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Influence of cattle breed on selected qualitative features of cold-stored veal

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Literature data indicate that the production purpose and breed of cattle have a significant impact on various qualitative characteristics of veal. Therefore the purpose of this study was to determine whether and in what way selected qualitative characteristics of veal change over time (24, 48, 72 and 96 hours after slaughter) depending on the cattle breed. The tests were conducted on meat from the quadriceps femoris muscle of calves of the following breeds: Simmental (30 head), Polish Holstein-Friesian of the Red-and-White variety (30 head) and Black-and-White variety (30 head), and Limousin (30 head). During four successive days of cold storage (temperature 2-4°C) pH decreased most slowly in the meat of the Limousin calves. In the meat of the other breeds the lowest pH was noted as early as 24 hours after slaughter. However, statistically significant differences were found only for pH_{48} between the meat obtained from the Simmental and the Polish Black-and-White Holstein-Friesian calves. Analysis of the post-slaughter maturation of the veal found the most favourable water-holding capacity and cooking loss in meat obtained from the carcasses of Polish Black-and-White Holstein-Friesian and Polish Red-and-White calves. The lowest-quality meat with respect to these features was obtained from the Simmental calves.

KEY WORDS: veal / meat quality / cattle breed

Beef and veal do not play a significant role as a raw material in food processing, as they are mainly used as fresh meat for cooking. Consumers buying veal mainly pay attention to its colour, marbling, consistency and smell [2, 12, 15].

The quality of veal is influenced by many factors. The most important include breed [11], feeding system [23], housing system [25], handling of animals [14], and the rate of post-slaughter changes [10]. Few studies have examined the effect of the season or month of slaughter on veal quality [17], particularly its fatty acid profile [3] and meat colour [4]. Literature data also indicate that the production purpose and breed of cattle have a significant influence on the individual quality characteristics of raw veal.

The aim of the study was to investigate whether and in what way selected quality traits of veal change over time (24, 48, 72 and 96 hours after slaughter), depending on the breed of cattle.

Material and methods

The research was conducted on meat from the leg of calves (bulls) of the following cattle breeds: Simmental (30 calves), Polish Black-and-White Holstein-Friesian (30), Polish Red-and-White Holstein-Friesian (30) and Limousin (30). The calves came from farms in south-eastern Poland. The bulls (weighing 90-120 kg before slaughter) were slaughtered in accordance with the technology used in the meat industry and under the supervision of veterinary services. After slaughter the veal carcasses were refrigerated (at 4°C) for 24 hours. A sample for analysis was cut from the quadriceps femoris muscle and refrigerated (at 2-4°C). Then, after 24, 48, 72, 96 hours of cold storage, in the laboratory of the Department of Processing and Agricultural Commodity of the University of Rzeszów, the colour, water-holding capacity, cooking loss and pH of the meat were assessed. In addition, the content of protein, fat and water were determined in the meat 24 hours after slaughter.

The colour was evaluated subjectively using the point method, according to colour standards (1 point – light meat; 5 points – dark meat). The colour assessment was carried out on a fresh cross-section of meat up to 10 minutes after the slices had been cut, in daylight in a location without sun.

The acidity (pH) of the muscle tissue was measured with a CPC-411 pH meter (OSH 12-01 electrode) with accuracy to within 0.01. The measurements were made 24 hours after slaughter (pH_{24}), 48 hours after slaughter (pH_{48}), 72 hours after slaughter (pH_{72}) and 96 hours after slaughter (pH_{96}).

Then a sample of meat was ground in a laboratory grinder with a plate with 4.0 mm holes, after which the chemical composition was determined using an NIR-FoodCheck analyser.

Water-holding capacity was determined according to the Grau-Hamm method [8] as modified by Pohja and Ninivaara [19], based on the amount of free water (expressed in %) lost by a meat sample placed on filter paper (Whatman No 1) and subjected to constant pressure (2 kg weight) between two glass plates. After planimetric determination of the infiltrated area (expressed in cm^2), the amount of free water was calculated, assuming that 1 cm^2 of the infiltrated area represented 10 mg of meat juice absorbed by the paper. This measurement was performed twice and the mean was calculated.

Cooking loss was determined by Walczak's method, in which a meat sample was cooked at 85°C for 10 minutes and cooled for 20 minutes, and then the percentage of water lost was determined based on the difference in weight before and after heat treatment [24].

The results were subjected to statistical calculations. The tables present arithmetic means and standard deviations (SD) for each of the characteristics. One-way analysis of variance was used to determine the significance of the influence of cattle breed on selected quality traits of the veal. The null hypothesis in the analysis of variance was verified using the Fisher-Snedecor test (F test). Means between which differences were significant at $p \leq 0.05$ were designated with different letters A, B, C and D. The absence of superscript letters or the same letters indicate that there were no statistically significant differences between them. The calculations were made using STATISTICA PL software ver. 10.

