

**SCIENTIFIC AND PRACTICAL JUSTIFICATION  
OF THE OPTIMAL EXPRESSION  
OF MEAT FORMS OF CATTLE**

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**INTRODUCTION**

People have used domestic animals as a food source, adapting them to produce more products. During this work, people have used selection methods to change the functional features of cattle, which were formed in wild ancestors as a result of natural selection. In particular, the traits of beef productivity, such as linear and weight growth as well as muscular development and a tendency to accumulate fat, which are defined as meat forms in the evaluation of exteriors, have changed considerably. In modern cattle breeding, the study of animal growth should include consideration of the possible consequences of changes in their shape and body composition on the functional manifestation of other traits. The ratio of muscle, fat and bone in the carcass is a very important indicator of beef composition for consumers. In large, obese animals, the growth of muscle tissue is slow. This, in combination with high energy consumption for fat deposition and body maintenance, results in low biological growth efficiency.

As the mass of carcasses increases, the ratio of muscle tissue to bone improves, as muscles grow faster than the skeleton. The change in body composition towards the meat type led to an increase in the share of difficult calving. The expression of meat forms in recent decades has been the main feature of selection for beef cattle. Selection according to exterior forms as influenced by exhibitions, together with unrealistic feeding patterns, has been very detrimental to beef cattle breeding and this has manifested itself in an increase of arthritis and difficult calving in British breeds<sup>1</sup>.

In Ukraine, the evaluation of bulls of beef breeds on the quality of progeny and testing of bull calves on the growth rate, feed expenses, and

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<sup>1</sup> Berg R.T., Butterfield R.M. New Concepts of Cattle Growth. Sydney University Press, Sydney, 1976. 240 p.

meat forms was conducted according to the methodological guidelines<sup>2</sup>. Their evaluation and selection by average daily gain led to a decrease in breeding value by live weight, sperm production and quality of first-generation progeny (reproductive capacity of heifers, number of calving during life). Breeding cattle with better meat forms results in more meat products, but decreased growth rate and increased fat content in fat depots and feed consumption per gain.

The problem of cattle reproduction in beef cattle breeding is becoming increasingly relevant. The reproductive capacity of bulls has a significant impact on the economic efficiency of beef production. Their selection based on the characteristics of meat productivity negatively affects the ability to reproduce. Therefore, it is necessary to consider the risks of this relationship when selecting them. The purpose of writing this scientific paper is to substantiate the feasibility of applying the trait of meat form expression in bull calves for selection to improve their breeding value and reproductive ability.

### **1. Methodology of determination of cattle meat form expression**

The expression of meat forms of bull calves according to the methodical guidelines<sup>3</sup> is assessed using a 60-point scale (Table 1.1).

Young cattle are divided into<sup>4</sup> three groups according to muscularity: strongly muscled and widely set limbs; moderately muscled and moderately wide set limbs; weakly muscled and narrowly set limbs. Cattle suitable for efficient fattening are well-developed and healthy, with a broad, voluminous upper barrel with widely spaced ribs and relatively deep sides. These animals are large for their age and have straight lines of the bottom and top of their barrels, a high degree of symmetry and uniformity. Muscle development, bone expression (sciatic tuberosity, hips, spinous processes of lumbar and dorsal vertebrae) and barrel shape are assessed by eye examination on the rear third of the barrel and the animal as a whole. Muscle development is assessed on the parts of the barrel that are less susceptible to fat deposition, i.e. a leg of beef, rump and

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<sup>2</sup> Prakhov L.P. Evaluation of bulls of meat breeds by the quality of offspring and testing of bulls by growth intensity, feed payment, meat forms: methodological guidelines. M.: MSH of the USSR, print-multiplication group VNIIMS, 1972. 18 p.

<sup>3</sup> Prakhov L.P. Evaluation of bulls of meat breeds by the quality of offspring and testing of bulls by growth intensity, feed payment, meat forms: methodological guidelines. M.: MSH of the USSR, print-multiplication group VNIIMS, 1972. 18 p.

