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INFLUENCE OF THE GENOTYPE AND GENDER OF YOUNG BEEF CATTLE ON THE VALUE OF CARCASSES PURCHASED BY ONE OF THE POLISH MEAT PROCESSING PLANTS

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Abstract: The quality of beef is determined, among others, by factors such as breed, age and sex of slaughtered animals and fattening intensity. The aim of the study was to assess carcass quality of young cattle purchased by a selected domestic meat processing plant. The study included a group of 300 bulls and 300 heifers with selected genotypes (Limousine breed; crossbreds – Charolaise, Limousine, Simental × Polish Holstein-Friesian; Polish Holstein-Friesian breed). The following were determined for each animal: body weight before slaughter (kg), hot carcass weight (kg), hot carcass quality index (%), carcass conformation class and carcass fatness class according to the EUROP system. The mean body weight of slaughtered animals was found to be 650 kg. Carcass yield of the assessed young cattle was on average 54%. Carcasses of bulls (non-castrated males) were on average 90 kg heavier and had 3 pp. higher carcass yield than carcasses of uncalved females ($P < 0.05$). The conformation classes of the EUROP system showed that almost 48% of the carcasses of young Limousine bulls reached the highest classes, i.e. E− and U. Limousine bulls (57.2%) had the highest carcass yield among the determined genotypic groups. The desired lowest degree of fatness was found in carcasses of bulls of all genotypes (an average of 2.9 points).

Key words: cattle, genotype, gender, carcass yield, EUROP system.

INTRODUCTION

The carcass value of cattle is mainly determined by such features as: carcass yield, percentage of carcass cuts with the highest commercial value and meat quality. Carcass class in the EUROP classification system is determined by the degree of formation of the front, back and leg parts. Therefore, when assessing the cattle carcass value, those are preferred, from which the greatest amount of culinary meat can be obtained.

Along with the increasing interest of the meat industry in crossbreds of very good carcass value, Polish breeders began crossing commercial and dairy domestic breeds with beef breeds

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(Solarczyk et al. 2020). The Charolaise breed played the greatest role in commercial crossbreeding in the country. Currently, the active population of purebred females and crossbreds with this breed is 75% and 80%, respectively (PZHiPBM 2019).

Beef is primarily used as culinary meat, therefore the raw material should be obtained from animals with appropriate carcass value (Solarczyk et al. 2020). It is assumed that the best quality meat is obtained from young animals up to 2 years of age and from beef breed animals (Drouillard 2018; Nogalski et al. 2018). However, the final quality of it is determined by many genetic and environmental factors, such as race, sex, age, nutrition system or health (Nogalski et al. 2018; Mwangi et al. 2019; Nguyen 2021).

The dominant breed of beef cattle in Poland is the Limousine breed, followed by Charolaise and Hereford (PZHIPBM 2017). Commercial crossing, consisting of obtaining hybrids of beef breeds with cows of domestic breeds, should be the main method of beef production in the country. As indicated by research results and observations of Litwińczuk et al. (2001) and Grodzki et al. (2006), beneficial effects of such crossbreeding are as follows: higher daily gains, lower feed consumption per 1 kg body weight gain, significantly higher degree of muscularity in crossbreds, higher carcass yield (by 2–4%), higher score of muscularity and lower fatness when evaluating half-carcasses according to the EUROP classification system.

The aim of the study was to assess the influence of the genotype and gender of animals on the carcass value of cattle purchased by one of the Polish meat processing plants.

MATERIAL AND METHODS

The study included a group of 600 heads of young cattle, kept by individual farmers in the country, slaughtered in the period from June to December 2016 in a selected meat processing plant. The data came from a large plant located in the Mazowieckie Voivodeship, which includes several production plants. Slaughter and post-slaughter processing were carried out in accordance with Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of slaughter. Classification on warm beef carcasses (up to 1 hour after slaughter) was made by three employees of the plants, who had the qualifications of an expert in the field of classification. Production was carried out in accordance with the requirements of internationally recognized IFS and BRC standards. All plants are ISO14001 certified, which confirms that they meet the highest environmental requirements.

The following were determined for each animal: body weight before slaughter (kg), hot carcass weight (kg), hot carcass quality index (%), carcass conformation class and carcass fatness class according to the EUROP system. Hot carcass quality index (%) was calculated on the basis of animal pre-slaughter weight and hot carcass weight.

