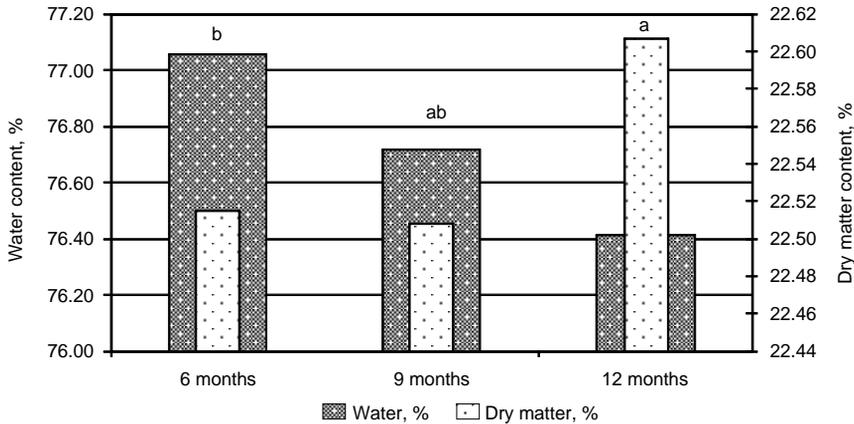


Fig. 4. The percentage share of water and dry matter in the meat of bulls depending on their age: a, b, c – columns designated with various letters differ significantly at the level of $P \leq 0.05$, comparisons take into account the influence of age for water content

The average dry matter content ranged from 21.85% for the meat of H breed at the age of 6 months up to 23.01% in the case of raw material from 12 months old PR cattle (Table 3). Statistically significant differences in the content of this component in meat were recorded between the PR breed and H and BW breeds, as well as between H and L breeds (Fig. 3). No statistically significant differences in the dry matter content between the examined age groups of experimental animals were observed as its level ranged from 22.51% to 22.61% (Fig. 4).

pH value

Results characterising changes in the pH value show that it declined together with the duration of storage up to the 96th h after slaughter (Table 4). The mean pH value of meat 45 min after slaughter reached 6.87. This value decreased to the level of 5.51 at 48 h and rise slightly again at 72 h to the level of 5.57. Further observations of the degree of meat acidification revealed that it exhibited similar values even 96 and 240 h after slaughter.

Final pH value, most commonly assumed as those taken 48 h after the slaughter of animals, was similar in meat samples from the H and L bulls of 6th month of life (Table 5). Meat obtained from the BW breed in the same age group of animals had the lowest pH value (5.46), while in the meat of the PR cattle, the highest (5.53). However, observed differences were not significant statistically (Table 5). In the group of 9-month old animals, identical pH values were recorded in the meat of the H and PR cattle (5.48). This value was higher than that determined in the BW cattle (5.46) but lower

Table 4. Changes in pH value during in the course of maturation

Statistical characteristic	Period of storage					
	45'	24 h	48 h	72 h	96 h	240 h
Mean value	6.87 ^c	5.79 ^d	5.51 ^{ab}	5.57 ^c	5.49 ^a	5.53 ^{bc}
Standard deviation	0.22	0.17	0.07	0.12	0.08	0.08

a, b, c, d, e Values designated with various letters differ significantly at the level of $P \leq 0.05$.

Table 5. Changes in the final pH value in relation to genotype and age of animals

Breed		pH value (after 48 h)		
		6 months	9 months	12 months
Polish Holstein-Frisian of Black and White variety	\bar{x}	5.46 ^a	5.46 ^a	5.47 ^a
	sd	0.03	0.05	0.04
Hereford	\bar{x}	5.49 ^a	5.48 ^a	5.60 ^b
	sd	0.04	0.05	0.11
Limousine	\bar{x}	5.50 ^a	5.49 ^a	5.59 ^b
	sd	0.10	0.03	0.10
Polish Red Cattle	\bar{x}	5.53 ^{ab}	5.48 ^a	5.50 ^a
	sd	0.06	0.03	0.06

a, b, c, d, e Values designated with various letters differ significantly at the level of $P \leq 0.05$; the comparisons take into account the influence of age and breed.

than that found in the L animals (5.49). As in the case of the group of the 6-month old animals, also in the group of 9-month old animals no statistically significant differences were observed between the analysed breeds. At the age of 12 months, meat of the H and L breeds was characterised by similar pH values (5.60 and 5.59, respectively) and these values were statistically significantly different in relation to the remaining two breeds not only in the group of 12-month old animals but also in the remaining age groups, with the exception of the 6-month old PR breed (Table 5). The lowest pH value (5.47) was recorded for the 12-month old animals of the BW breed. The highest final pH value was determined for the H cattle slaughtered at the age of 12 months (5.60), whereas the lowest – for 6 and 9 months old BW cattle (5.46).