<sup>4</sup> Minish G., Fox D. Beef production and management. Reston publishing company, ZNC. A. Prentice-hall company Reston, Uinginia, 1982. – 478 p.

forearm. The muscularity of these areas sufficiently characterizes the development of muscle tissue in the animal's body.

Table 1.1

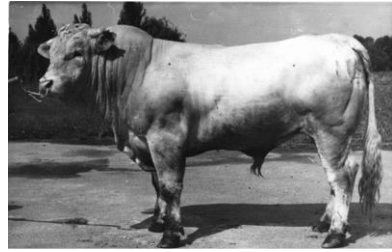
**Scale for evaluating the expression of meat forms of bull calves**

Body gender and overall development of the animal	Requirements for evaluating with the highest score	Rating	Coefficient	Amount of points
General appearance and fullness of musculature	Proportional breed-typical body structure. Broad, long, with well-developed musculature	5	3	15
Chest	Broad, rounded and deep, without depressions behind the shoulder blades. A well-developed, broad, forward-leaning brisket	5	2	10
Withers, back, lower back	Wide, long, smooth, well-muscled	5	2	10
Sacrum	Smooth, wide, long, well-muscled	5	2	10
Ham	With well-developed muscles, it descends to the hock joint. The inner side of the thigh is fleshy, the top is at the level with the lower line of the barrel	5	2	10
Limbs	Strong, properly placed, with strong hooves	5	1	5
Total points		-	-	60

The difference in thickness of fat is assessed on those areas of the body where it is deposited most rapidly: an underbelly, back, at the base of the tail. Fat cattle are wider and deeper. Muscle development should be as follows: a broad posture of fore and hind limbs; greatest width of the barrel is in shoulders and centre of the forequarter, forearm muscles, kneecap are viewed from all four sides; loin is butterfly shaped; lumbar muscle protrudes from spinal groove; prominent musculature. Animals with poorer meatiness have relatively tall and long barrels (Figure 1.1). Better meat forms are characterized by low legs and short bodies (Figure 1.2).



**Fig. 1.1. Bull Pavlyn 7604 has slightly worse expressed meat forms (53.5 points). A live weight is 677 kg at the age of 18 months**



**Fig. 1.2. Bull 6887 CHRUM-61 with slightly better expressed meat forms (59.5 points). A live weight is 610 kg at the age of 18 months**

## **2. Genotypic parameters of the expression of meat forms**

Fat tissue is the most variable in both quantity and distribution in the carcass. It has a significant influence on the exterior shape and appearance of the carcass due to subcutaneous fat and the deposition of fat between muscles<sup>5</sup>. The defined body forms of bull calves at a young age (9 months; Figure 2.1) were retained up to 1.5 years of age in 55.6 % of the animals with worse expressed meat forms and in 66.7 % of the animals with better meat forms.



relatively worse expressed



relatively better expressed

**Fig. 2.1. Expression of meat forms of bull calves at the age of 9 months**

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<sup>5</sup> Berg R.T., Butterfield R.M. New Concepts of Cattle Growth. Sydney University Press, Sydney, 1976. 240 p.

The expression of meat forms has hereditary predispositions. The possibility of effective selection of cattle on it is more than among other types of farm animals. The expression of meat forms in bull calves is characterized by high and average (from 0.40 to 0.60) values of the coefficient of heritability<sup>6</sup>. However, it is desirable that this feature is combined with high performance. A positive relationship (0.63 – 0.93) exists between the expression of meat forms of bull calves at the age of 15 months and their slaughter yield (table 2.1). In other words, during selection only according to barrel shapes, the improvement of animals for slaughter yield is achieved at the same time. This is very important because it is much easier to select animals by meat forms than by post-slaughter yield due to the complexity of record keeping.

Table 2.1

**Correlation between performance characteristics  
in meat bull calves<sup>7 8</sup>**

Trait	Correlation coefficient
Evaluation of meat forms during life – slaughter yield	0.93 – 0.63
The average daily growth rate is from 8 to 15 months – meat forms at the age of 15 months.	0.5 – 0.7

We found no positive correlation between them ( $r = -0.03$  to  $-0.12$ ; Table 2.2) by studying the relationship between meat form expression and live weight and sperm production.

