Analysis of post-slaughter indicators of cattle bred on a collective farm (APK) named after Michurin, Vavozhsky district

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Abstract. The scientific and economic experiment was conducted in the conditions of the Michurin collective farm in the Vavozhsky district. The purpose of the research was to conduct a scientific and economic experiment to study the meat productivity of black-and-white cattle of different sex and age groups bred in the conditions of the Michurin collective farm (SHPC), followed by an assessment of the compliance of the beef obtained with the requirements of GOST 34120- 2017. The following experimental groups were formed in the experiment: 1 experimental group (AC) – adult cattle (cows of two or more calves); 2 experimental group (MCP) – young cattle, first-calf cows – young female cattle that calved once; 3 experimental group (MT) - young cattle, heifers aged from 8 months to two years. 4 experimental group (MB) - young animals, bulls aged from 8 months to two years. In the course of scientific and economic experience, it was found that among all sex and age groups of cattle entering for slaughter and primary processing at LLC Uvinsky Meat Processing Plant, only fattening bulls (a group of young animals) fully comply with the requirements of the modern standard GOST 34120-2017 in terms of carcass weight, morphological composition of carcasses.
Keywords: adult cattle, young animals, cow, first-calf cow, heifers, fattening bulls.

1. Introduction

Currently, an urgent problem facing the agro-industrial complex of our country is the increase in the production of livestock products. However, an important task is to obtain high-quality and environmentally friendly beef. This issue is solved by breeding dairy cattle and combined areas of productivity. Despite the already existing positive experience of animal husbandry, this industry is often low-profitable [2, 3, 12, 13].

Among the largest agricultural producers of the Udmurt Republic, there is a collective farm named after Michurin of the Vavozhsky district. This enterprise has the status of a breeding plant for a black–and-white breed. The company's specialization is mixed: livestock and crop production. It is known that the main point of delivery of live cattle is LLC "Uvinsky meat processing plant" village of Uva [3, 4].

To date, the company has been successfully developing the dairy cattle breeding sub-sector, and this is confirmed by the fairly high milk productivity of the dairy herd of cows. However, for more than five years, the company has not paid due attention to the assessment of meat productivity, cattle coming to slaughter. For example, the last control slaughter was carried out

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in 2016. In addition, increasingly stringent requirements are being imposed on the modern meat processing industry, in particular, related to stricter requirements for the quality of meat raw materials used in meat processing enterprises [3].

In this regard, in 2021, we conducted studies on the meat productivity of cattle of all sex and age groups bred in the conditions of the Michurin collective farm (SHPC) of the Vavozhsky district, and received for slaughter and primary processing in LLC "Uvinsky meat Processing Plant" of the Uvinsky district of the Udmurt Republic.

2. Materials and Method

The purpose of the work: to conduct a scientific and economic experiment to study the meat productivity of black-and-white cattle of different sex and age groups bred in the conditions of the Michurin collective farm (SHPC), followed by an assessment of the compliance of the beef obtained with the requirements of GOST 34120- 2017 standards.

To achieve this goal, the following tasks were set:

1. To analyze the growth and development of young cattle of the black-and-white breed, including the dynamics of live weight, average daily gains and relative gains from birth to the first insemination and removal from fattening.

2. Analyze the live masses of cows coming to slaughter due to culling.

3. To evaluate the meat productivity of cattle coming to slaughter by examining post-slaughter indicators.

The object of scientific and economic experience was black-and-white cattle bred in the conditions of the Michurin collective farm in the Vavozhsky district of the Udmurt Republic. The research period is 2021.

The accounting of meat productivity indicators was carried out in stages, as the cattle arrived for slaughter.

All age and sex groups of cattle entering for slaughter and primary processing in LLC "Uvinsky Meat Processing Plant" took part in the research. Thus, the following experimental groups were formed in the experiment: 1 experimental group (AC) – adult cattle (cows of two or more calves); 2 experimental group (MCP) – young cattle, first-calf cows – young female cattle that calved once; 3 experimental group (MT) - young cattle, chicks aged from 8 months to two years. 4 experimental group (MB) - young animals, bulls aged from 8 months to two years.

In the conditions of the collective farm, all animals were raised in the same conditions, according to the technology adopted in the farm. Animal feeding rations were made according to the planned average daily live weight gains (700-800 grams) and average daily milk yields, in accordance with detailed feeding norms.

A lifetime assessment of the growth of young cattle was carried out according to the indicators of live weight and average daily growth monthly. Based on the weighing data, calculations were made according to the formula of S. Brody.

