

Beef for baby food from bulls and castrates

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Abstract. The research was conducted to compare bulls and castrates in relation to the morphological composition of carcasses, the yield of beef suitable for the production of baby food products, and the quality and safety of raw meat. The research was based on the results of monitoring the safety of the environment, feed, and meat raw materials during the growing and fattening of steers with a meat productivity direction. The pre-slaughter weight and the yield of lean beef of 16-month-old Hereford bull-calves are higher in comparison with castrated animals of the same age, by 6.4 and 1 %, respectively. The muscle tissue of castrates contained 11.5 % of fat, and bulls - 9.7 %. The protein content in the longest muscle of bulls was 19.8 %, and in castrates-17.0. The amount of fat beef that is not suitable for baby food is higher in castrate carcasses by 4.7 % compared to bull calves. A high protein quality index of the longest muscle of bulls (6.5) indicates a higher biological value of beef compared to meat from castrates (4.1). In terms of the content of residual amounts of pesticides, toxic elements, and antibiotics, the meat of castrates and bulls of the Hereford breed had no significant differences.

1 Introduction

Meat productivity of animals closely related to biological status. For fattening beef bulls with pronounced meat qualities and getting lean beef suitable for the production of baby food products, you need to choose not only the slaughter age, but also between bulls and castrates [1-5]. Italian beef management is usually based on entire males, since they show better growth rate and higher lean yield carcasses. Despite consumer's preferences require lean meat, producers have been inducing to consider the positive effect of castration especially on meat organoleptic traits [6-8].

There are conflicting opinions on this issue. The results of the study by the authors of the Bashkir Agricultural University indicate the influence of the genotype and physiological state of animals on their meat qualities, regardless of sexual status.

Crossbred bulls and castrates demonstrated the advantage, both in quantitative and qualitative indicators.

There are author's data on differences in meat productivity and beef quality between castrates and bulls of the same breed.

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There are differences in the content of fat in muscle tissue. The content of fat cells in the connective tissue layers studied by the authors as part of the longest muscle of Kalmyk castrates was significant. According to some researchers, bull meat has a higher water-holding capacity compared to castrates.

Significant differences in the physical and chemical characteristics of the muscle tissue of castrated and intact bulls were also found [9-10].

In this regard, comparative studies were carried out in accordance with the methodological principles for evaluating meat productivity and quality of cattle meat [11].

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According to some researchers, the meat of bulls has a higher water-holding ability compared to castrates. Significant differences were also found in the physicochemical characteristics of the muscle tissue of castrated and non-castrated bulls [12-14].

In this regard, comparative studies were carried out in accordance with the methodological principles for assessing meat productivity and meat quality in cattle [15]. The aim of the study was to compare the productivity, quality and safety of meat raw materials of castrates and bulls of Hereford breed in order to determine its suitability for the production of baby food. The Agro Industrial Complex Otradnenskaya LLC selected the meat productivity of bulls and castrates of Hereford breed, the quality and environmental suitability (safety) of beef for the production of baby food as objects of study.

2 Materials and methods

The farms that supply raw meat for baby food products are the place to study the effect of the sexual status (castrates, bulls) of cattle on meat productivity, quality and environmental safety of the suitability of beef for baby food.

The studies were based on the results of monitoring the safety of the environment, feed, meat raw materials obtained during the growing and fattening of beef bulls.

Young animals were raised according to the technology of specialized beef cattle breeding : up to 6 months of age under the nurse's mothers (cow - calf).

The castration was performed at the age of 6 months. After weaning and up to 16 months, bulls and castrates were kept on a feedlot with a paddock. The bulls and castrates were kept in groups, loose. The animals were fed and watered in the walking and feeding yard under a canopy. At the age of 16 months castrates (live weight 382.3 ± 5.7 kg) and bulls (live weight 406.7 ± 6.0 kg) of the Hereford breed (n=12) were slaughtered. The morphological composition of bull and castrate carcasses and the yield of meat suitable for the production of baby food were studied in a comparative aspect.

3 Results and discussion

Pre-slaughter live weight 16 months castrates and bulls of the Hereford breed of compact type in LLC "Agro Industrial Company Otradnenskaya", the Otradnaya station of the Krasnodar Territory amounted, respectively, to 382.3 ± 5.2 and 406.7 ± 4.0 kg, i.e. bulls by weight exceeded castrates of the same age by 24 kg (table 1).

Table 1. Meat productivity of Hereford castrates and bulls ($X \pm m$), $n=12$.