The performed one-way analysis of variance revealed statistically significant differences between meat pH values assessed 48 hours after slaughter and obtained from the animals of the BW breed and the remaining breeds. Values of pH were found the lowest for the BW breed. On the other hand, differences in age groups were apparent for the meat obtained from the 12-month old animals in relation to meats derived from the animals which were 6 and 9 months old. Meat derived from the oldest cattle was characterised by the highest pH values.

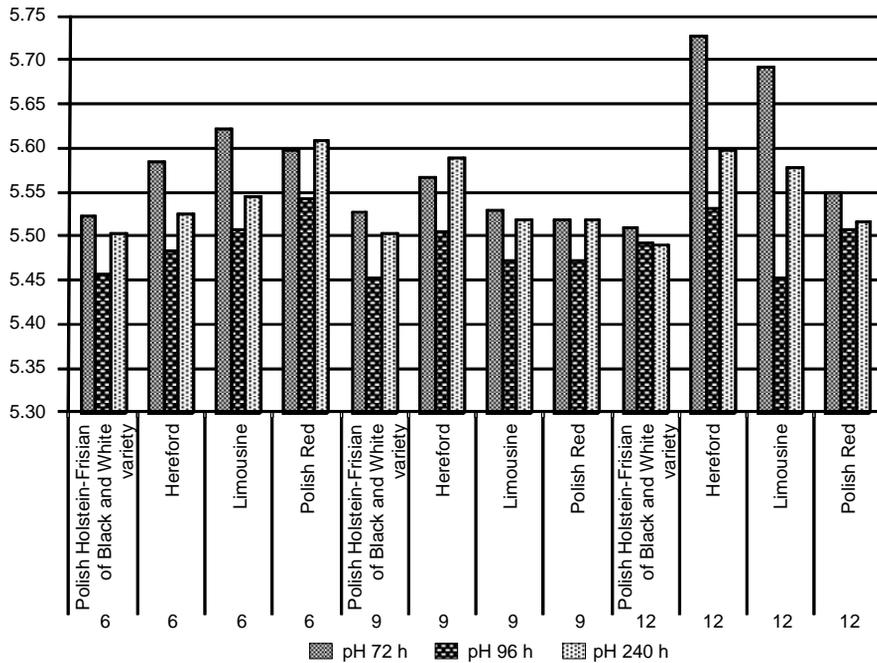


Fig. 5. Changes in pH value of *m. longissimus dorsi* during its cold storage (72-240 h) depending on the age and the genotype of bulls

The analysis of consecutive times of pH measurements of the experimental four cattle breeds slaughtered in three age groups revealed similar results to those observed at the 48th h of measurements. The highest pH values were recorded both 72 as well as after 96 and 240 h after slaughter for 12-month old cattle of H breed (Fig. 5). Also meat of 12-month L cattle 72 and 240 h after slaughter was characterised by equally high pH values. The lowest pH values were found for the BW cattle from 72 to 240 h after slaughter.

DISCUSSION OF RESULTS

Slaughter value and body weight gain

The obtained values of dressing percentage of the four analysed breeds were relatively low which is apparently connected with the age of the slaughtered animals (Table 1). In Poland young cattle is usually slaughtered at the age of 18 to 24 months. However, at present in countries with long traditions of culinary beef production there are trends to slaughter heavier animals but at younger age. The aim of such practice is obtaining carcasses with higher proportions of culinary meat characterised by better quality in comparison with the meat derived from carcasses of older animals [Daszkiewicz and Wajda 2002 b].

Slightly higher dressing percentage for L and BW breeds than those determined in this study was reported by Daszkiewicz and Wajda [2002 c]. In their experiments [Daszkiewicz and Wajda 2002 c], the carcasses of L breed achieved the dressing percentage at the level of 61.84%, i.e. 1.16 percent unit higher than stated in this study. However, the BW bulls from the experiments carried out by Daszkiewicz and Wajda [2002 c] exhibited similar dressing percentage (50.22%) to that established in this experiment (50.68%). The observed differences, albeit small, were connected with the lower body weight of cattle at slaughter in our experiment.

