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Biotechnological Characteristics of Meat Cattle Breeds in the Tyumen Region

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Abstract

Economically useful characteristics of the Charolais, Limousine, Salers and Aubrac cattle have been studied in the comparative aspect to the natural-and-economic conditions of the Northern Trans-Urals during their acclimatization. The biotechnological characteristic of the analyzed animal breeds shows that animals of the extensive Salers and Aubrac breeds have the best adaptive qualities for the conditions of Northern Trans-Urals by the complex of biological and technological parameters; the list is ended by the stud Limousine and Charolais breeds. The results obtained over the 15-year period of breeding specialized beef cattle in the Tyumen region show improved basic productive indicators of animals of all imported species. The annual growth of the livestock is 10-12%, heifers' insemination age decreases to 19 months, the commercial yield of calves reaches 87%, the milk consumption for bulls is 237 kg, and for heifers - 218 kg. Overall assessment by the set of productive traits shows that over 90% of animals fully meet the requirements of the standard. This directly indicates good acclimatization of the imported beef cattle and success of developing meat cattle breeding in the conditions of the Tyumen region.

Keywords: Aubrac, breed, Charolais, exterior, hair coat, Limousine, milk and meat productivity, reproductive ability, Salers.

INTRODUCTION

The Priority State Program for Agriculture Development in Russia for 2013-2020 speaks of increasing the production of high-quality pedigree stock and stimulating breeding aimed at improving the breeding and productive qualities of agricultural animals [1-3].

At the present stage of agricultural development, one of the important and complex problems that the agro-industrial complex is facing is the increase in meat production, mainly, beef [4, 5]. However, given the prospects of meat cattle breeding development in various regions of the country, including Siberia, the existing stock of breeding beef animals in terms of both quantity and the breed structure is clearly insufficient [6-9]. Therefore, it is necessary to develop beef cattle breeding through the use of native breeds and involving new promising resources of the world's gene pool, such as the Charolais and Limousine breeds [10], and relatively unknown breeds – Salers and Aubrac [11-14].

However, the success of breeding the imported cattle primarily depends on its acclimatization abilities to specific conditions [15-19].

This work is aimed at studying the age-related, breed-related and economic-biological features of animals of the imported beef breeds in the comparative context, and in the process of acclimatization.

MATERIALS AND METHODS

The experimental part of the work was accomplished at pedigree raiser in the southern areas of the Tyumen region intended for breeding beef cattle. The research was based on the methodological guidelines for studying the acclimatization ability of meat cattle breeds [20, 21].

The objects of the research were imported French beef cattle breeds - Charolais, Limousine, Salers and Aubrac. The animals were kept according to the technology of beef cattle breeding, and the levels of feeding were the same for all breeds. The exterior was assessed according to the standard techniques [22].

The state of hair coat was examined by its density, weight of clean hairs at the level of the last rib from the area of 1 cm^2 and the length of 100 hairs; and the ratio of fur hairs, beard-hairs and transitional hairs was determined [23].

Based on the zootechnical accounting data, and during observations of sexual processes, the reproductive ability was determined [24-26].

Milk yield of cows was determined by the difference in live weight of calves (bulls) before and after suckling dams. Chemical composition of milk was determined at the laboratory of the State Agrarian University of Northern Trans-Urals.

The dynamics of live weight were studied based on monthly weight measurements with subsequent calculation of the average daily gain. Meat productivity was studied by control slaughter of animals [27].

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RESULTS

For a more nonbiased understanding of the breed qualities and exterior characteristics, the indices of body build were calculated during valuation, based on the measurements made (Table 1).

The body build indices show that Aubrac cows look more long-legged; with that, they have a lower index of overgrowth, which indicates greater uniformity of cows in terms of rump height and withers height. In addition, Aubrac cows had the best index of full beefiness, but were inferior to the counterparts of other breeds in terms of meat type intensity due to greater height at the withers and lower, compared to other cows, chest girth.

Salers cows, compared to other breeds, look more stretched, have the highest index of overgrowth, massiveness, beefiness and meat type intensity. Charolais cows look blockier; have the largest chest, pelvis-chest indices and the body width index, indicating good development of chest width. Limousine cows are inferior to other breeds in terms of the indices that characterize chest width, and the full beefiness index.

For the cows from first calving, exterior characteristic is as follows (Table 2).

Data about body build indexes indicate that heifers of the Salers breed are more long-legged. They also feature high indices of meatiness, full beefiness, meat type intensity, due to the greater half-girth of quarters, compared to other breeds, but are inferior to counterparts of other breeds in the pelvis-chest and body width index that characterize development of chest width.