The average daily increase in live weight (g) was calculated by the formula:

$$D = ((W_1 - W_0) / t)*1000 \qquad (1)$$

where, W_1 – the weight of the animal at the end of the accounting period, kg;
W_0 – the weight of the animal at the beginning of the accounting period, kg;
t – the time elapsed between weigh-ins, in days.
Relative growth rate of live weight (%):

$$K = [(W_1 - W_0 / 0,5*(W_1 + W_0)]*100 \qquad (2)$$

where, W_1 – the weight of the animal at the end of the accounting period, kg;
W_0 – the weight of the animal at the beginning of the accounting period, kg.

Determination of the category of fatness of live animals and the resulting beef was carried out on the basis of weight data, based on the requirements of GOST 34120-2017 "Cattle for slaughter. Beef and veal in carcasses, half-carcasses and quarters. Technical conditions".

The evaluation of slaughter qualities was carried out according to the results of the control slaughter of animals (3 heads from each group) in the conditions of LLC "Uvinsky meat Processing Plant" of the Uvinsky district of the Udmurt Republic according to the methodology of VIZ and VNIIMP (1977).

At the same time, the live weight was taken into account when removed from fattening, the pre-slaughter live weight, the mass of the steamed and cooled carcass, the output of the carcass and internal fat, the slaughter output.

To determine the morphological composition of the carcass after 24-hour cooling at a temperature of 0 ... +4 ° C, the carcass was cut into natural anatomical parts, followed by deboning and veining of the pulp. At the same time, the mass of pulp, connective and bone tissues was taken into account. The meat content coefficient of experimental animals was calculated by the ratio of the amount of pulp to bone tissue. The obtained results of scientific research were processed by the method of variation statistics described by E.K. Merkuryev (1983) and N.A. Plokhinsky (1961) using a statistical analysis package of Microsoft Excel software; the reliability of the difference between the indicators was assessed by the Student.

3.   Results

In 2021, 102 cows were received for slaughter at Uvinsky Meat Processing Plant LLC for forced reasons, of which 61 heads were cows of 3 lactation, 23 heads were cows of 2 lactation, and 16 heads were cows of 1 lactation (Table 1). The average live weight of cows received for slaughter was 605.2 kg.

Table 1. Live weight of cows received for slaughter at LLC "Uvinsky meat processing Plant"

Lactation number	Number of heads	Live weight, kg
1 lactation	36	577.3±2.86
2 lactation	32	592.6±1.27
3 lactation and older	70	614.9±3.77
Total	138	605.2±3.03

According to the results of a lifetime assessment of the meat productivity of adult cattle according to the requirements of GOST 34120- 2017 "Cattle for slaughter. Beef and veal in carcasses, half-carcasses and quarters. Technical conditions" 101 head corresponded to the first category of fatness. The musculature was developed satisfactorily, the shape of the trunk was somewhat angular, the shoulder blades stood out, the hips were slightly tightened, the spinous processes of the dorsal and lumbar vertebrae, the sciatic tubercles and maclocks protruded, but not sharply; deposits of subcutaneous fat were felt at the base of the tail and on the ischial mounds, the probe was poorly performed. 1 cow corresponded to the second category of fatness. The musculature of the animal was less satisfactorily developed, the shape of the trunk was angular, the shoulder blades stood out noticeably, the hips were flat, taut, the spinous processes of the dorsal and lumbar vertebrae, the maclocks and sciatic tubercles protruded noticeably; deposits of subcutaneous fat were in the form of small areas on the sciatic bumps and the lower back.

First-calf cows according to GOST 34120-2017 belong to the sex and age group "young". In accordance with the standard, the first-calf cows corresponded to the category "Super", class A, subclass 1. They had strongly convex, rounded and proportional forms of the trunk, the bones of the body were not visible and did not protrude, the musculature was luxuriantly developed. The hip part was very wide and smooth, the overhang of the thigh muscles in the knee joint area was well pronounced, the base of the tail was rounded, the sciatic tubercles and maclocks were

slightly marked, but did not protrude; the back and loin are wide and thick almost to the withers, the body is barrel-shaped, the spinous processes of the vertebrae are covered with musculature, were only slightly marked, but did not protrude; the withers of the bulls are thick and wide, the shoulder blades and chest are rounded and wide, without interception behind the shoulder blades; the hind and front legs are widely spaced; when viewed from behind, the animal looks rounded, with bulging muscles, when viewed from the front - wide, with a very well-developed chest. Subcutaneous fat deposits were poorly developed, slightly palpable at the base of the tail and on the sciatic mounds, but invisible in the probe.

In order to study the peculiarities of changes in the live weight of young animals, regular weighing of animals is carried out on the farm. In the Michurin collective farm (SHPC), the live weight control of heifers and bulls is carried out monthly, starting from birth.