Miciński et al. [2005] reported dressing percentage at level 63.86% for L and 55.3% for H breed and the above values were higher than in our experiments (3.10 percent unit (L) and 1.37 percent unit (H) respectively). This can be explained by the age differences at slaughter. The above-mentioned researchers carried out their study on animals slaughtered at approximately 14th month of their life.

Basic composition of meat

Analysing results of the meat proximate composition depending on the age of animals (Figs 2 and 4), it can be concluded that meat of 6-month old bulls was characterised by the highest water content which was found to decrease as the animals grew. The decrease of water content with the age of animals is a typical phenomenon earlier reported by many researchers [Schön et al. 1958, Litwińczuk and Litwińczuk 1998].

A reverse relationship was found for the intramuscular fat content in meat. Increased fat content together with age of animals were reported by Jacobsoma and Fentona [1956] as well as Litwińczuk and Litwińczuk [1998]. Moreover, study conducted by Papstein and Ender [1996] on meat of different cattle breeds i.e. German Holstein, Angus and Belgian Blue showed that these relationships were observed for *longissimus dorsi* muscle, sirloin (*m. psoas major & minor*) and shoulder muscles.

The concentration of protein in all age groups remained at a very comparable level (Fig. 2). Similar relationship was observed in the dry matter content, although its content fluctuated at a slightly higher interval of values, on average at approximately 1% (Fig. 4).

The comparison between the involved breeds revealed that the experimental BW cattle represented the mean content of each of the compared components within the four breeds (Table 3). In this group of cattle none of the examined constituents occurred at exceptionally high or low content. The meat of H cattle was found to contain the highest water (Fig. 3) and the lowest protein content of all the analysed animal breeds (Fig. 1). The meat of L cattle, in comparison with the remaining groups, distinguished itself for its lowest intramuscular fat and high protein content. The PR breed was characterised by the lowest water content in meat but also by the highest content of fat. Also the protein content in meat was high in this breed. Data on the above-mentioned parameters can be found in Figures 1 and 3.

Daszkiewicz and Wajda [2004] found that mean percentage content of intramuscular fat in the meat of BW bulls as well as BW x L crosses of 210-300 kg live weight was at the level of 1.60%. They also reported that this fat content in meat was accompanied by a distinct increase in the dry matter content. Differences in dry matter content were highly significant for the BW cattle at the fat content in the range from 1 to 3%. Daszkiewicz et al. [2000] determined slightly higher percentage content of fat (2.21%) in the meat of BW bulls in comparison with crosses of the BW and L cattle (2.01%). In the

case of this study, the purebred BW and L bulls exhibited statistically significant differences in the level of fat content. In comparison with the L cattle, the content on fat in the meat of the BW cattle was by 0.36% higher.

Comparing the data concerning fat content in meat obtained in this experiment with the results of Daszkiewicz and Wajda [2002 a, b, c], it can be concluded that those authors determined higher fat content both in the case of L (1.40%) as well as BW (1.33%) cattle. While this difference with regard to the BW cattle was smaller (0.55%; Fig. 1), it was much higher in the case of the L cattle (Fig. 1). In samples analysed in our experiments, mean content of this constituent reached 0.5% and was almost three times lower in comparison with the levels determined in others samples in this experiment. These results were determined in the meat obtained from animals with the live weight ranging from 271 to 351 kg, i.e. within the weight interval of animals (134-445 kg) analysed in the course of this experiment.

It is evident from the study carried out by Daszkiewicz et al. [2000] on the meat quality of heifers and bulls of the BW breed, as well as hybrids of BW and L breeds that the *longissimus dorsi* muscle derived from carcasses of the BW breed had a slightly higher content (25.13%) of dry matter in comparison with the meat derived from carcasses of crosses of BW and L breeds (25.00%). A reverse relationship was observed in the experiment described in this study because the mean dry matter content of 22.41% was recorded for the purebred BW breed bulls, while the meat of L bulls contained 22.69% dry matter. However, it is necessary to state that the differences were not significant. The relationships observed in this experiment were confirmed by results reported by Daszkiewicz and Wajda [2002] who also found a higher dry matter content in the meat of L cattle (24.71%) in comparison with BW cattle (23.98%).