Table 1 – Body build indices of full-age cows of meat breeds ($\overline{X} \pm s_{\overline{x}}$), %

Index	Breed			
	Charolais	Limousine	Salers	Aubrac
Long-leggedness	48.57 ± 2.46	47.84 ± 0.85	45.76 ± 6.99	50.29 ± 2.59
Lengthiness	116.34 ± 1.36	119.05 ± 3.08	128.51 ± 0.95	121.74 ± 1.33
Blockiness	133.62 ± 2.66	131.32 ± 2.73	122.99 ± 2.07	120.49 ± 0.53
Chest	75.05 ± 3.66	62.17 ± 2.76	64.60 ± 7.39	67.92 ± 2.18
Pelvis-chest	87.42 ± 2.32	79.48 ± 2.45	79.77 ± 5.71	85.99 ± 0.69
Body width	24.69 ± 0.53	20.75 ± 0.94	21.78 ± 1.12	22.97 ± 0.52
Overgrowth	104.48 ± 0.49	105.56 ± 1.89	107.43 ± 1.23	103.52 ± 0.89
Massiveness	157.40 ± 2.79	156.26 ± 3.16	159.34 ± 4.22	146.70 ± 2.41
Meatiness	82.05 ± 1.16	83.14 ± 4.76	91.79 ± 0.45	90.37 ± 2.75
Full beefiness	70.53 ± 0.86	69.77 ± 2.42	70.73 ± 0.87	74.21 ± 1.45
Intensity of type	109.76 ± 1.56	109.27 ± 2.35	109.89 ± 1.59	106.9 ± 1.58

Table 2 – Body build indices of first-calf heifers of meat breeds ($\overline{X} \pm s_{\overline{x}}$), %

Index	Breed			
	Charolais	Limousine	Salers	Aubrac
Long-leggedness	42.10 ± 7.08	49.38 ± 2.29	52.67 ± 2.35	51.88 ± 0.51
Lengthiness	126.89 ± 5.31	117.83 ± 3.14	124.13 ± 5.19	114.68 ± 3.88
Blockiness	128.09 ± 3.93	129.92 ± 2.82	129.29 ± 11.69	127.30 ± 7.59
Chest	70.47 ± 10.82	62.92 ± 2.93	67.56 ± 0.93	74.22 ± 1.10
Pelvis-chest	89.28 ± 4.69	78.68 ± 2.56	78.03 ± 4.56	90.52 ± 2.31
Body width	24.89 ± 1.06	20.79 ± 0.99	20.20 ± 1.51	24.50 ± 1.26
Overgrowth	107.76 ± 0.71	104.73 ± 1.70	103.50 ± 0.86	101.50 ± 0.02
Massiveness	162.43 ± 1.80	153.15 ± 6.46	159.42 ± 9.53	145.84 ± 3.77
Meatiness	89.81 ± 1.56	84.01 ± 4.98	95.34 ± 0.91	82.72 ± 3.00
Full beefiness	70.86 ± 4.19	71.22 ± 2.51	77.16 ± 3.81	72.13 ± 0.18
Intensity of type	111.20 ± 2.49	108.81 ± 3.24	113.93 ± 6.48	106.49 ± 2.28

Table 3 – Indicators of hair coat quantitative composition ($\overline{X} \pm s_{\overline{x}}$)

Indicator	Breed			
	Charolais	Limousine	Salers	Aubrac
Mature cows				
Beard hairs, pcs/cm^2	52.0 ± 12.73	80.3 ± 6.01	91.0 ± 15.56	81.0 ± 26.87
%	7.50 ± 2.04	10.55 ± 1.13	10.81 ± 1.72	10.31 ± 2.70
Transitional hairs, pcs/cm^2	186.7 ± 43.85	323.3 ± 7.95	351.0 ± 4.24	365.0 ± 21.21
%	26.47 ± 5.39	42.31 ± 1.65	47.74 ± 1.00	46.94 ± 0.69
Fur hairs, pcs/cm^2	460.0 ± 18.71	363.0 ± 42.11	399.0 ± 1.41	332.0 ± 8.49
%	66.03 ± 3.45	47.14 ± 2.62	47.45 ± 1.00	42.75 ± 2.02
Overall quantity, pcs/cm^2	698.67 ± 40.63	766.67 ± 47.83	841.0 ± 9.90	778.0 ± 56.57
First-calf heifers				
Beard hairs, pcs/cm^2	89.0 ± 7.07	92.3 ± 9.23	83.3 ± 15.90	117.5 ± 6.50
%	10.92 ± 0.23	10.87 ± 0.93	9.38 ± 1.53	13.62 ± 0.15
Transitional hairs, pcs/cm^2	156.0 ± 59.40	318.7 ± 12.03	216.0 ± 24.54	390.0 ± 8.00
%	18.85 ± 5.38	37.59 ± 1.81	24.45 ± 2.85	45.29 ± 1.07
Fur hairs, pcs/cm^2	571.0 ± 15.56	437.3 ± 14.17	586.0 ± 48.81	354.5 ± 23.50
%	70.23 ± 5.15	51.54 ± 1.19	66.16 ± 4.19	41.08 ± 0.92
Overall quantity, pcs/cm^2	816.0 ± 82.02	848.33 ± 11.63	885.33 ± 44.32	862.0 ± 38.0