Beef carcasses were assessed using the visual method, whose classifier took into account the general appearance of the animal's carcass and the degree of muscularity of the most valuable cuts, i.e. the back, leg and shoulder, in order to determine the conformation class and assign the appropriate fatness class in the EUROP system. An additional division was also made of the conformation classes into three subclasses marked as: "+", "No sign" and "−" to facilitate carcass classification showing intermediate characteristics between the basic classes (Commission Regulation (EC) No 1249/2008).

Carcasses of the test animals belonged to two (of the five) categories:

A. carcasses of uncastrated young males from 12 to 24 months of age (300 heads).

E. carcasses of uncalved females from 12 to 24 months of age (300 heads).

The animals in the assessed population of young slaughter cattle were divided into the following groups according to gender and genotype:

1. Limousine bulls (100 heads).

2. Crossbred bulls [Charolaise, Limousine, Simental × Polish Holstein-Friesian] (100 heads).
3. Polish Holstein-Friesian bulls (100 heads).
4. Limousine heifers (100 heads).
5. crossbred heifers [Charolaise, Limousine, Simental × Polish Holstein-Friesian] (100 heads).
6. Polish Holstein-Friesian heifers (100 heads).

The data were analyzed statistically using Statistica version 9.0 software. The effects of genotype (Limousine, crossbred – Charolaise, Limousine, Simental × PHF, PHF) and gender (bulls and heifers) on the carcass value of beef were determined by the least squares method using the formula

$$Y_{ijk} = \mu + A_i + B_j + (AB)_{ij} + e_{ijk}$$

Where: Y_{ijk} – the value of the analyzed parameter, μ – population mean, A_i – the effect of genotype (Limousine, crossbred – Charolaise, Limousine, Simental × PHF, PHF), B_j – the effect of gender (bulls and heifers), $(AB)_{ij}$ – the genotype × gender interaction, e_{ijk} – random error. The differences between means were estimated by Duncan's test at $P < 0.05$. Frequency results from carcasses with different conformation classes in the EUROP system by animal groups were analyzed using a chi-square (χ^2).

RESULTS

The main criteria for selecting animals for analysis were: gender (bulls and heifers) and genotype (Limousine breed, crossbreds of beef breeds with Polish Holstein-Friesian). Table 1 presents the numerical distribution of the assessed population of young slaughter cattle for animal body weight before slaughter and the allocation to the appropriate carcass conformation class according to the EUROP system. It was found that 56% of the test animals obtained a high body weight, between 650 and 750 kg. Only 98 assessed carcasses were given the highest classes, i.e. E− and U.

Table 1. Numerical distribution of the assessed population of slaughter cattle (units) according to animal weight before slaughter [kg] and the carcass conformation class according to the EUROP system

Factor	N	%
Weight of animals before slaughter, kg		
550–600	151	25,2
601–650	110	18,3
651–700	217	36,2
701–750	122	20,3
Carcass conformation class according to EUROP		
E−, U+, U, U−	98	16,3
R+, R, R−	281	46,8
O+, O, O−	221	36,9
Total	600	100

The mean body weight of slaughtered animals was 650 kg (Table 2). The analysis of the results concerning body weight at slaughter showed that bull carcasses (uncastrated males) were on average 90 kg heavier than the carcasses of uncalved females ($P < 0.05$). The genotype also had a significant impact on the body weight of slaughtered animals. It was found that Limousine bulls and crossbred bulls (697 kg and 696 kg, respectively) had the highest body

weight. Limousine heifers (598 kg) had the lowest body weight at slaughter. Statistically significant differences ($P < 0.05$) in the group of heifers were noted between purebred hf and crosses of hf with meat, and purebred limousine heifers. The difference in body weight between the above-mentioned groups of heifers was 11–12 kg, in favor of purebred hf heifers and crosses of hf with meat breeds.

Table 2. Body weight at slaughter [kg] depending on sex and genotype

Factor	N	Body weight, kg			
		mean	SD	min	max
Group of animals (sex and genotype)					
Limousine bulls	100	697[a]	27.4	650	750
crossbred bulls	100	696[a]	29.8	650	748
Polish Holstein-Friesian bulls	100	693[a]	29.6	650	750
Limousine heifers	100	598[c]	33.4	552	677
crossbred heifers	100	610[b]	42.9	550	696
Polish Holstein-Friesian heifers	100	609[b]	36.7	550	700
Animal carcass category					
Carcasses of uncastrated males aged 12–24 months	300	695[a]	28.9	650	750
Carcasses of uncalved females aged 12–24 months	300	605[b]	38.2	550	700
Total/average	600	650	56.2	550	750

Mean, SD – standard deviation; a, b, c – values in columns, between factors with different letters differ significantly ($P \leq 0.05$).

