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Genetic Aspects for Meat Quality of Purebred and Crossbred Bull-Calves

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Abstract | The aim of the current study is to analyze the meat efficiency of Simmental bull-calves and their first-generation crosses with the red steppe and black-motley cows. For the experiment, we used semi-carcasses of purebred Simmental bull-calves (group I), half-breed crosses with red steppe cattle (½ Simmental x ½ red steppe; group II), and crosses of Simmentals and black-motley cattle (½ Simmental x ½ black-motley; group III). The animals were kept in the same conditions in the feedyard; after fattening, three bull-calves from each experimental group were slaughtered. To assess the meat productivity of the animals, a morphometric analysis of the semi-carcasses of the experimental animals was made, along with a comparative qualitative analysis of the meat products. The results of the research showed that the carcasses of the Simmental bull-calves and their half-breed crosses with black-motley cattle were of a higher quality.

Keywords | Meat production, Beef, Bull-calves, Crossbred cattle, The morphological composition of the carcass, Meatiness index, Slaughtering

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INTRODUCTION

The main task of the agro-industrial complex in Russia is to provide high-quality and biologically high-grade food products for the population, especially under the sanctions that are being constantly introduced (Kosilov et al., 2010; Nikonova et al., 2014; Kosilov and Mironenko, 2010; Kosilov et al., 2006; Kubatbekov, 2006; Kubatbekov et al., 2014). First, it is necessary to increase the meat production, particularly beef production that share significantly in the meat balance (Kubatbekov et al., 2017; Kharlamov et al., 2015; Kosilov and Mironenko, 2005; Zadnepryansky et al., 2012; Kosilov et al., 2012; Bozymov et al., 2016; Kayumov et al., 2019; Mironova et al., 2018; Fatkullin et al., 2018; Sedykh et al., 2018; Tyulebaev et al., 2019). For this purpose, it is necessary to use all the available resources in the livestock breeding industry. Therefore, it is advisable to develop and implement a set of measures in the zootechnical practice that might contribute to complete the implementation of the genetic potential in the meat productivity of domestic cattle breeds. Due to the small population of cattle of specialized meat breeds in the country, the main source of beef meat is the extrareplacement for young stock of dairy and combined breeds where cow were replaced from the main herd for various reasons. While maintaining the reproductive ability, the breeding stock may become a basis for obtaining crossbred young stock.

The prospects of using crosses in beef production are determined by the fact that they have good productive qualities due to the combination of the positive

properties of the breeding source in their genotype. Besides, interbreed mating of the animals with various productivities contributes to a significant improvement in the meat product quality. In this regard, the development and testing of the optimal interbreeding schemes with the use of the domestic gene pool are required. Within that, a mandatory measures to monitor the quality of the obtained meat products are essentially required.

MATERIALS AND METHODS

This study aims to assess the quality of the meat products obtained from slaughtering for Simmental bull-calves and their first-generation crosses with red steppe and black-motley cows. For the experiment, we used semi-carcasses of the purebred Simmental bull-calves (group I), half-breed crosses with the red steppe cattle (½ Simmentals x ½ red steppe group II), and the Simmental crosses with the black-motley cattle (½ Simmentals x ½ black-motley group III). After intensive fattening in the feedyard, a check slaughtering was made at the age of 18 months following the guidelines of the All-Russian Research Institute of Metrological Service (VNIIMS, 1984). During the study, efforts were made to minimize suffering of the animals and reducing the number of used samples.

To assess the quality of the meat products, the right semi-carcasses were divided into five natural anatomical parts; the cervical part, the scapulohumeral part, the back and ribs part, the lumbar part with the flank, and the leg and hip part while all cuts were deboned. The boneless meat was divided into structural elements and sorted following the sausage classification.