Table 4 – Length of hair coat ($\overline{X} \pm S_{\overline{x}}$), mm

Type of hair	Breed			
	Charolais	Limousine	Salers	Aubrac
Mature cows				
Beard hair	31.72 ± 4.47	30.75 ± 1.80	34.44 ± 4.74	33.30 ± 3.56
Transitional hair	22.92 ± 1.46	18.63 ± 0.24	24.90 ± 5.66	22.50 ± 2.48
Fur hair	20.29 ± 0.99	19.65 ± 1.01	21.77 ± 2.26	19.65 ± 1.13
Average	24.98 ± 2.24	23.01 ± 0.49	27.04 ± 4.22	25.15 ± 2.77
First-calf heifers				
Beard hair	36.21 ± 2.18	29.92 ± 0.21	38.03 ± 2.64	35.22 ± 2.06
Transitional hair	23.50 ± 4.42	19.14 ± 0.48	29.79 ± 2.10	23.34 ± 1.56
Fur hair	16.49 ± 1.55	22.12 ± 1.92	28.49 ± 3.67	25.93 ± 1.44
Average	25.40 ± 2.72	23.73 ± 0.83	32.11 ± 2.63	28.17 ± 1.26

The highest chest and pelvis-chest indices are characteristic of Aubrac first-calf heifers; they also feature lower index of overgrowth, indicating their greater uniformity in height at rump and height at withers, massiveness, meatiness and meat type intensity.

Limousine first-calf heifers look bulkier. They also have the lowest chest index, indicating insufficient chest width development, compared to depth.

Compared to other breeds, Charolais first-calf heifers look more stretched, they have the highest overgrowth, massiveness and body width indices.

Analysis of body measurements of local first-calf heifers and those reimported from France showed superiority of local heifers in all analyzed measurements.

In general, based on the exterior characteristics, the identified tendency of Aubrac and Salers breeds' superiority in terms of basic analyzed measurements is most probably determined by their unpretentiousness to the feeding and keeping conditions; Charolais and Limousine breeds, in turn, being stud breeds, are more demanding, and in the keeping and feeding conditions that are inappropriate to their biological requirements suffer more.

To study the animals' acclimatization ability, it is also necessary to study the hair coat characteristics in animals of various ages and breeds (Table 3).

By the indicators of hair coat, there were some differences between groups related to different reaction of the organisms of animal to changing environmental conditions.

A characteristic feature of Salers animals is the best development of hair density, while Charolais have the rarest hair coat. Thus, hair thickness in Salers animals was higher than that of Aubrac animals by 63 hairs, or by 8.1%, that of Limousine animals by 74.3 hairs, or by 9.7%, and that of Charolais animals by 142.3 hairs, or by 20.4%.

The similar trend in changing the quantitative hair coat composition was also observed in first-calf heifers. The difference between the species was minimal; namely, Salers exceeded Aubrac ones by 23.3 hairs, or by 2.7%, Limousines by 37 hairs, or by 4.37%, and Charolais ones by 69.3 hairs, or by 8.5%.

Comparison of the hair quantity of first-calf heifers and mature cows shows clearly the advantage of local first-calf heifers. Thus, Charolais first-calf heifers surpass mature cows in terms of hair density by 117.3 hairs, or by 16.8%, Limousines - by 81.7 hairs, or by 10.7%, Salers - by 44.3 hairs, or by 5.3%, and Aubracs - by 84 hairs, or by 10.8%.

Hair coat composition and structure by fractions has the following features (Table 3). Hair coat of animals of all groups is dominated by fur hair and transitional hair. With that, the highest number of fur hairs was observed in Charolais cows - 66%, with little fur hairs and transitional hairs. In other breeds, the structure of the hair coat on the average was as follows: beard hair – 10%, transitional and fur hair – 45% each.

Analysis of the age dynamics in the structure of hair coat shows the following pattern. Animals of almost all breeds showed decreased shares of fur hair with increased shares of transitional and beard hair, which was the most desirable feature in the summer.

The length of hairs also has an important effect on the protective barrier of the organism. The hair coat length in terms of age and breed is shown in Table 4.

In terms of hair coat length, Salers animals are outstanding in all age periods. Their long hair coat determines large curls and the hair elasticity, which is characteristic of good hair thickness. With that, all types of hair in this breed are longer than in other breeds, and the average hair length is 27.04 mm, surpassing Aubracs by 1.89 mm (7.52%), Charolais – by 2.06 mm (8.25%), and Limousines - by 4.03 mm (17.52%).