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<sup>6</sup> Leslie D.F. Genetic basis of agricultural animal breeding. M: Kolos, 1982, 391 p.

<sup>7</sup> Prakhov L.P. Increase the efficiency of breeding work with meat breeds of cattle. Dairy and meat cattle breeding, 1978, No. 3. P. 33-35.

<sup>8</sup> Prakhov L.P., Magamedova M.G. Use of breeding and genetic parameters in the selection of Kazakh white-headed cattle. Stock breeding in beef farming: collection of scientific papers VASHNIL. M: Kolos, 1980. p. 98-105.

Table 2.2

**Correlation between the expression of meat forms in bull calves  
(n=52) and other characteristics<sup>9</sup>**

Trait	r±m
Live weight in 15 months.	-0.06±0.14
Live weight in 18 months.	-0.02±0.14
The average daily growth rate is from 8 to 15 months.	-0.02±0.14
Ejaculate volume	-0.03±0.14
Sperm motility	-0.04±0.14
Sperm concentration	-0.04±0.14
Total number of sperm in the ejaculate	-0.06±0.14
Total number of sperm with rectilinear translational motion in the ejaculate	-0.06±0.14
Fertilization capacity of sperm after the first insemination	-0.12±0.14

The data obtained coincide with the results of K.L. Julamanova and K.M. Dubovskova<sup>10</sup>, who reported that there is no definite relationship between the expression of meat forms of bull calves and their live weight. Thus, when evaluating and selecting bull calves based on their own productivity, it does not make sense to take into account the expression of meat forms on a 60-point scale due to the lack of reliable grounds for this. Although the appearance of the exterior of animals indicates possible productivity, it still does not allow us to predict its level<sup>11</sup>.

At the same time, it was found that the height in the sacrum ( $r=0.45$ ) and oblique barrel length ( $r=0.43$ ) determined at 12 months of age probably correlate with the visual expression of meat forms in 15-month-old bull calves (Table 2.3). It can be considered as evidence that these measurements should be used to predict muscular development at 15 months of age.

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<sup>9</sup> Ugnivenko A.M., Koropets L.A. Justification of traits of selection of bull calves of meat breeds. Agricultural science and education. 2005. Vol. 6. No.3-4. p. 72-81.

<sup>10</sup> Julamanov, K., Dubovskova K. Techniques and methods for improving Hereford cattle. Dairy and meat cattle breeding, 2000. № 4. P. 39-43.

<sup>11</sup> Maciejewski Ya. Zemba Yu. Genetics and methods of animal breeding. M: Vysshaya Shkola publ., 1988, 447 p.

Table 2.3

**Relationship between the evaluation of meat forms in 15-month-old bull calves and their body measurements at 12 months (n=22)**

Measurement	r±m
Height at the withers	0.11±0.22
Height in the sacrum	0.45±0.20 <sup>x</sup>
Chest depth	-0.12±0.22
Chest width	0.09±0.22
Oblique barrel length	0.43±0.20 <sup>x</sup>
Heart Girth	-0.18±0.22

Note: P>0.95

No probable correlation ( $r = -0.02 \dots -0.12$ ) between the expression of meat forms at the age of 15 months with the live weight of bull calves at the age of 3 years and indicators of their sperm productivity is associated with a lower concentration of sperm in bull calves with better meat forms. Data of D.T. Vinnichuk and I.O. Garmash<sup>12</sup> also indicate the possibility of reducing the role of evaluating bulls for meat forms, as those, which are subjective and not decisive in determining breeding value. The presence of positive probable correlation coefficients with the height in the sacrum ( $r = 0.45$ ) and oblique barrel length ( $r = 0.43$ ) is the basis for the expediency of changing the subjective expression of meat forms on a 60-point scale with an evaluation based on the named exterior measurements during the test of bull calves. So, body measurements that indicate the large stature of bull calves (height at the withers and sacrum, oblique barrel length) can be used to predict the live weight of bull calves of meat breeds. Due to the subjectivity of evaluating the expression of meat forms on a 60-point scale, when selecting bull calves, it should not be given dominant importance, but much more attention should be paid to measuring the height at the withers and sacrum and the oblique length of the barrel (by stick).