Within that, pure muscle tissues without visible connective tissue formations were classified as top-grade; boneless meat with the presence of ≤ 6 % of thin connective tissue formations was classified as first grade, and boneless meat with ≤20 % of thin connective tissue formations was classified as second grade with the presence of small veins, tendons, and films allowed. The morphometric parameters for the rib eye were also determined. The muscle samples were taken between ribs nine and twelve. The depth and the width of the muscle, their ratio, and the area of the "muscle eye" were determined by finding the cross-sectional area of the muscle. The experimental data were processed by the method of variational statistics in Microsoft Office Excel (Microsoft, USA) with data processing in the Statistica 10.0 application (Stat Softinc, USA).

RESULTS AND DISCUSSION

It is well known that the quality of meat products, their nutritional and biological value are largely determined by the development of the muscle tissues of the carcass, the specific weight of which in well-fed animals exceeds 65 %. Likewise, the development of the muscle tissues and, to some extent, their quality are characterized by their size and the cross-section area (the "muscle eye") of the rib eye.

Our results for the muscles morphometric examinaion show the effect of the bull-calves' genotype on their development (Table 1). The purebred young Simmentals in group I and the crosses (½ Simmental x ½ red steppe) in group II were inferior to them in terms of the depth of the muscle by 4.9 % and 10.3 %, and in terms of the width of the muscle by 9.8 % and 21.8 %, respectively. While, the leading position in terms of the studied parameters was taken by the crossbred (½ Simmental x ½ black-motley) bull-calves from group III. The differences between the groups in terms of the size of the rib eye determined the unequal area of the "muscle eye" with the predominance of the crossbred bull-calves in group III with superiority in terms of the analyzed parameter over the purebred Simmental bull-calves in group I was 8.4 cm^2 (12.6 %, $P < 0.01$), and over the crossbred young animals (½ Simmental x ½ red steppe) in group II 18.6 cm^2 ($P < 0.001$).

The minimum morphometric parameters for the rib eye were observed in the crossbred bull-calves (½ Simmental x ½ red steppe) in group II that were inferior to the purebred Simmental bull-calves in terms of the muscle depth by 5.2 %, in terms of the width by 10.9 %, and in terms of the "muscle eye" area by 10.2 cm^2 (18.1 %, $P < 0.001$).

The quality of carcasses is largely characterized by the meatiness index of the natural anatomical parts of the carcasses, which shows the yield of boneless meat (the edible part of the carcass) per kg of bones. The obtained data and their analysis showed the influence of the anatomical and topographic location of individual carcass cuts on the value of the analyzed parameter (Table 2).

The cervical natural anatomical cut of the semi-carcass had the maximum characteristic meatiness index as its value in this cut was greater than the scapulohumeral cut by 4.70 – 6.21 kg (111.1 % – 167.6 %, $P < 0.001$), greater than the back-and-ribs cut by 5.42 – 6.70 kg (159.4 % – 215.4 %, $P < 0.001$), greater than the lumbar cut by 0.95 – 2.93 kg (12.1 % – 42.6 %, $P > 0.05$ and greater than the leg-and-hip cu by 3.60 – 4.80 kg (69.0 % – 95.8 %, $P < 0.05 – 0.01$).

On the other hand, the lumbar natural anatomical part of the semi-carcass also had a high meatiness index. In the scapulohumeral cut, the analyzed parameter was lower than the lumbar cut by 2.76 – 4.17 kg (67.0 % – 112.7 %, $P < 0.05 – 0.01$), lower than the back-and-ribs cut by 3.48 – 4.76 kg (102.3 % – 153.0 %, $P < 0.05$), and lower than the leg and hip cut by 1.66 – 2.86 kg (31.8 % – 53.5 %, $P > 0.05$.

Table 1: Rib eye measurements in the bull-calves in the experimental groups at the age of 18 months.