The shortest hair coat was observed in Limousines - 23.01 mm; with that, they were inferior to other breeds in terms of all hair types. In first-calf heifers, hair length changes similar to those of adult cows.

Comparison of hair length of mature cows and first-calf heifers shows a significant reduction in the length of all hair types with the age. Thus, in Charolais, this reduction was about 0.42 mm (1.69%), in Limousines – 0.72 mm (3.13%), in Salers – 5.07 mm (18.75%), and in Aubracs - 3.02 mm (12.01%). It should be noted that transitional hair in first-calf heifers was much thinner than in mature cows, and was badly different from the fur hair.

An important feature of Charolais animals is an increased length of fur hair by 3.8 mm, or by 23.1%, rather than the reduced length observed in other breeds; with that, the number of hairs is the maximum. This change is presumably due to the process of acclimation, or to the prolonged period of change of coat.

During the research, characteristics of the hair coat of homegrown first-calf heifers were examined compared to imported first-calf heifers. The results have led to the conclusion that hair coat density in local cows is better than that in imported animals for all types of hair. Hair length in homegrown animals was longer, especially the length of transitional hair, and only slightly of beard hair.

When the animals are moved to new climatic conditions, these consequences primarily affect the reproductive functions; therefore, studying reproductive ability of the animals is one of the main indicators of organism adaptation to new environmental conditions (Table 5).

Table 5 – Reproductive ability

Indicator	Breed			
	Charolais	Limousine	Salers	Aubrac
The number of matings per one successful mating	1.39	1.38	1.27	1.32
Duration of pregnancy, days	287.3 ± 6.40	285.4 ± 3.55	282.5 ± 4.11	283.7 ± 3.47
Duration of service period, days	135.6 ± 11.02	127.7 ± 12.69	106.2 ± 11.26	118.3 ± 12.47
Calf crop per 100 dams, %	53.8	64.9	79.1	77.0

Table 6 – Chemical composition of milk from first-calf heifers (n = 5), %

Indicator	Breed			
	Charolais	Limousine	Salers	Aubrac
Mass fraction of fat	4.08 ± 0.17	4.16 ± 0.17	4.09 ± 0.17	4.19 ± 0.22
Mass fraction of protein	3.44 ± 0.07	3.56 ± 0.06	3.92 ± 0.14	3.71 ± 0.14
Milk sugar	4.46 ± 0.02	4.44 ± 0.02	4.53 ± 0.03	4.53 ± 0.03
Dry matter	12.65 ± 0.19	12.70 ± 0.15	12.81 ± 0.15	12.91 ± 0.27
Nonfat milk solids	8.57 ± 0.03	8.54 ± 0.04	8.71 ± 0.06	8.72 ± 0.06
Ash	0.69 ± 0.01	0.68 ± 0.01	0.70 ± 0.01	0.70 ± 0.01
Energy value per 1 kg of milk, J	2968.23 ± 82.16	3016.87 ± 72.98	3071.09 ± 87.21	3073.00 ±113.07

Table 7 – Dynamics of young stoc k live weight ($\overline{X} \pm S_{\overline{x}}$), kg

Age, months	Breed			
	Charolais	Limousine	Salers	Aubrac
Bulls				
Newborns	36.5 ± 2.11	30.5 ± 0.52**	27.0 ± 0.29***	28.8 ± 0.71**
6	189.2 ± 6.53	180.3 ± 3.90	181.8 ± 3.46	182.3 ± 4.84
8	235.0 ± 7.03	220.5 ± 5.23	223.4 ± 6.22	223.7 ± 8.42
12	307.5 ± 10.92	295.8 ± 10.67	305.3 ± 8.12	309.6 ± 7.95
15	376.4 ± 8.75	356.5 ± 9.15	384.7 ± 7.84*	388.7 ± 8.20
18	467.5 ± 13.53	437.9 ± 21.43	478.6 ± 16.28	471.6 ± 16.34
Heifer calves				
Newborns	34.5 ± 2.05	29.5 ± 0.81*	26.0 ± 0.42***	27.5 ± 0.68**
6	176.1 ± 4.27	173.6 ± 5.87	176.0 ± 4.67	176.6 ± 7.13
8	212.3 ± 6.76	215.5 ± 4.30	202.3 ± 4.84	220.8 ± 7.15
12	291.6 ± 16.80	278.7 ± 13.09	270.5 ± 8.10	298.5 ± 7.13
15	348.2 ± 12.06	334.2 ± 8.16	341.9 ± 4.67	364.7 ± 6.82
18	415.8 ± 19.64	395.8 ± 16.59	420.3 ± 19.69	420.8 ± 13.49

Note: *** – P<0.001; ** – P<0.01; * – P<0.05 compared to the Charolais breed.