Indicators	Biological status	
	castrates	bulls
Pre-slaughter weight, kg	382.3±5.2	406.7±4.0 ^a
%	100.0	106.4
Weight of the fresh carcass, kg	199.3±1.5	210.7±2.2 ^a
Weight of chilled carcass, kg	196.7±3.4	205.2±3.8
Including boneless beef for baby food, kg	120.4±3.4	127.7±3.7
Boneless beef for baby food, %	61.2	62.2
Including beef boneless fat, kg	26.4±1.7	17.9±1.2 ^a
Boneless fat, %	13.4	8.7
Raw fat, kg	1.5±1.4	2.2±1.5
Connective tissue, kg	2.9±0.5	2.5±0.7
Bones, kg	20.3±1.2	22.28±0.9 ^a
Technical stripping, kg	2.2±0.2	2.1±0.3
Bones to carcass weight, %	21.5	22.4

Note: ^a - $p < 0,05$.

The weight of the cooled carcass in bulls was higher (205.2±3.8 kg) compared to castrates (196.7±3.4).

The yield of boneless beef for baby food in bulls (127.7±3.7 kg) is also significantly higher than in castrates (120.4±3.4 kg), and in percentage of the mass of the cooled carcass, respectively, 62.2 and 61.2 %.

Fat beef, which is not suitable for baby food, was received significantly less from bulls (by 32.2 %) than from castrates.

Meat for baby food differs significantly from castrates and bulls in terms of fat and protein in the composition of the longest back muscle (table. 2).

Table 2. Physical and chemical composition of the longest muscle (*longissimus dorsi*) for 16 month castrates and Hereford bulls, $n=12$.

Indicators	Biological status	
	castrates	bulls
Mass fraction of moisture, %	70.5	69.4
Mass fraction of protein, %	17.0	19.8 ^a
Mass fraction of fat, %	11.5	9.7 ^a
Mass fraction of ash, %	1.0	1.1
The color intensity of Extinction *1000	75.45	82.5 ^a
pH	5.7	5.9 ^a
Including collagen + elastin	1.9	1.8
Tryptophan, mg / 100 g of meat	260.00	320.00
Oxyproline, mg / 100 g of meat	63.4	49.23
Protein quality index (ratio of the content of tryptophan and oxyproline)	4.1	6.5 ^a

Note: ^a - $p < 0,05$.

The studies have shown that in terms of the chemical composition, the muscle tissue of bulls contained more protein (by 2.8 percent) and less fat. The muscle tissue of castrates contained 11.5% of fat and that of bulls – 9.7%.

The protein content in the longest muscle of bulls was 19.8 %, and in castrates-17.0.

The protein quality index (the ratio of tryptophan and oxyproline content) is significantly higher in bulls (6.5) compared to castrates (4.1), which indicates a higher biological value of beef.

According to the authors, the protein quality index of the longest back muscle of castrates is 4.6 and of bulls - up to 6.7.

The hydrogen index-pH is an important technological characteristic, which was more optimal for bulls – 5.9.

The colour intensity is closely related to the index of hydrogen ion activity.

It is significantly higher in the muscle tissue of bulls (82.5) compared to castrates (75.45), which indicates the best technological properties of beef from bulls.

The quality of protein for baby food products was determined by the degree of balance of their amino acid composition and compliance with the standard - female breast milk.

Studies of the amino acid composition of the meat of bulls and castrates have shown that the rate of such essential amino acids as lysine, histidine and phenylalanine was more than 100 % in relation to the standard – women's milk.

Leucine (73.7 %) and Valine (80.9%) were the limiting amino acids in castrates (table.3).

The limiting amino acids in bulls are Valine (82.0 %) and isoleucine (82.2 %).

Table 3. Amino Acid score of the longest muscle (*longissimus dorsi*) of Hereford bulls and castrates in relation to the standard-breast milk, % (n=12).

Amino acid (essential)	Standard (breast milk), mg / kg	Bulls		Castrates	
		mg / kg dry matter	score, %	mg / kg dry matter	score, %
Histidine	26.0	38.9	149.6	40.4	155.4
Isoleucine	46.0	37.8	82.2	33.9	73.7
Leucine	93.0	84.1	90.4	80.1	86.1
Lysine	66.0	85.4	129.4	80.1	121.4
Methionine + Cystine	42.0	38.0	90.5	38.3	91.2
Phenylalanine + Tyrosine	72.0	75.9	105.4	73.8	102.5
Threonine	43.0	39.8	92.6	39.5	91.9
Tryptophan	17.0	16.6	97.6	16.5	97.5
Valine	55.0	45.1	82.0	44.5	80.9

The mineral composition of the muscle tissue of bulls and castrates differs in some elements: the meat of bulls has more phosphorus, magnesium, iron, copper, selenium, Iodine and cobalt (table. 4).