The average carcass yield of animals was calculated on the basis of animal pre-slaughter weight and carcass weight after slaughter. It was on average 53.8% for 600 heads of young cattle (Table 3). It is worth noting that this indicator was significantly higher for the group of males than for females (on average by 2.7%). Limousine bulls (57.2%) had the highest average carcass yield, while the Polish Holstein-Friesian heifers (50.5%) had the lowest average carcass yield.

Table 3. Influence of sex and genotype of animals (group) on the carcass yield [%] of the studied population of young cattle

Factor	N	Carcass yield, %			
		mean	SD	min	max
Group of animals (sex and genotype)					
Limousine bulls	100	57.2[a]	3.3	50	64
Crossbred bulls	100	54.9[b]	3.7	48	66
Polish Holstein-Friesian bulls	100	53.5[d]	3.3	46	63
Limousine heifers	100	54.0[c]	3.0	44	60
Crossbred heifers	100	53.1[d]	2.7	47	62
Polish Holstein-Friesian heifers	100	50.5[e]	3.4	44	61
Animal carcass category					
Carcasses of uncastrated males aged 12–24 months	300	55.2[a]	3.7	46	66
Carcasses of uncalved females aged 12–24 months	300	52.5[b]	3.4	44	62
Total/average	600	53.8	3.8	44	66

Mean, SD – standard deviation; a, b, c – values in columns, between factors with different letters differ significantly ($P \leq 0.05$).

The study also assessed the percentage distribution of carcasses in different conformation classes according to the EUROP system (Table 4). Considering the results of individual groups of animals in terms of the obtained conformation classes, it should be stated that almost half (48%) of the carcasses of young Limousine bulls acquired the highest conformation classes, i.e. E− and U. The following groups with the highest conformation classes were: crossbred bulls and Limousine heifers, although only 20% and 16% of carcasses were in classes E− and U, respectively. The carcasses of the population of young Polish Holstein-Friesian beef cattle were mostly carcasses with the so-called fair musculature (class O). In our study, the chi-square test showed a highly significant effect (P ≤ 0.001) of genotype and gender on the frequency of EUROP conformation score.

Table 4. Percentage distribution of carcasses with different conformation classes in the EUROP system by animal groups

Group of animals	EUROP conformation score, point			Total %
	E−, U+, U, U−	R+, R, R−	O+, O, O−	
Limousine bulls	48	37	15	100
Crossbred bulls	20	47	33	100
Polish Holstein-Friesian bulls	2	22	76	100
Limousine heifers	16	64	20	100
Crossbred heifers	10	75	15	100
Polish Holstein-Friesian heifers	2	36	62	100

Chi-Square 223.6 (P < 0.001)

Carcasses containing large amounts of muscle tissue and little fat are the most valuable for meat processing plants. The expert assessing the carcasses of young animals selected for testing in a chosen plant determined the average fatness degree as 3.1 points on a five-point scale (Table 5). It was an average fatness according to the EUROP system nomenclature regarding the degree of fat. The desired lowest level of fatness was found in carcasses of bulls of all genotypes (2.9 points on average) compared to heifers, with an average rating of 3.5 points.

Table 5. Influence of animal group (sex and genotype) and carcass category on carcass fatness (points) of the studied population of young cattle

Factor	N	EUROP fatness score, point			
		mean	SD	min	max
Group of animals (sex and genotype)					
Limousine bulls	100	2.8^{b}	0.6	2	4
Crossbred bulls	100	2.9^{b}	0.4	2	4
Polish Holstein-Friesian bulls	100	2.9^{b}	0.3	2	4
Limousine heifers	100	3.5^{a}	0.6	2	5
Crossbred heifers	100	3.5^{a}	0.6	3	5
Polish Holstein-Friesian heifers	100	3.4^{a}	0.5	3	5
Animal carcass category					
Carcasses of uncastrated males aged 12–24 months	300	2.9^{b}	0.4	2	4
Carcasses of uncalved females aged 12–24 months	300	3.5^{a}	0.6	2	5
Total/average	600	3.1	0.6	2	5

Mean, SD – standard deviation; a, b – values in columns, between factors with different letters differ significantly (P ≤ 0.05)

DISCUSSION

The conducted research showed that the indicators of the carcass value of purebred Limousine bulls and crossbreds with beef breeds were significantly higher ($P < 0.05$) compared to Limousine heifers, crossbreds, and heifers of the Polish Holstein-Friesian breed. The highest carcass value of Limousine bulls was also demonstrated by Litwińczuk et al. (2012). The average body weight of these animals was 19.5 kg higher than the weight of Polish Holstein-Friesian bulls, with a shorter fattening period of Limousine males by 34 days.