Parameter	Group					
	I		II		III	
	Parameter					
	X ± Sx	C_v	X ± Sx	C_v	X ± Sx	C_v
Depth, cm	6.1 ± 0.12	2.10	5.8 ± 0.14	2.23	6.4 ± 0.16	2.43
Width, cm	11.2 ± 0.18	2.34	10.1 ± 0.20	2.52	12.3 ± 0.22	2.73
Cross-section area, cm^2	66.4 ± 3.12	2.88	56.2 ± 3.21	2.90	74.8 ± 3.44	3.12
Depth/Width*100%	54.46 ± 2.90	2.14	57.42 ± 3.01	2.43	52.03 ± 2.94	2.30

Table 2: The meatiness index of individual natural anatomical parts of semi-carcasses of the bull-calves in the experimental groups at the age of 18 months, kg.

Group	Natural anatomical part									
	cervical part		scapulohumeral part		back and ribs part		lumbar part		leg and hip part	
	Parameter									
	X ± Sx	C_v	X ± Sx	C_v	X ± Sx	C_v	X ± Sx	C_v	X ± Sx	C_v
I	9.02 ± 0.88	1.92	3.92 ± 0.34	1.88	3.20 ± 0.19	1.31	7.10 ± 0.28	1.43	5.11 ± 0.22	1.40
II	8.82 ± 0.96	1.98	3.70 ± 0.42	1.98	3.11 ± 0.23	1.56	6.88 ± 0.44	1.81	5.01 ± 0.28	1.48
III	9.81 ± 0.90	1.96	4.13 ± 0.50	1.94	3.40 ± 0.32	1.72	7.87 ± 0.40	1.88	5.22 ± 0.26	1.43

Table 3: The grade composition of the boneless meat for semi-carcasses of the bull-calves in the experimental groups at the age of 18 months (following the sausage classification).

Parameter	Group					
	I		II		III	
	Parameter					
	X ± Sx	C_v	X ± Sx	C_v	X ± Sx	C_v
kg	111.4 ± 2.01	2.33	101.6 ± 2.12	2.47	119.5 ± 2.23	2.54
Boneless meat, total %	78.5 ± 0.43	1.14	77.1 ± 0.52	1.36	79.8 ± 0.55	1.46
kg	21.4 ± 0.89	2.40	19.1 ± 0.92	2.58	23.8 ± 0.98	2.70
Including top grade, %	19.2 ± 0.89	4.10	18.8 ± 0.96	5.12	19.9 ± 1.10	6.44
kg Grade I %	53.7 ± 1.96	5.12	47.9 ± 2.01	5.64	59.5 ± 2.21	5.88
	48.2 ± 1.90	4.88	47.1 ± 1.99	5.61	49.8 ± 2.10	6.20
kg Grade II %	36.3 ± 1.88	4.32	34.6 ± 1.97	4.80	36.2 ± 1.99	4.96
	32.6 ± 1.64	3.92	34.1 ± 1.78	4.02	30.3 ± 1.88	4.24

Comparative assessment of the meatiness index of the leg and hip natural anatomical part, the scapulohumeral and the back-and-ribs part showed less significant difference for its value in favor of the leg and hip part cut. It noticed that the scapulohumeral part was inferior to it in terms of the analyzed parameter by 0.89 – 1.52 kg (21.6 – 41.1, $P > 0.05$), and the back-and-ribs part by 1.61–2.11 kg (47.3 % – 67.8 %, $P > 0.05$. The differences in the meatiness index of the scapulohumeral and the back-and-ribs natural anatomical parts were non statistically significant. At the same time, the scapulohumeral cut tended to be superior over the back-and-ribs cut in terms of the analyzed parameter.

The obtained data and their analysis showed the influence of the bull-calves genotype on the meatiness index of the natural individual anatomical parts of the semi-carcasses. Within that, the leading place in terms of the meatiness index belonged to the crossbred (½ Simmental x ½ black-motley) bull-calves in group III. The Simmental bull-calves in group I and the crossbred bull-calves (½ Simmental x ½ red steppe) in group II were inferior to them in terms of the meatiness index of the most valuable cuts for the lumbar and the leg-and-hip ones by 0.77 kg (10.8 %), 0.99 kg (14.4 %) and 0.11 kg (2.2 %), 0.21 kg (4.2 %), respectively.