These trace elements are necessary for the immune system of the child's body.

Table 4. Content of macro-and microelements in the longest muscle (*longissimus dorsi*) of Hereford bulls and castrates ($X \pm m$), n=12.

Mineral element	Biological status	
	Castrates	Bulls
Potassium, g / kg	3.23±0.8	2.98±0.8
Phosphorus, g / kg	1.07±0.01	1.36±0.04*
Sodium, g / kg	0.81±0.2	0.61±0.3
Magnesium, g / kg	0.13±0.1	0.19±0.1*
Calcium, g / kg	0.13±0.01	0.12±0.01
Zinc, mg / kg	30.13±1.10	32.35±1.10
Iron, mg / kg	17.8±1.4	26.30±3.7*

Copper, mg / kg	5.2±0.1	8.3±0.1*
Manganese, mg / kg	0.10±0.01	0.13±0.02
Iodine, mg / kg	0.025±0.01	0.035±0.01*
Selenium, mg / kg	0.021±0.01	0.026±0.01*
Cobalt, mg / kg	0.020±0.01	0.025±0.01*

Note: * - $p < 0,05$.

According to safety indicators, namely, the content of residual amounts of toxic elements, antibiotics, pesticides, mycotoxins, hormonal drugs, radioactive substances, the meat of castrates and Hereford bulls did not have significant differences and met the safety requirements for baby food (table. 5).

The results of environmental objects monitoring obtained in the raw material zone of meat suppliers (LLC "Agro Industrial Company Otradnenskaya", the Otradnaya station of the Krasnodar Territory) confirm its environmental safety.

Our results are close to the data of early studies of authors who conducted monitoring in the Stavropol Territory, Rostov region and the Republic of Kalmykia of the Russian Federation (research data on raw material zones of the branch "Factory of children's Canned Meat "Tikhoretsky" JSC «DANON Russia").

Table 5. Residual amounts of toxic substances in meat (average minced beef sample) of 16-month-old castrates and Hereford bulls.

Name of the environmental safety indicator	Ground beef for the production of baby food products	
	castrates	bulls
Toxic element:		
Lead, mg / kg	0.040±0.03	0.035±0.03
Cadmium, mg / kg	<0.01	<0.01
Mercury, mg / kg	< 0.005	< 0.005*
Arsenic, mg / kg	< 0.0025	< 0.0025*
Antibiotics:		
Tetracycline group, units/g	<0.01*	<0.01*
Bacitracin, units/g	<0.02*	<0.02*
Levomycesin (chloramphenicol), mg / kg	< 0.0003*	< 0.0003*
Streptomycin, mg / kg	< 0,2*	< 0.2*
Penicillin, mg / kg	< 0.0025*	< 0.0025*
Pesticides:		
Hexachlorocyclohexane (α , β , γ – isomers), mg / kg	< 0.004*	< 0.004*
(1,1,1-trichloro-2,2-bis(4-chlorophenyl) ethane and its metabolites, mg / kg	< 0.004*	< 0.004*
Other pesticides, mg / kg (heptachlor, karbofos, metaphos, basudin, phosphamide, 2,4-D amine salt)	below the detection limit	
Mycotoxins: Aflatoxin B ₁ , mg / kg	< 0.0005*	< 0.0005*
Dioxins, mg / kg	below the detection limit	
Hormonal preparation, mg / kg	below the detection limit	
Radionuclides, Bq/kg		
Caesium 137	2.2	2.0
Strontium 90	-	-

Note: *- the residual amount is below the detection limit of the method.

4 Conclusion

Raw meat from castrates and bulls of the Hereford breed at the age of 16 months meets the requirements of the technical regulations for raw materials for baby food. Beef is environmentally safe.

From non-castrated bulls, the yield of lean beef suitable for the production of baby food products was higher by 1.0 % compared to castrates.

The amount of fat beef, which is not suitable for use in the production of baby food, was 4.7% higher in the castrate carcasses compared to bulls of the Hereford breed at the age of 16 months, which meets the requirements of the technical regulations for raw materials for baby food.

According to the standard for baby food, the fat content in muscle tissue should not exceed 10 %. In the longest back muscle of steer's carcasses, the fat content met the standard and amounted to 9.5 %.

In the longest muscle of castrate carcasses, the fat content was 11.5 %, which is not significantly higher than the amount allowed by the standard.

A high protein quality index of the longest muscle of bulls (6.5) indicates a higher biological value of beef compared to meat from castrates (4.1).

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