Table 8 – The average daily gain in young stock live weight ($\overline{X} \pm S_{\overline{x}}$), g

Age, months	Breed			
	Charolais	Limousine	Salers	Aubrac
Bulls				
0 – 6	848.3 ± 25.31	832.2 ± 17.82	860.0 ± 14.73	852.8 ± 29.62
0 – 8	827.1 ± 29.50	791.7 ± 23.58	818.3 ± 17.08	812.1 ± 31.09
8 – 12	604.2 ± 31.15	627.5 ± 28.63	682.5 ± 31.21	715.8 ± 61.12
12 – 15	765.6 ± 33.42	674.4 ± 34.17	882.2 ± 31.50**	878.9 ± 40.73**
15 – 18	1012.2 ± 51.23	904.4 ± 44.41	1043.3 ± 31.73*	921.1 ± 74.69
0 – 18	798.1 ± 27.16	754.4 ± 28.71	836.3 ± 39.14	820.0 ± 20.93*
Heifer calves				
0 – 6	786.7 ± 25.79	800.6 ± 17.64	833.3 ± 14.41	828.3 ± 49.34
0 – 8	740.8 ± 11.62	775.0 ± 18.82	734.6 ± 14.36	805.4 ± 28.32*
8 – 12	660.8 ± 51.40	526.7 ± 31.07*	568.3 ± 28.21	647.5± 40.76
12 – 15	628.9 ± 34.53	616.7 ± 24.55	793.3 ± 36.94**	735.6 ± 39.41*
15 – 18	751.1 ± 42.86	684.4 ± 42.42	871.1 ± 38.51*	623.3 ± 54.14
0 – 18	706.1 ± 26.18	678.3 ± 19.43	730.2 ± 24.36	728.3 ± 16.08

Mating of animals was natural and took place in the spring and in the summer. With that, cattle of French breeds were inseminated at the age of 24 months because of their late maturity and recommendations of French professionals.

Breeds Charolais and Limousine were harder to manage in terms of mating. Duration of pregnancy in the imported breeds was also longer. After calving, animals of the studied breeds had long recovery period, cows were not bulling for a long time, which in the end affected the length of the service period.

In Charolais and Limousine animals, calving was quite hard and difficult. Assistance was often needed in calving, especially with Charolais animals. The number of the assisted

calvings for them reached 73%, since calves were born large. Charolais cattle, in case of inefficient assisted calving, were subjected to cesarean section – 18% of the number of calving heifers. In turn, calving of Salers and Aubracs was relatively easy. Thus, in terms of reproductive ability, Charolais breed was behind its counterparts; the best reproductive ability was in the Hereford breed, and heifers of Salers and Aubrac breeds took an intermediate position.

In comparing cattle of beef breeds, main attention is more often paid to meat production, and the question of milkability goes to the background; however, dairy cows play a very important role in young-stock breeding.

During lactation, Charolais cows produced 1,065 kg of milk, Limousine cows -1,083 kg, Salers cows – 1,146, and Aubrac cows - 1,173 kg. It should be noted that the level of milk producing ability of Aubrac and Salers cows was slightly higher than those in the Limousine and Charolais breeds. This is confirmed by the average daily milk productivity during lactation, which in the Aubrac breed was 4.89 kg, in Salers breed - 4.77 kg, in Limousine breed - 4.51 kg, and in Charolais breed - 4.44 kg.

Aubrac cows showed an increased milk production until the fourth month of lactation; the maximum daily milk productivity during this period of lactation was 7.0 kg. In other studied breeds, this increase was observed only until the third month of lactation, with the average daily level of milk yield between 6.1 and 6.8 kg.

During milk study and sampling for chemical analysis, it was noted that Charolais had calm temper during milking; sometimes they could be milked without fixation in crates. Salers and Aubrac breeds featured especial fearfulness and aggressiveness.

In addition to the quantity of the milk sucked out, young stock development was significantly influenced by its quality; analysis of its chemical composition is shown in Table 6.

Fat content in the milk from Aubrac cows was 4.19%, from Limousine cows - 4.16%, followed by Salers cows - 4.09%, and Charolais ones – 4.08%. On the contrary, protein content was the highest in Salers breed - 3.92%, followed by Aubrac breed - 0.21%, Limousine breed – 0.36%, and Charolais breed - 0.48%. By the end of lactation, fat and protein content tended to increase.

The amount of milk sugar was higher in milk from Salers and Aubracs equally - 4.53%. It is important to note that the highest level of sugar in milk had been noted in the first months after calving - 4.63% and 4.6%, after that it reduced by the end of lactation.