A similar observation was observed during analyzing the differences between the groups in terms of the meatiness index of other natural anatomical parts of the semi-carcasses. Our results revealed that the crossbred bull-calves

(½ Simmental x ½ black-motley) in group III exceeded the purebred young Simmental cattle in group I and the crosses (½ Simmental x ½ red steppe) in group II in terms of the meatiness index of the back-and-ribs cut by 0.20 kg (6.3 %) and 0.29 kg (9.3 %), of the scapulohumeral cut by 0.21 kg (5.4 %) and 0.43 kg (11.6 %), and of the cervical cut by 0.79 kg (8.8 %) and 0.99 kg (11.2 %).

The data analysis shows that the minimum level of the meatiness index of all the natural anatomical parts of the semi-carcasses was observed in the crossbred bull-calves (½ Simmental x ½ red steppe) in group II. They were inferior to their purebred Simmental peers in terms of the analyzed parameter in the leg-and-hip cut by 0.10 kg (2.0 %), in the lumbar cut by 0.22 kg (3.2 %), in the back-and-ribs cut by 0.09 kg (2.9 %), in the humeroscapular cut by 0.22 kg (5.9 %), and in the cervical cut by 0.20 kg (2.3 %).

The materials obtained during trimming and sorting of the edible part of the carcasses showed the influence of the young cattle' genotype on the yield of individual meat grades (Table 3). The best grade composition was observed in the meat products obtained during slaughtering of the crossbred bull-calves (½ Simmental x ½ black-motley) in group III as they exceeded the purebred Simmental bull-calves in group I and the young crossbred cattle (½ Simmental x ½ red steppe) in group II in terms of the absolute weight of top-grade meat by 2.4 kg (11.2 %, $P < 0.05$) and 4.7 kg (24.6 %, $P < 0.01$), and in terms of the relative weight by 0.7 % and 1.1 %, respectively. Similar differences between the groups were observed in terms of the yield of first-grade meat. as noticed that the purebred Simmental bull-calves in group I and the crosses (½ Simmental x ½ red steppe) in group II were inferior to their crossbreed peers (½ Simmental x ½ black-motley) in group III in terms of the absolute weight of first-grade meat by 5.8 kg (10.8 %, $P < 0.01$ and 11.6 kg (24.2 %, $P < 0.001$), and in terms of the relative weight by 1.6 % and 2.7 %, respectively.

It was found that the lowest values that characterize the grade composition of the meat product were found in the crossbred (½ Simmental x ½ red steppe) young calves in group II that were inferior to their purebred Simmental peers in group I in terms of the absolute weight of top-grade meat by 2.3 kg (12.0 %, $P < 0.05$), of first-grade meat by 5.8 kg (12.1 %, $P < 0.01$), and of relative weight by 0.4 % and 1.1 %, respectively. While for second-grade meat, in terms of the absolute weight, it was in the range of 1.6 – 1.7 kg (4.6 % – 4.9 %), was superior in the crossbred bull-calves (½ Simmental x ½ black-motley) in group III and the purebred young Simmentals in group I, while, in terms of the relative weight of second-grade meat, they were inferior to their crossbred peers (½ Simmental x ½ red steppe) in group II by 1.5 – 3.8 %.

CONCLUSIONS

The meat products obtained by slaughtering of purebred and crossbred bull-calves have high quality which evidenced by the morphometric parameters of the rib eye, the ratio of its tissues, and the grade composition of the edible part. Within that, the carcasses of Simmental bull-calves and half-breed crosses with black-motley cattle have higher quality.

AUTHORS CONTRIBUTION

All authors contributed equally to the manuscript.

CONFLICT OF INTEREST

The authors have declared no conflict of interest.

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