Additional information is provided by the comparison of data referred to the content of intramuscular fat and dry matter from research carried out by Daszkiewicz and Wajda [2004]. Comparing the proximate meat composition of BW breed bulls, as well as crosses of this breed with L cattle of different intramuscular fat content, they found that lower dry matter content was in the meat of the BW cattle in comparison with its hybrids, if the intramuscular fat content did not exceed 2%. This relationship was completely reverse above this value. Different results, depending on the fat content, can be explained by differences obtained during experiments conducted by Daszkiewicz et al. [2000] who reported mean dry matter content for the BW cattle at the level of 25.13% (fat content ranging from 2.01-2.21%) and the results obtained in this study (fat content below 1%) where the mean dry matter content was 22.41%.

Chelmecka [2000] obtained mean protein content in the meat of the Red and White cattle (21.10%) similar to that stated in our experiment for the BW cattle (21.31%). The above researcher obtained higher values of fat (2.70%) and dry matter (24.08%) content, which could have been connected with the higher body weight (up to about 500 kg) of cattle.

pH value

The process of meat acidification in all examined animals was slow and the final pH value was low. The comparison of the data from other experiments [Denaburski and Bąk 2002, Dzierżyńska-Cybulko 1983 a, b] with those determined in this experiment (Table 4, 5, Fig. 5) showed that the meat acidification was proper and typical for this species.

It is generally accepted that the pH value most desirable for beef of normal quality should range from 5.4-5.5 to 5.8 [Kortz 2001, Silva et al. 1999, Beltrán et al. 1997, Wichłacz 1995, Grześkowiak et al. 2006 a]. Additionally, some of them [Kortz 2001, Silva et al. 1999, Beltrán et al. 1997, Wichłacz 1995] defined meat with pH above 6.2-6.3 as DFD meat, while meat with pH ranging from 5.8 to 6.2-6.3 – as moderate or intermediate DFD.

Results of numerous Polish experiments [Grześkowiak et al. 2006 a, Wajda 2001, Pisula 1996] indicate that meat of BW breed cattle is frequently characterised by high pH value. According to Wajda [2001] traits indicating DFD defects were determined in about 80% of meat of BW young bulls. The final pH value at the level of 5.95 which exceeds the acceptable range for meat of normal quality was determined in the *longissimus dorsi* muscle the BW breed recently by Grześkowiak et al. [2006 a]. The above authors suggest that this cattle breed does not have such capability to glycogen storage as beef type breeds. They also indicated that the described phenomenon could have been caused by excessive fatigue and stress of animals before slaughter.

In this experiment, the final pH values for the BW cattle was low (on the average 5.46-5.47; Table 5). Our data prove that it is possible to achieve the desirable acidification in the case of BW cattle. The differences observed between animal groups could probably be attributed to differences in their handling prior to their slaughter. In the case of the analysed bull, their slaughter took place following a short transportation (about 30 km). The experimental animals were in good condition which may not have been the case when animals were assessed by other researchers [Grześkowiak et al. 2006 a, Pisula 1996, Wajda 2001].

However, it was observed that pH values of meat of H and L cattle breeds slaughtered at the age of 12 months were slightly higher in comparison with the domestic dual-purpose breeds. The pH differences between these groups were significant and ranged from 0.09 to 0.13 and had no influence on meat quality with the pH value in this range.

The above distinguishes this meat from that analysed by Chambaz et al. [2003] who evaluated the meat of L steers. They obtained the pH value of 5.50 48 hours after slaughter which was lower than the value determined in our study (Table 5). However, it is worth stressing that steers reveal lower sensitivity to stress than bulls and hence the process of acidification can be somewhat deeper.

Similar results to these obtained in this experiment were reported by Revilla et al. [2006] on 8-month old bulls. On the third day of cold storage of the meat the determined pH was 5.60 which is almost the same as in our case (Table 5) for the entire experimental population.

Meller et al. [1998] compared physico-chemical traits of the meat derived from BW and Belgian Blue cattle and reported only slight acidification. The obtained values were: 5.54 and 5.90, respectively. The bulls were fattened up to the 20th month of life.