The level of the main milk components had significant influence on its energy value. During lactation, this value increased, and was the maximum during the 8th month. The most nourishing milk was in Aubracs and Salers, less nutritious milk was from Charolais cows.

Thus, comparing the obtained data, one can make a conclusion that qualitative composition of milk was higher in the samples from the Aubrac and Salers breeds, while Limousine and Charolais first-calf heifers were inferior to their peers in terms of milk chemical composition.

Live weight, being one of the most important economically useful features that characterize growth and meat qualities of animals, is shown in Table 7.

At birth, Charolais bulls had their usual large size and in terms of this indicator surpassed their peers of the Aubrac breed by 7.7 kg ($P<0.001$), Salers breed - by 9.5 kg ($P<0.001$), and the Limousine breed - by 6.0 kg ($P<0.05$). In Charolais young stock, the weight advantage at birth continued during the other age periods: at 6 months, they were heavier by 6.9 kg, 8.9 kg, and 17.4 kg than Aubrac, Limousine and Salers bulls, respectively. At weaning, Charolais young stock was heavier that analogues of the Aubrac breed by 11.3 kg, of the Limousine breed - by 14.5 kg, and that of the Salers breed - by 11.6 kg.

At the age of 12 months, Aubrac bulls were heavier than their peers of the Charolais, the Limousine and the Salers breeds by 2.1 kg, 13.8 kg, and 4.3 kg, respectively. At the age of 15 months, Charolais, Limousine and Salers bulls were still inferior to those of the Aubrac breed in terms of weight within 12.3 kg, 32.2 kg ($P<0.01$), and 4.0 kg, respectively. At the end of the growing period, the highest live weight was observed in Salers bulls - 478.6 kg, and the lowest live weight was observed in the Limousine breed – 437.9 kg, which was less than that of Salers bulls by 40.7 kg. By this indicator, Aubrac and Charolais bulls were superior to their Limousine peers by 33.7 kg and 29.6 kg, respectively.

Similar regularities in changing the body mass by growing periods were found for the live weight of heifers of the studied breeds. The dynamics of heifers' weight growth confirmed the findings for bulls.

It should also be noted that, due to sexual dimorphism, heifers were born smaller, and in the suckling period the difference in the live weight was 8 - 15 kg, after that, the difference increased to 26 - 58 kg, and at the end of the growing period it was on the average within 55 kg. Limousine bulls were inferior to Salers and Aubrac bulls in terms of live weight, which supposedly indicated Salers and Aubrac breeds' better stability to new conditions.

The average daily gain data by the periods of growing animals of various groups show that young stock growth rate varied (Table 8). Thus, during the suckling period up to 6 months of age, all experimental animals showed rather high average daily gain. In this period, no significant difference was observed, except for the Limousine bulls, which were inferior to their peers by 16.1-27.8 g (0.7-3.9%), for heifers, this difference was 17.8-88.3 g (1.9-3.2%). At the end of the preweaning period (8 months of age), young stock growth rate significantly decreased, which was associated with the sharply decreased milk productivity of cows. Low growth rates were observed in the period between 8 and 12 months due to calves' weaning during this period and switching to winter fodder.

During further age periods, the highest growth rate was observed in Salers bulls, followed by Charolais and Aubrac ones. Among heifers, Charolais ones were superior during the after-weaning period; their average daily gain was higher than that of Aubrac heifers by 13.3 g (2.0%), and of the rest ones - by 92.5-134.1 g (14.0 to 20.3%). In the period from 1 year to 15 months, the average daily gain in all analogues decreased on the average by 150 g, and further increased again. The maximum growth rate was observed in bulls during the last period of growing, and was over 900 g (in Charolais and Salers bulls - over 1,000 g).

In analyzing the entire period of rearing, the maximum growth rate was observed in Salers bulls (1,043.3 g), followed by Charolais ones – 1,012.2 g. In terms of this indicator, Limousines and Aubracs were behind Salers by 138.9 (13.3%) and 122.2 g (11.7%). During assessing growth intensity of heifers of the analyzed breeds, the same growth trend was observed as in bulls of compared breeds. Heifers simply had lower daily gain in all periods of growth due to the severity of sexual dimorphism.

To study meat productivity and to identify differences among the breeds, control slaughtering of animals was conducted (Table 9).

The data in Table 9 show that the meat productivity of bulls of the studied breeds, both in absolute and in relative values, is quite similar.

Thus, Limousine bulls had slightly lower preslaughter live weight, compared to the peers, about 8 kg, which, in turn, similarly affected the hot carcass weight.

In terms of the amount of visceral crude fat, Aubracs

slightly exceeded Salers by 0.11 kg, or by 5.2%, and Limousines by 0.78 kg, or by 53.8%. This is more visible in relative terms from the slaughter weight: 0.58% in Aubracs, 0.55% in Salers, and 0.39% in Limousines.