Grodzicki et al. (2010) also reported that 18-month-old bulls, crossbreds from Limousine bulls, had higher body weight before slaughter (by 81.4 kg) and higher carcass yield (by 3.21%) compared to Black-and-White bulls. The values of bulls' carcass yield index reported by Młynek and Litwińczuk (2001) and Młynek and Guliński (2007) ranged from 50.9% to 57.6%, thus they were similar to those presented in the current study.

At the same time, significantly higher carcass yield indices were found of bulls compared to heifers of different categories supplied by commercial stock producers. This was consistent with the results of Litwińczuk et al. (2006), where bull calves had the heaviest hot carcass weight (from 260.5 to 347.8 kg) and the highest hot carcass quality index (from 53.7 to 56.8%). However, the above-mentioned indicators in the case of heifers ranged from 200.8 to 263.9 kg and from 49.6 to 54.0%, respectively.

Wajda et al. (2011) classified most Holstein Friesian bull carcasses as class O (77.25%) followed by class R (22.75%). According to Janiak et al. (2016), the most numerous class of carcass formation in all categories was O (71.91%), followed by R (15.07%), P (11.88%) and U (1.14%). Litwińczuk et al. (2006) indicated that conformation class O was assigned to the highest number (54.37–84.85%) of carcasses of all three animal categories (heifers, cows and young bulls). In the work of Nogalski et al. (2013) the slaughter value of 200 young bulls was assessed (108 crossbred beef bulls – Holstein-Friesian cows crossed with bulls of the Limousin, Hereford or Simmental breeds and 92 Holstein-Friesians). Based on the EUROP carcass classification system, the majority of carcasses of crossbred beef bulls were classified into conformation class R (61,11%), and the carcasses of Holstein-Friesians were classified into class O (56,53%). Our results have confirmed these conclusions.

The present study demonstrated that carcasses from young males had generally less fat compared to carcasses of heifers, which was also observed by Blanco et al. (2020), Janiak et al (2016) and Martín et al. (2021). Litwińczuk et al. (2006) confirmed that most of the assessed animals were assigned classes 2 and 3. They found that the carcasses of heifers had the thickest layer of subcutaneous fat (12 mm), while the carcasses of bulls had only 5.4 mm.

CONCLUSION

The results of these studies indicate that genotype and sex had a significant influence on the value of carcasses of young beef cattle. It was also shown that Limousine bulls and crossbreed meat breeds had significantly better ($P < 0.05$) carcass value indicators, i.e. higher body weight before slaughter, higher carcass efficiency and better carcass structure and lower fat classes according to the EUROP system compared to bulls and PHF heifers of the genotypes discussed. Therefore, when deciding on the production process, beef producers should select animals of the appropriate genotype, where male meat is preferred.

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WPŁYW GENOTYPU I PŁCI NA WARTOŚĆ RZEŹNĄ MŁODEGO BYDŁA OPASOWEGO SKUPOWANEGO PRZEZ JEDEN Z KRAJOWYCH ZAKŁADÓW PRZEMYSŁU MIĘSNEGO

Streszczenie. Celem pracy była ocena wartości rzeźnej młodego bydła opasowego skupowanego przez wybrany krajowy zakład przemysłu mięsnego. Badaniami objęto grupę łącznie 300 sztuk buhajków i 300 sztuk jałówek o wybranych genotypach (rasa limousine, mieszańce międzyrasowe – charolaise, limousine, simental × polska holsztyńsko-fryzyjska, rasa polska holsztyńsko-fryzyjska). Stwierdzono, że średnia masa ciała zwierząt wynosiła 650 kg. Wydajność rzeźna ocenianego młodego bydła wynosiła średnio 54%. Tusze buhajów (samców niekastrowanych) były średnio aż o 90 kg cięższe oraz miały o 3 pp. wyższą wydajność rzeźną od tusz niewycielonych samic ($P < 0,05$). Pod względem uzyskanych klas uformowania wg systemu EUROP wykazano, że prawie 48% tusz młodych buhajów rasy limousine uzyskało najwyższe klasy, tj. E− i U. Spośród wyodrębnionych grup genotypowych najwyższą wydajnością rzeźną odznaczały się buhaje limousine (57,2%). Pożądanym najniższym stopniem otłuszczenia charakteryzowały się tusze buhajów wszystkich grup genotypowych (średnio 2,9 pkt.).

Słowa kluczowe: bydło, genotyp, płeć, wartość rzeźna, system EUROP.