There is also a relationship between the body structure of the sire and its sons. The correlation coefficient between these traits is  $+0.3 + 0.4$ <sup>13</sup>. Most of all, it manifests itself after weaning, since during the suckling period, the growth of calves is significantly affected by the mother's milk production.

<sup>12</sup> Vinnichuk D.T., Garmash I.O. Estimation and use of meat bulls. K: TSIOPGIPP "Plodvykonserv", 1992. 114 p.

<sup>13</sup> Prakhov L.P. Evaluation of bulls of meat breeds by the quality of offspring and testing of bulls by growth intensity, feed payment, meat forms: methodological guidelines. M.: MSH of the USSR, print-multiplication group VNIIMS, 1972. 18 p.

This makes it possible to draw conclusions about the breeding value of young bull calves based on their personal productivity. The best sires selected according to the expression of meat forms produce offspring with higher meat forms at 15 months of age. A comparison of the bull calves when estimating by mean values of the main traits with the corresponding traits of the parents confirms the positive relationship between them.

### **3. Growth of bull calves with different expressions of meat forms**

A biological feature of cattle is the uneven growth of organs and tissues and its slowing down with age until the body weight reaches about 1/3 of the weight of an adult animal. The growth rate is highest during the first months after birth, and then gradually and irregularly decreases. This is due to the relative decline in synthesis in the growing organism for an increase in the proportion of differentiated cells and tissues (their reproduction and growth are slow) and an increase in the number of reserve substances in the body.

Peculiarities of the growth of bull calves of the Ukrainian beef breed were studied in two replications. In the first one, the materials of the evaluation<sup>14</sup> of bull calves in the Catalogue of evaluated bulls were analyzed.<sup>15</sup> Animals at 15 months of age were distributed into two groups according to the expression of meat forms: 1) better expression (the score is higher than the average for the group of studied bull calves); 2) worse expression (the score is lower than the average for the group). Young animals of the Ukrainian meat breed with a worse expression of meat forms after weaning grow somewhat faster (by 2.7 %) until the age of 15 months, then this indicator decreases and the animals later (at 18 months of age) are aligned in live weight (table. 3.1).

The second replication of studies on the growth of bull calves of the Ukrainian meat breed with different expression of meat forms was made at "Volia" breeding plant, Cherkasy region. From birth to weaning, the offspring were kept with their mothers. They were additionally fed with concentrated feed and hay. At 8 months of age, animals that met the requirements of the first class (240 kg or more) were tested for their own performance, which lasted until they reached the age of 18 months. During

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<sup>14</sup> Prakhov L.P. Evaluation of bulls of meat breeds by the quality of offspring and testing of bulls by growth intensity, feed payment, meat forms: methodological guidelines. M.: MSH of the USSR, print-multiplication group VNIIMS, 1972. 18 p.

<sup>15</sup> Dmtrash N. A., Leontieva Z. A., Sokol V.I. Catalog of estimated bulls of the meat direction of productivity. Under the general editorship of A. M. Okopnyi. K: MSH OF THE UKRAINIAN SSR. 65 p.



the period from 8 to 18 months of age, each bull calf with a better meat form consumed 3061 fodder units respectively, and the bull calf with a worse meat form consumed 3087 feed units (Table 3.2).

Table 3.1

**Growth of bull calves with different expression of meat forms during the test, M ± m**

Meat forms in 15 months of age, points		The average daily growth rate from 8 to 15 months, g	Feed costs per 1 kg of growth, feed units	Live weight at age, months, kg	
n	M ± m			15	18
21	53.4±0.49	1104±32.3	8.7±0.67	557±12.7	642±18.9
20	48.2±0.50	1134±61.8	8.0±0.43	561±19.5	642±12.7