Table 2 shows the dynamics of live weight and average daily increments of bulls entered for slaughter in 2021.

In the collective farm, fattening bulls begin to be slaughtered from the age of 15 months. Fattening is produced up to 17 months of age. From birth to the final fattening, the bulls that entered the slaughter in 2021 grew in absolute weight by 485.9 kg. The average daily increase over the entire fattening period averaged 952.7 grams.

According to the requirements of GOST34120-2017 "Large-scale equipment for slaughter. Beef and veal in carcasses, half-carcasses and quarters. Technical conditions" at the age of 17 months, the bulls corresponded to the category "Super", class A, subclass 1.

Table 2. Dynamics of live weight and average daily gains of bulls from birth to 17 months of age.

Group	Live weight, kg	Average daily live weight gain, g
	X±m	X±m
At birth		
Bulls (n=81)	43.2±0.4	-
3 months		
Bulls (n=81)	128.8±1.30	951.1±1.1
6 months		
Bulls (n=81)	201.3±1.70	805.6±0.9
9 months		
Bulls (n=81)	279.8±1.10	872.2±1.13
12 months		
Bulls (n=81)	355.6±1.31	842.2±1.67
15 months		
Bulls (n=81)	459.9±1.13	1158.9±2.17
17 months		
Bulls (n=81)	529.1±1.27	1153.3±2.23

They had strongly convex, rounded and proportional forms of the trunk, the bones of the body were not visible and did not protrude, the musculature was luxuriantly developed. The hip part was very wide and smooth, the overhang of the thigh muscles in the knee joint area was well pronounced, the base of the tail was rounded, the ischial tubercles and maclocks were slightly marked, but did not protrude; the back and loin were wide and thick almost to the withers, the body was barrel-shaped, the spinous processes of the vertebrae were covered with

musculature, were only slightly marked, but did not perform; the withers of the bulls are thick and wide, the shoulder blades and chest are rounded and wide, without interception behind the shoulder blades; the hind and front legs are widely spaced; when viewed from behind, the animal looked rounded, with bulging muscles, when viewed from the front - wide, with a very well-developed chest. Subcutaneous fat deposits were poorly developed, slightly palpable at the base of the tail and on the sciatic mounds, but invisible in the probe.

The growth dynamics of heifers is presented in Table 3.

Table 3. Dynamics of live weight and average daily gains of heifers from birth to 18 months of age.

Group	Live weight, kg	Average daily live weight gain, g
	X±m	X±m
At birth		
Heifer (n=6)	33.1±1.98	-
6 months		
Heifer (n=6)	171.1±4.6	766.6±1.67
10 months		
Heifer (n=6)	270.8 ±3.2	830,8±2.75
12 months		
Heifer (n=6)	317.4±3.8	776.7±1.63
18 months		
Heifer (n=6)	456.8±1.89	774.4±1.17

In 2021, 6 heifers aged 18 months were delivered for slaughter. The main reasons for leaving the herd are animal diseases, injuries and accidents. From birth to the age of 18 months, the heifers received for slaughter in 2021 grew in absolute weight by an average of 423.7 kg. The average daily increase over the entire growth period averaged 784.6 grams.

According to the requirements of GOST34120- 2017 "Cattle for slaughter. Beef and veal in carcasses, half-carcasses and quarters. Technical conditions" at the age of 18 months, the heifers corresponded to the "Extra" category, class B, subclass 1. The heifers had convex and rounded trunk shapes, the musculature was well developed; the hip part was wide and smooth, rounded, the thigh musculature in the knee joint area was noticeable, but not overhanging, sciatic tubercles and maclocks slightly protruding; the loin and back were of medium width and thickness, the back noticeably narrowed to the withers, the spinous processes of the vertebrae slightly protruded; the shoulder blades and chest were well developed, without interceptions behind the shoulder blades, the withers were thick enough, not sharp, of moderate width, the thoracic vertebrae and ribs were slightly marked; the hind and front legs were moderately spaced, not brought together; when viewed from behind, the animal looked moderately rounded, the musculature was moderately developed, when viewed from the front it was of medium width, the shoulders were moderately wide, the bones were slightly visible.

Evaluation of meat productivity is carried out according to such indicators as: removable and pre-slaughter live weight, carcass yield, slaughter weight and slaughter yield, morphological composition, chemical composition of tissues and their physical (technological) properties, organoleptic value [1, 5, 7].