The most important indicator of slaughter is the slaughter yield. Slaughter yield of the studied breeds was rather low, about 55%, with slight advantage of Aubrac bulls.

Such low slaughter results, in the opinion of the authors, are due to the moderate growing of brood animals, and slaughtering animals before they complete their primary growth. The carcasses of bulls were cooled for 24 hours, and after that were subjected to dissection (Table 10).

Dissection results in beef breeds showed moderate content of muscles in the carcass. With that, accumulation of muscle tissues in the absolute terms was slightly higher in Limousines and Aubracs - 146 kg, followed by Salers - about 6 kg and 4.3%. In relative values, a clear trend of Limousines superiority over Aubracs by 4%, and more significant over Salers - 7.6%, was observed. It should be noted that in bulls of all breeds the yield of muscle tissue was sufficient.

The yield of prime grade meat in Limousines was higher by 6-6.5 kg in the absolute weight, and by 20.3 and 22.3% in the relative figures, compared to Salers and Aubracs. The absolute weight of first class meat in limousines was slightly different from that in Aubracs and Salers, but in the absolute values, the difference was 7 to 9.4%. The content of second grade meat was higher in the carcasses of the Aubrac bulls - 59.6 kg; Limousine and Salers bulls were inferior to Aubracs by 8.3 kg, or 16.2%, and by 8.4 kg, or 16.4%.

Table 9 – Results of bulls' control slaughtering ($\overline{X} \pm S\overline{x}$)

Indicator	Breed		
	Limousine	Salers	Aubrac
Preslaughter live weight, kg	374.6 ± 11.31	383.3 ± 7.42	382.3 ± 13.72
Hot carcass weight, kg	201.8 ± 4.52	209.8 ± 6.50	209.3 ± 5.08
Weight of visceral crude fat, kg	1.45 ± 0.21	2.12 ± 0.17	2.23 ± 0.11
Slaughter weight, kg	203.2 ± 5.59	211.9 ± 6.54	211.5 ± 5.7
Carcass yield, %	54.0 ± 0.42	54.7 ± 0.64	54.8 ± 1.35
Crude fat yield, %	0.39 ± 0.04	0.55 ± 0.04	0.58 ± 0.02
Slaughter yield, %	54.4 ± 0.38	54.7 ± 0.67	55.4 ± 1.36

Table 10 – Morphological and variety assortment of carcasses ($\overline{X} \pm S\overline{x}$)

Indicator	Breed		
	Limousine	Salers	Aubrac
Chilled carcass weight, kg	192.8 ± 5.37	205.5 ± 6.36	203.9 ± 5.59
Muscle tissue, kg	146.0 ± 2.26	140.0 ± 2.83	146.3 ± 7.24
%	75.7 ± 0.94	68.1 ± 0.73	71.7 ± 1.87
including: prime grade, kg	35.6 ± 1.55	29.6 ± 0.92	29.1 ± 0.78
%	18.5 ± 1.32	14.4 ± 0.02	14.3 ± 0.66
1 grade, kg	55.9 ± 1.56	54.4 ± 2.76	55.3 ± 3.50
%	29.0 ± 0.01	26.5 ± 2.16	27.1 ± 1.20
2 grade, kg	51.3 ± 3.11	51.2 ± 3.75	59.6 ± 2.56
%	26.6 ± 0.87	24.9 ± 1.05	29.2 ± 0.69
trimmings meat, kg	3.2 ± 0.85	3.7 ± 0.14	3.5 ± 1.06
%	1.7 ± 0.49	2.4 ± 0.37	1.1 ± 0.71
Fat tissue, kg	1.1 ± 0.07	2.3 ± 0.85	4.27 ± 0.57
%	0.6 ± 0.05	1.1 ± 0.38	2.1 ± 0.31
Total meat, kg	147.1 ± 2.19	142.3 ± 2.68	150.6 ± 6.73
%	76.3 ± 0.99	69.3 ± 0.35	73.8 ± 1.55
Connective tissue, kg	6.5 ± 0.42	8.3 ± 2.69	9.0 ± 0.53
%	3.4 ± 0.13	4.0 ± 1.18	4.4 ± 0.29
Bones, kg	38.0 ± 2.69	46.8 ± 0.21	44.3 ± 2.0
%	19.7 ± 0.84	22.8 ± 0.60	21.7 ± 1.28
Fleshing index	4.05 ± 0.22	3.21 ± 0.12	3.62 ± 0.28

Table 11 – Chemical composition and energy value of rib eye ($\overline{X} \pm S\overline{x}$)