Many researchers [Wajda and Hutnikiewicz 1997, Grześkowiak et al. 2006 a, b, Pisula and Florowski 2008, Bach and Dünkel 1993] claimed that beef pH intended for production of culinary meat should not exceed the level of 6.00. It is usually recommended that 48 hours after slaughter it should be in the range from 5.4 to 5.8. In the analysed case, pH values obtained for the meat of domestic dual-purpose breeds, as well as beef type breeds did not exceed 6.00 and ranged from 5.46 to 5.60. Hence this meat can be recommended for utilization for culinary purposes.

CONCLUSIONS

The diversity of principal quality indices of culinary meat between compared breeds of young bulls was small, however often statistically significant.

The performed analysis of the slaughter value revealed that the PR cattle breed, although considered as dairy cattle, achieved dressing percentage similar to that of beef type cattle.

The highest protein content was found in the L and PR breeds despite the fact that they do not belong to the same production types. In comparison with the L cattle, the protein content determined in the H cattle was the lowest and that of fat – the highest. The difference can be attributed to the predisposition for animals' intensive growth and protein and fat metabolism associated with it.

With age, the content of fat and protein increased and the water content decline. Significant differences refer to the meat derived from animals slaughtered at the age of 6 and 9 months in comparison with that obtained from animals 12 months old.

The meat of bulls was characterised by the pH value ranging from about 5.46 to 5.60 indicating the proper course of meat acidification, as well as its good quality and suitability for culinary purposes.

In the case of the beef type cattle breeds, slightly higher pH values were observed in the meat obtained from 9- and 12-month old animals than from the dual-purpose production types, although the degree of acidification corresponded to meat of normal quality.

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OCENA ZRÓŻNICOWANIA PODSTAWOWYCH WSKAŹNIKÓW JAKOŚCI MIĘSA KULINARNEGO POZYSKIWANEGO Z MŁODYCH BYCZKÓW RÓŻNYCH RAS

Wstęp. Do podstawowych sprawdzianów określających wartość odżywczą mięsa, jego przydatność kulinarną i przetwórczą, które składają się na pojęcie jakości mięsa należy skład podstawowy oraz wartość pH mięsa. Celem pracy było porównanie wartości rzeźnej, składu podstawowego oraz przebiegu zmian wartości pH w mięsie pozyskanym z czterech ras bydła: limousine, hereford, holsztyno-fryzyjskiej odmiany czarno-białej i polskiej czerwonej.

Materiał i metody. W tuszach oznaczano udział mięsa, tłuszczu i kości metodą dysekcijną. Badania chemiczne prowadzono na mięśniu najdłuższym grzbiecie, który wycinano po wychłodzeniu tusz. Próby do badań przechowywano w opakowaniach próżniowych przez 10 dni w 2°C.

Wyniki. Większą wartość rzeźną uzyskano w mięsnych rasach bydła w porównaniu z bydlęciem ras rodzimych. Wraz z wiekiem zwierzęcia w mięsie następował wzrost zawartości tłuszczu i białka oraz zmniejszenie zawartości wody. U rasy limousine i polskiej czerwonej zaobserwowano największą zawartość białka w tkance mięśniowej, a u bydła hereford

– najniższą, ono też charakteryzowało się największym udziałem tłuszczu. Przebieg procesu zakwaszania mięsa wszystkich badanych zwierząt był prawidłowy, aczkolwiek u bydła ras mięsnych uzyskano nieco większe końcowe wartości pH.

Wnioski. Zróżnicowanie podstawowych wskaźników jakości mięsa kulinarnego między ocenianymi rasami młodego bydła było małe, chociaż często istotne statystycznie. W analizie wartości rzeźnej wykazano, iż bydło polskie czerwone wyróżniało się wydajnością poubojową podobną do bydła mięsnego rasy hereford. Jednakże największą wydajnością poubojową i mięsnością spośród wszystkich analizowanych byczków charakteryzowała się rasa limousine. Największą zawartość białka zaobserwowano u rasy limousine i polskiej czerwonej, mimo że nie należą do tych samych typów użytkowych. Mięso bujaków wyróżniała wartość pH w przedziale od ok. 5,46 do 5,60, co wskazuje na prawidłowy przebieg zakwaszania mięsa, jego dobrą jakość i przydatność do wykorzystania na cele kulinarne.

Słowa kluczowe: wartość rzeźna, skład podstawowy mięsa wołowego, wartość pH

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