Table 3.2

**Feed consumption by bull calves with different expression of meat forms**

Age period, months	Expression of meat forms	Feed								Costs	
		concentrated feed		rough		juicy		green		Total	Per 1 kg of weight gain
		Feed units	%	Feed units	%	Feed units	%	Feed units	%		
From 8 to 12	Better (n=12)	558	45.8	196	16.1	209	17.1	256	21.0	1219	8.89
	Worse (n=10)	580	46.1	189	15.0	224	17.8	266	21.1	1259	8.58
From 12 to 15	Better (n=11)	449	43.9	171	16.8	236	23.1	166	16.2	1022	10.01
	Worse (n=10)	460	45.3	140	13.6	213	20.8	208	20.3	1026	9.41
From 8 to 15	Better (n=12)	998	48.5	360	17.5	391	19.2	311	14.8	2060	8.61
	Worse (n=10)	1052	48.4	336	15.5	373	17.2	411	18.9	2172	8.53
From 15 to 18	Better (n=7)	494	45.0	117	10.7	211	19.2	276	25.1	1098	13.89
	Worse (n=6)	452	42.4	107	10.0	207	19.4	301	28.2	1067	13.17
From 8 to 18	Better (n=7)	1468	48.0	488	15.9	513	16.8	592	19.3	3061	9.62
	Worse (n=6)	1493	48.4	448	14.5	507	16.4	639	20.7	3087	9.32

Their meat forms were evaluated at 15 months of age in accordance with the guidelines given in the paper<sup>16</sup>. The formation of animals into groups for the analysis of results was made at the age of 15 months according to the value of the meat form expression score: 1) the group with better expression; 2) the group with worse expression. The growth of bull calves was studied from birth to 18 months of age.

Early-maturing animals with large meat forms have a reduced growth rate when they reach 8 months of age, while the individuals with smaller forms have a more stable growth rate and grow longer (Table 3.3). In this case, their growth rate by 18 months of age is slightly higher than that of the early-maturing individuals.

Table 3.3

**Average daily growth (g) of bull calves  
with different expression of meat forms**

Age periods, from-to:	Better – over 54.5 (n=56.5)				Worse – up to 54.5 (n=51.8)			
	n	M ± m	Cv,%	σ	n	M ± m	Cv,%	σ
0-8	23	989±20.6	9.8	96.5	27	949±16.4	8.8	83.5
8-12	23	1119±51.1	21.4	239.7	27	1158±45.5	20.1	232.2
8-15	23	1129±41.8	17.4	195.9	27	1179±32.1	13.9	163.8
8-18	16	1051±45.5	16.8	176.1	20	1094±28.6	11.4	124.8
12-15	23	1140±57.5	23.7	269.6	27	1208±48.2	20.3	245.7
15-18	16	840±74.4	34.3	288.3	20	897±62.7	30.4	273.1

Bull calves with moderate expression of meat forms already at the age of 18 months have a tendency (0.5%) to the advantage behind the live weight of animals with better exterior appearance during the period of testing (Table 3.4).

For example, those with meat forms up to a score of 54.5 at test reach an average live weight of 595 kg at 1.5 years of age, while those over 54.5 reach only 592 kg. The best of them reach a live weight of 1,320 kg at 3 years of age (Figure 3.1).

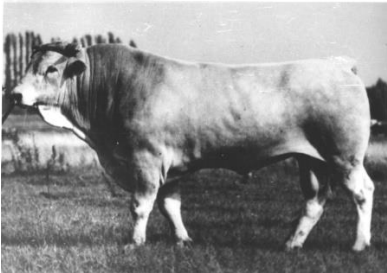
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<sup>16</sup> Prakhov L.P. Increase the efficiency of breeding work with meat breeds of cattle. Dairy and meat cattle breeding, 1978, No. 3. P. 33-35.