Indicator	Breed		
	Limousine	Salers	Aubrac
Moisture, %	79.9 ± 0.07	79.4 ± 0.61	79.2 ± 0.37
Dry matter, %	20.1 ± 0.07	20.6 ± 0.61	20.8 ± 0.37
Protein, %	18.54 ± 0.34	19.26 ± 0.33	19.41 ± 0.36
Fat, %	0.63 ± 0.32	0.32 ± 0.19	0.33± 0.07
Ash, %	0.93 ± 0.06	1.05 ± 0.09	1.05 ± 0.07
Energy value 1 kg, MJ	3.43 ± 0.07	3.43 ± 0.13	3.46 ± 0.05

Table 12 – Biotechnological characteristics of meat cattle breeds in the Tyumen region, score*

Indicator	Breed			
	Charolais	Limousine	Salers	Aubrac
Ease of calving	2.5	3	3.8	3.7
Maternal qualities	3.8	4	4.5	4.5
Milkability	4.7	4.6	4.3	4.3
Unpretentiousness	2.5	3.5	4	4
Resistance to cold	3	3.1	3.5	3.6
Duration of economic use	4.5	4.5	4.5	4.5
Calf crop	3	3.5	4.1	4.1
Early maturation	3.2	3.75	4.0	4.1
Marbling of meat	3.2	3.2	3	3
Taste of the meat	4	4	4	4
Average score	3.44	3.84	3.97	3.98
Rank	3	2	1	1

*Top rating – 5 points, lowest rating – 1 point.

The amount of fat tissue was higher in the carcasses of Aubrac bulls - 4.27 kg or 2.1% of the weight of a chilled carcass. With that, this indicator in Salers was 2 times lower, and in Limousines - 4 times lower. The content of connective tissue was higher in Aubracs - 9 kg, and in Salers - 8.3 kg, with the minimum content in Limousine bulls – 6.5 kg. The share of bones was higher in Salers - 22.8%, or 46.8 kg, Aubracs were slightly inferior to this value by 2.5 kg, and the minimum bone weight was in Limousines - 38 kg, or 19.7% of the carcass weight.

The general indicator of the morphological composition of the animal carcass is the fleshing index – the yield of flesh per 1 kg of bones. In absolute terms, the share of meat was higher in the carcasses of Aubrac bulls - 150.6 kg, but after comparing the relative indicators, higher results were obtained for Limousines – 76.3%, followed by Aubracs - 73.8%, and Salers - 69.3%.

The carcass fleshing index was quite low for beef cattle, and was in the normal range for dairy and mixed-type cattle. The obtained results show that the value of the index was higher in Limousine bulls - 4.05, followed by Aubrac bulls - 3.62, with the minimum value in Salers bulls - 3.21.

Studying the chemical composition of meat should be considered as one of the main methods of assessing its quality (Table 11).

Analysis of the obtained data about rib eye chemical composition shows that there are no considerable interbreed differences in terms moisture content and dry matter in the meat.

It should be noted that in the rib eye of Aubrac and Salers bulls, there is a trend to containing a bit more protein with little fat.

High fat content in the muscles was observed in Limousine bulls - 0.63%; they were almost 2 times superior to other compared breeds.

Based on the authors' own research, the biotechnological characteristics of the used beef cattle breeds have been presented (Table 12).

CONCLUSIONS

The success of the breeding beef cattle is determined by a complex of economically useful qualities, which include reproductive quality, growth rate, meat quality, technological features of the breed, etc. Analysis of the reproductive ability has shown that stud breeds, Charolais and Limousine, are inferior to the analyzed breeds in terms of service period duration and commercial yield of young stock.

Milk productivity of first-calf heifers in all studied breeds is high, which ensures necessary milk supply to suckling calves. In terms of milk chemical composition, all studied breeds are characterized by high content of fat and protein, and high energy value. Young stock live weight growth dynamics show higher growth rates of Salers and Aubrac breeds, with Limousine and Charolais breeds behind them in terms of the breed standard.

Meat productivity of French bulls is characterized by satisfactory indicators. It should be noted that in bulls of all breeds the yield of muscle tissues was sufficient. When full beefiness of carcasses and meat quality was assessed, the highest grade was granted to the Limousine breed. The results obtained over the 15-year period of breeding the specialized beef cattle in the Tyumen region show improved basic productive indicators of animals of all imported species. The annual growth of the livestock was 10-12%, heifers' insemination age decreased to 19 months, the commercial yield of calves reached 87%, the milk consumption for bulls was 237 kg, and for heifers - 218 kg. Overall assessment by the set of productive traits shows that over 90% of animals fully meet the requirements of the standard. This directly indicates good acclimatization of the imported beef cattle and success of developing meat cattle breeding in the conditions of the Tyumen region.

Finally, in terms of comprehensive technological indicators for the conditions of Northern TransUrals, the leaders are the animals of extensive Salers and Aubrac breeds, while the list is closed by such stud breeds as Limousine and Charolais ones.

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