Results and discussion

Colour is a basic distinguishing feature of beef quality. Its saturation depends on the concentration and chemical form of myoglobin [12, 18]. Table 1 presents data on changes in the colour of veal obtained from the carcasses of calves of different breeds. The darkest colour was found in the muscles of the Simmental, Polish Black-and-White Holstein-Friesian and Limousin calves – 4.00 points, assessed 24 hours after slaughter. The lightest colour was found in the muscles of the Simmental and Limousin calves – 3.00 points, assessed 96 hours after slaughter. However, statistically significant differences in colour were noted only on the fourth day of refrigeration, between the muscles of the Polish Holstein-Friesian calves of the Red-and-White (3.50) and Black-and-White (3.25) varieties. Florek et al. [6], in a study of the quality of the meat of four breeds of calves, found that Simmental and Polish Red calves had the lightest carcasses (the highest L* value and the lowest a* for surface muscles on the leg, abdomen and neck), while both varieties of the Polish Holstein-Friesian breed had the darkest carcasses. Lagoda et al. [13] report that consumers judge the freshness and tenderness of veal mainly by the colour of the meat, and thus this feature is the main criterion for carcass classification and its commercial value. The light colour of veal is due to the low concentration of pigments in the muscle tissue of growing animals, whose feed has low iron content, e.g. milk [1, 16].

In an online survey conducted in April 2005, consumers were asked what quality characteristics they were guided by when buying veal, given the choice of colour, tenderness and palatability. Among the respondents, 89.95% considered tenderness to be very important or important and 89.1% selected palatability. Colour was not found to be a significant quality characteristic of veal. Consumers are mainly interested in the taste, smell and structure of meat after cooking and pay little attention to the colour, which changes as a result of high temperature. However, the next question regarding the choice of colour showed that consumers from countries with a tradition of eating beef and veal preferred light pink or white meat (France – 86.77% and Italy – 81.58%) [21, 22]. Consumer preferences regarding the colour of veal meat are divided; for example, white or pale pink meat is preferred in France, Italy, and also Poland, while consumers in Belgium, Portugal, Spain, Sweden, Germany and Denmark expressed a liking for dark meat as well [21].

Table 1
Changes in colour and pH of veal obtained from carcasses of cattle of individual breeds

Specification		Breed			
		Simmental	PHF RW	PHF HO	Limousin
Colour (pt)					
24 h	$\bar{x}$	4.00	3.75	4.00	4.00
	SD	0.71	0.35	0.82	0.82
48 h	$\bar{x}$	3.50	3.50	3.75	3.50
	SD	0.71	0.71	0.87	0.71
78 h	$\bar{x}$	3.37	3.00	3.50	3.50
	SD	0.75	0.71	0.41	0.41
96 h	$\bar{x}$	3.00	3.50^{B}	3.25^{C}	3.00
	SD	0.58	0.71	0.64	0.58
pH_{24}	$\bar{x}$	5.75	5.55	5.81	6.08
	SD	0.10	0.02	0.11	0.31
pH_{48}	$\bar{x}$	5.82^{A}	5.71	5.61^{C}	5.85
	SD	0.12	0.08	0.07	0.28
pH_{72}	$\bar{x}$	5.70	5.83	5.66	5.64
	SD	0.18	0.05	0.18	0.24
pH_{96}	$\bar{x}$	5.81	5.87	5.79	5.60
	SD	0.21	0.33	0.13	0.12

PHF RW – Polish Holstein-Friesian Red-and-White variety
PHF HO – Polish Holstein-Friesian Black-and-White variety
A, B, C – means denoted with various letters differ statistically significantly at $p \leq 0.05$

The pH value is a basic determinant of meat quality. The meat ageing process is associated with the breakdown of glycogen in the muscle tissue. The proper glycogen level in the muscles before slaughter is a condition of correct pH after slaughter. The pH of normally acidified meat ranges between 5.5 and 5.8 [9, 18]. Table 1 presents data on changes in the pH of the muscles of calves of each breed. The observations show that the decrease in pH was slowest in the muscles of the Limousin calves. The leg muscles of the calves of the other breeds had already reached the recommended pH 24 hours after slaughter. However, statistically significant differences were observed only for pH_{48} between muscles obtained from Simmental calves (pH 5.82) and Polish Black-and-White Holstein-Friesian calves (pH 5.61).

Florek et al. [6] conducted a study on changes in meat acidity at various times after the slaughter of calves of four breeds, measuring pH in the longissimus lumborum and semimembranosus muscles. They found greater variation between breeds in the pH of

Table 2
Changes in cooking loss and water-holding capacity of calf meat depending on the breed

Specification		Breed			
		Simmental	PHF RW	PHF HO	Limousin
Cooking loss (%)					
24 h	$\bar{x}$	27.11	23.00	26.58	23.75
	SD	1.47	6.36	3.59	1.59
48 h	$\bar{x}$	30.45^{A}	28.40	25.65^{C}	27.59
	SD	1.42	1.91	2.89	2.39
72 h	$\bar{x}$	27.57	29.53	26.43	26.33
	SD	2.57	3.15	2.59	4.10
96 h	$\bar{x}$	26.90	24.33	27.29	27.79
	SD	1.16	1.41	2.22	1.18
Water-holding capacity (%)					
24 h	$\bar{x}$	29.42	25.50	25.79	26.50
	SD	5.14	3.30	0.21	4.24
48 h	$\bar{x}$	26.27	23.50	24.17	27.33
	SD	1.74	2.59	2.97	2.36
72 h	$\bar{x}$	28.66	27.00	26.42	27.50
	SD	2.35	3.30	2.87	2,36
96 h	$\bar{x}$	29.33	26.58	25.91	25.58
	SD	4.80	5.54	2.89	1.06