Table 3.4

**Live weight (kg) of bull calves  
with different expression of meat forms**

Age, months	Better – over 54.5 (n=56.5)				Worse – up to 54.5 (n=51.8)			
	n	M ± m	Cv	σ	n	M ± m	Cv	σ
Newborn	23	32.8±0.6	8.9	2.9	26	32.7±0.6	9.5	3.1
3	15	120±4.2	13.0	15.6	12	113±7.3	21.4	24.2
6	15	195±7.7	14.8	28.8	12	193±8.5	14.5	28.1
8	23	274±5.2	8.9	24.4	27	264±4.1	8.0	21.0
12	23	411±7.9	9.0	37.0	27	405±7.6	9.6	38.9
15	23	513±9.5	8.6	44.3	27	514±14.4	6.9	43.5
18	16	592±13.6	8.9	52.8	20	595±9.6	7.0	41.7



Buk 099 CHRUM-3: expression of meat forms at the age of 15 months is 52 points; live weight at the age of 3 years is 1320 kg



Lionok 7070 CHRUM-63: expression of meat forms at the age of 15 months is 58 points; live weight at thy age of 3 years is 1160 kg

**Fig. 3.1. Results of selection of bull calves by the expression of meat forms at the age of 15 months**

However, in bull calves with worse expressed meat forms, there is a tendency for the average daily gain to increase by 4.1% from birth to 8 months of age. Perhaps this is due to the better milk productivity of their mothers, which affects the growth rate during the suckling period. According to the Chervinsky-Maligonov law,<sup>17 18</sup> the organs and tissues that develop the most at this time are most affected by restricted feeding

<sup>17</sup> Chyrvynskiy N. P. Changes in agricultural animals under the influence of intensive and insufficient feeding at a young age. Selected works. M: Rosselkhozizdat Publ., 1949. Vol. 1. P. 47-49.

<sup>18</sup> Malygonov A.A. Selected works. M: Kolos, 1968.

at a young age. Conversely, improved nutritional conditions promote active growth of tissues developing at the appropriate age. With faster growth in the suckling period, bull calves tend to increase live weight at the age of 8 months by 3.8% and improve the expression of meat forms. In the future, the difference decreases, compared to animals with a worse exterior. However, these and other bull calves maintain a high growth rate until the age of 18 months. Bull calves with worse meat forms grow faster for a longer time. The average daily increase in their live weight from 8 to 18 months is 4.1% higher compared to their peers with better meat forms.

The trend of preference for live weight in peers with a worse expression of meat forms begins to manifest itself at the age of 15 months. Bull calves with better meat forms have greater variability in the average daily growth compared to their peers. This indicates that their adaptation to environmental conditions is relatively different, both during the suckling period and after weaning. The coefficient of variation of live weight in bull calves with worse meat forms at the age of 15 and 18 months tends to decrease compared to peers.

Consequently, against the background of lower variability in the growth rate, animals with worse expressed meat forms tend to stabilize live weight at an older age (15 and 18 months). Animals with better expressed meat forms spend 3.2% more feed units per kilogram of growth during the test period from 8 to 18 months of age (see Table 3.2); 0.9 from 8 to 15 months; 5.5% from 15 to 18 months compared to peers with worse meat forms.

#### **4. Meat productivity of bull calves with various forms of exterior**

The body structure of cattle is thought to<sup>19</sup> affect the muscle-bone ratio and the percentage of high-value cuts in carcasses. It is not always the case that animals with better barrel structures are characterized by better meat productivity. It is proven<sup>20</sup> that Brama cattle have the same proportion of valuable beef cuts as Hereford cattle. In dairy cattle,<sup>21</sup> the proportions of high-value cuts are the same as those of meat breeds. Breeds that are characterized by the dairy type are now increasingly used for beef

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<sup>19</sup> Berg R.T., Butterfield R.M. *New Concepts of Cattle Growth*. Sydney University Press, Sydney, 1976. 240 p.

<sup>20</sup> Butler O. D. The relation of conformation to carcass traits. *Journal of animal science*, 1957. 16(1). 227-233.

<sup>21</sup> Cole J. W., Ramsey C. B., Hobbs C. S., Temple R. S. Effects of type and breed of British, zebu, and dairy cattle on production, carcass composition, and palatability. *Journal of dairy science*, 1964. 47(10), 1138-1144.

production in many countries around the world. Animals that are very different in shape are almost identical in the distribution of muscle mass in carcasses<sup>22</sup>. Animals with a dense body structure have a large mass of muscles. They produce a higher percentage of the high-value parts of their respective cuts. With similar fatness, animals with more rounded shapes have insignificant advantages (table 4.1).