The level of meat productivity depends on the breed of cattle, fatness, age, gender, season of the year. Undoubtedly, of all the factors, the genotype of animals and their feeding has the greatest impact on meat productivity [6, 8, 10]. In order to study the meat productivity of cattle

entered for slaughter in 2021, a control slaughter of 3 heads from each group was carried out (Table 4, figure 1).

Table 4. Results of control slaughter of cattle of all age and sex groups.

Indicator	Group (n=3)			
	1 experienced (MC)	2 experienced (MCP)	3 experienced (MT)	4 experienced (MB)
Removable live weight, kg	609.8±3.31	577.3±2.86	456.8±1.89	529.1±1.27
Pre-slaughter live weight, kg	591.5±3.1	568.6±2.8	449.9±1.1	521.1±3.2
Weight of the steamed carcass, kg	282.7±2.1	204.2±2.9***	210.5±2.7	263.9±1.8**
Carcass yield, %	47.8±1.1	35.9±0.2	46.8±0.5	50.6±0.2
Internal fat mass, kg	11.3±0.43	9.8±0.48	10.3±0.45	10.6±0.45
Internal fat output, %	1.91±0.06	1.72±0.10	2.28±0.08	2.03±0.02
Slaughter weight, kg	294.1±3.24	205.9±3.1	212.8±2.7	265.9±2.1
Slaughter yield, %	49.7±0.65	36.2±1.1**	47.3±0.52	51.0±2.1
The thickness of fat on the back in the area of 10-12 ribs, cm, not more than 0.5 cm (GOST 34120- 2017)	1.3±0.31	0.78±0.21	0.47±0.19	0.4±0.13

*$P \geq 0.95$; **$P \geq 0.99$, ***$P \geq 0.999$

Fig.1. Beef half–carcasses obtained from adult cattle (cow) and from young cattle (bull): on the left – adult cattle, on the right - young.

When analyzing the results of the control slaughter, it was found that the largest removable live weight was observed in cows of 591.5 kg, the smallest removable live weight was possessed by heifers of 449.9 kg. The heaviest carcasses were obtained from adult cattle (cows), whose mass was 282.7 kg. The lowest indicator was in first-calf cows, the mass of their carcasses left 204.2 kg, which is 78.7 kg lower than the mass of carcasses of adult cattle ($P \geq 0.999$).

The carcass weight of bull calves was 263.9 kg, which is 19.8 kg inferior to the group of adult cattle ($P \geq 0.99$). In the group of young animals, the heaviest carcasses were obtained from bull calves, their mass exceeded the mass of carcasses obtained from heifers by 53.4 kg ($P \geq 0.999$).

When analyzing the slaughter yield, it was noted that the highest slaughter yield was observed in carcasses obtained from fattening bulls, which amounted to 51%. The lowest slaughter yield was observed in carcasses obtained from first-calf cows and amounted to 36.2%, which is 14.8% lower than the carcass of bulls ($P \geq 0.99$). This fact indicates that edible parts develop to a greater extent in the carcasses of fattening bulls, and meat productivity is expressed in the best way. The slaughter yield of adult cattle and heifers was 49.7% and 47.3%, respectively, which is 1.3% and 3.7% lower than the slaughter yield of bulls. The resulting difference is unreliable.

The carcasses obtained from bulls had the smallest thickness of subcutaneous fat (0.4 cm), this indicator was lower relative to the carcasses of adult cattle by 0.9 cm.

Beef obtained from fattening steers, according to the requirements of GOST 34120- 2017, was classified as "Extra", class B, subclass 1. The carcasses were full-bodied with rounded well-developed muscles. The hip part is of medium width, smooth, the thigh muscles in the knee joint are noticeable, but not overhanging, the back and loin are of medium width, but narrowed towards the withers, the spinous processes of the vertebrae were not visible, the shoulder blades and chest were rounded, filled with muscles, the interception behind the shoulder blades was not visible, the scapular bone was hidden by muscles. The muscles, with the exception of the shoulder blades and butt bulges, were covered with a thin layer of fat. There was a weakly pronounced fat "watering" at the base of the tail and on the upper inner side of the thighs. The thickness of the fat on the back in the area of 10-12 ribs was 0.4 cm. Which met the requirements of the standard.

Beef obtained from heifers according to GOST34120-2017 was classified as "Excellent", class G, subclass 1. The carcasses were slightly rounded, slightly flat and straight in shape, there were noticeable depressions, not filled with musculature. The hip part is developed from medium to satisfactory, the depressions at the base of the tail are slightly noticeable, the sciatic tubercles and maclocksnoticeably protruded, but not sharp, the back and loin of moderate width, noticeably narrowed from about the middle of the back to the withers. The spinous processes of the vertebrae and ribs were noticeable, the shoulder blades and chest were developed from medium roundness to flat shapes, the chest was narrow. The joints were noticeably protruding. The muscles, with the exception of the shoulder blades and butt bulges, were covered with a thin layer of fat. There was a weakly pronounced fat "watering" at the base of the tail and on the upper inner side of the thighs. The thickness of the fat on the back in the area of 10-12 ribs was 0.47 cm, which met the requirements of the standard.