PHF RW – Polish Holstein-Friesian Red-and-White variety
PHF HO – Polish Holstein-Friesian Black-and-White variety
A, B, C – means denoted with various letters differ statistically significantly at $p \leq 0.05$

the semimembranosus muscle, with the significantly lowest values for this parameter in all measurements recorded in the Simmental calves, and the highest in the Polish Red calves. In another study, Florek et al. [5] analysed the pH of the semitendinosus muscle of calves and found significantly higher pH 24 hours after slaughter in spring (5.73) than in autumn (5.60). The decrease in veal pH in 48 hours from 6.81-6.87 (45 min post-slaughter) to 5.58-5.62, in both seasons, indicated that post-slaughter acidification was proceeding correctly.

The water-holding capacity of meat means its ability to hold water and to bind additional water from outside. The water-holding capacity of meat is highest immediately after slaughter and decreases with post-mortem transformations. Cooking loss is a characteristic associated with the pH and water-holding capacity of meat. Determination of the level of

cooking loss is very important because it provides information on the loss of meat juices that may result from heat treatment [7].

Table 2 contains data on changes in cooking loss and water-holding capacity depending on the breed of calf. The data show that the highest mean cooking loss was observed after 48 hours from the muscles of the Simmental calves (30.45%), and the lowest after 24 hours from the meat of Polish Red-and-White Holstein-Friesians (23.00%). However, statistically significant differences in the level of cooking loss were found 48 hours post-slaughter between the meat of Simmental calves (30.45%) and Polish Black-and-White Holstein-Friesians (25.65%).

The lowest water-holding capacity was observed 24 hours after slaughter in the meat of the Simmental calves (29.42%), and the highest in the meat of Polish Red-and-White Holstein-Friesian calves 48 hours after slaughter (23.50%). The water-holding capacity did not undergo substantial fluctuations in any of the breeds tested, remaining at a similar level for 4 days. The average water-holding capacity was 28.42% in the muscles of the Simmental bulls and 25.98% in other breeds. There were no significant statistical differences between the groups in terms of this feature. Florek et al. [5] found that calf meat obtained in spring had a poorer water-holding capacity than meat obtained in autumn (larger free-water area and higher cooking loss).

Table 3
Content of fat, water and protein in calf meat depending on the cattle breed

Specification		Breed			
		Simmental	PHF RW	PHF HO	Limousin
Fat (%)	$\bar{x}$	2.62	2.76	2.11	2.06
	SD	0.89	1.17	0.28	0.53
Water (%)	$\bar{x}$	75.33	75.24	75.77	75.80
	SD	0.75	0.94	0.24	0.49
Protein (%)	$\bar{x}$	20.74	20.70	20.85	20.86
	SD	0.22	0.28	0.06	0.13

PHF RW – Polish Holstein-Friesian Red-and-White variety
PHF HO – Polish Holstein-Friesian Black-and-White variety

Analysis of the chemical composition of the meat of calves of different breeds (Table 3) revealed the lowest fat content in the meat of Limousin (2.06%) and Polish Black-and-White Holstein-Friesian calves (2.11%). On the other hand, the content of protein and water was similar in all calf muscles tested. In terms of the chemical constituents analysed, there were no statistically significant differences between the muscles of different breeds.

Florek et al. [6], investigating the proximate chemical composition of muscles in relation to the breed of calves, found significant differences in the proportions of water and ash. They showed significantly higher water content and at the same time lower ash content in both muscles tested in Polish Black-and-White Holstein-Friesian and Simmental calves. In the longissimus lumborum muscle, the protein content ranged from 21.0% to 22.1%, and fat content from 0.7% to 1.0%, while the corresponding values in the semimembranosus muscle were 21.7-23.3% and 0.8-1.2%. In a study by Śmiecińska and Wajda [20], the total protein content in the longissimus dorsi muscle of cattle in different EUROP classes ranged from 21.34% to 21.54%.

Our study showed that during four consecutive days of refrigerated storage, the pH of the meat of the Limousin calves decreased most slowly. In the meat of other breeds, the lowest pH was noted 24 hours after slaughter. However, statistically significant differences were found only for pH_{48} between the meat of the Simmental calves and the Polish Black-and-White Holstein-Friesians.

The analysis of the post-slaughter ageing period of veal showed the most favourable water-holding capacity and cooking loss in the material obtained from the Polish-Holstein-Friesian calves of both the Black-and-White and Red-and-White varieties. The worst meat in terms of these properties was obtained from the carcasses of the Simmental calves.

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