Beef obtained from first-calf cows according to GOST34120- 2017 was classified as "Good", class G, subclass 1. The carcasses were slightly rounded, slightly flat and straight in shape, cavities were noticeable, not filled with musculature. The hip part is developed from medium to satisfactory, the depressions at the base of the tail are slightly noticeable, the sciatic tubercles and maclocks noticeably protruded, but not sharp, the back and loin of moderate width, noticeably narrowed from about the middle of the back to the withers. The spinous processes of the vertebrae and ribs were noticeable, the shoulder blades and chest were developed from medium roundness to flat shapes, the chest was narrow. The joints were noticeably protruding. The muscles, with the exception of the shoulder blades and butt bulges, were covered with a thin layer of fat. There was a weakly pronounced fat "watering" at the base of the tail and on the upper inner side of the thighs. The thickness of the fat on the back in the area of 10-12 ribs was 0.78 cm. Which did not meet the requirements of the standard.

Beef obtained from adult cattle (cows), according to GOST34120-2017, was assigned to the first category of fatness. The muscles were developed satisfactorily, the spinous processes of the dorsal and lumbar vertebrae, sciatic tubercles, and maclocks were not sharply distinguished; subcutaneous fat covered the carcass from the eighth rib to the sciatic mounds; neck, shoulder blades, front ribs and hips, pelvic cavity and groin area had fat deposits in the form of small areas. The thickness of the fat on the back in the area of 10-12 ribs was 1.3 cm, which is acceptable according to the requirements of the standard.

It is known that the indicators of meat productivity of animals cannot be estimated only by conducting a single calculation of the slaughter yield. The morphological composition of the carcass is an important qualitative indicator in assessing meat productivity [9, 11, 14]. When studying the morphological composition of carcasses (pulp, bones, cartilage and tendons), the absolute and relative content of pulp, bones, cartilage and tendons were taken into account.

The data on the morphological composition of the carcasses of experimental bulls of different groups are presented in Table 5.

Table 5. Morphological composition of cattle carcasses

Indicator	Group (n=3)							
	1 experimental (MC)		2 experimental (MCP)		3 experimental (MT)		4 experimental(MB)	
	kg	%	kg	%	kg	%	kg	%
Mass of chilled carcass	282.7±2.1	100	204.8±2.9	100	210.5±2.7	100	263.9±1.8	100
Pulp mass	223.6±2.1	79.1	156.1±1.5	76.2	164.8±2.6	78.3	211.9±2.2***	80.3
Bone mass	51.5±0.34	18.2	38.2±0.42	18.6	35.6±0.4	16.9	43.5±2.3	16.5
Tendon mass	7.6±0.2	2.7	10.6±0.9	5.2	10.1±0.1	4.8	8.4±1.2	3.2
Meat index	3.8		3,2		3.6		4.1	

*P≥0.95, **P≥0.99,***P≥0.999

Based on the conducted research, it can be concluded that in the group of young animals, the highest pulp content was found in the carcasses of bulls, which amounted to 211.9 kg. In the group of young animals, this indicator exceeds by 47.1 kg (22.2%) (P≥0.999) the group of heifers, and by 55.8 kg (26.3%) (P≥0.95) the group of first-calf cows (P≥0.999). In comparison with carcasses of adult cattle, the pulp content in carcasses obtained from bulls was lower by 11.7 kg (5.23%) (P≥0.95).

The absolute yield of bones in the carcasses of bulls was 43.5 kg, in the carcasses of heifers 35.6 kg, first-calf cows 38.2 kg. This indicator was the highest in the carcasses of adult cattle, and amounted to 51.5 kg.

Carcasses obtained from bulls had the highest meat content index and amounted, respectively, to 4.1. The lowest meat content index was observed in the carcasses of first-calf cows – 3.2.

4. Conclusion

Thus, based on the results of the research on the study of meat productivity of cattle bred in the conditions of the Michurin collective farm (SHPK), and in connection with the tightening of requirements for the quality of meat raw materials used in meat processing enterprises, the Michurin collective farm (SHPK) can be recommended to be slaughtered in LLC "Uvinsky Meat Processing Plant" only fattening steers. Beef obtained from this sex and age group fully complies with the requirements of the modern standard GOST 34120- 2017.

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