Table 4.1

**Comparison of carcasses of animal analogues in terms of weight and fatness, which have different body structures<sup>23</sup>**

Trait	Body structure	
	better	worse
Number of carcasses	12	12
Carcass evaluation (on a seven-point scale)	5.3	3.6
Bones, %	15.0	15.8
Fat, %	18.2	17.4
High-value cuts, %	42.0	41.0
Lean pulp in high-value cuts, %	45.8	45.8
Muscular fibre, cm <sup>2</sup>	52.6	48.3

Well-muscled animals with a low fat content in the carcass have a higher percentage of muscle tissue and less bone. In animal carcasses with better body shapes, the ratio of muscles and bones is slightly better. The carcasses of animals with better forms are fatter. Animals with better forms do not have significant advantages in terms of the share of high-value cuts or the distribution of lean meat. A thicker lumbar cut in animals with a better exterior is associated not with a larger area of the muscular fibre, but with a layer of fat covering it. The better shapes of the body structures are achieved by excessive fat deposition, which negates the insignificant advantages in the muscle-bone ratio.

Muscle tissue affects the shape of the barrel of cattle due to the variability of its mass, and not due to the difference in the relative size of the muscles, a certain role in this is also played by fat between the muscles,

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<sup>22</sup> Butterfield R.M. Estimation of Carcass and Appraisal of Meat Animals, CSSRO, Melbourne, 1963.

<sup>23</sup> Harrington G. The shape of beef cattle and their carcasses in Relation to carcass merit in Beef in the Seventies. An Foras Taluntais, Dublin, 1971.

shifting them to the surface<sup>24</sup>. Muscular animals are characterized by the development of muscles in those parts of the body where they are not surrounded by fat (in the forearm area). Consequently, fat tissue affects the structure of the animal's body. Fat under the skin most affects the shape of the exterior, because it lies directly under it and deeper<sup>25</sup>. As the amount of fat in the carcass increases, its distribution plays an increasingly important role in determining the shape of the barrel.

At the present stage of meat cattle breeding in Ukraine, it is important to know the features of formation of meat productivity in animals at different rates of meat form expression. This will allow us to predict it depending on the age and shape of the exterior. Therefore, we justified the optimal expression of meat forms of big-growing Ukrainian meat breeds, determining the increase in the mass of their carcasses, internal fat and body organs per unit of live weight and per day of life. A study to establish the expediency of growing Ukrainian meat breed bull calves with different expressions of meat forms for meat was conducted at "Volia" breeding plant, Cherkasy region. Selected animals up to 6-7 months of age were raised near their mothers using suckling. They were additionally fed with concentrated feed and hay. During this period, they were tested for the reliability of their origin by blood type factors. After weaning up to 8 months of age, they were accustomed to a typical diet and conditions of keeping. At the age of 8 months of age, the animals were tested for their own performance, which lasted until they reached 18 months of age (4 heads in the group), 21 months of age (3 heads in the group) and 23 months of age (3 heads in the group), respectively. The total level of their feeding was calculated to obtain an average daily increase from 1000 to 1200 g. The mass of feed eaten by each bull calf was taken into account every decade (two consecutive days) by weighing the specified feeds and their residues. Based on the actual feed consumed, their energy value (in feed units) and costs per 1 kg of live weight gain were calculated. For the period from 8 to 18 months of age, from 8 to 21 months of age and from 8 to 23 months of age, each bull calves consumed 2873 and 2886, 4277 and 4348 and 5545 and 5509 feed units, respectively (Table 4.2). The share of concentrated feed in the diet from 8 to 18 months of age was

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<sup>24</sup> Berg R.T., Butterfield R.M. *New Concepts of Cattle Growth*. Sydney University Press, Sydney, 1976. 240 p.

<sup>25</sup> Harrington G. *The shape of beef cattle and their carcasses in Relation to carcass merit in Beef in the Seventies*. An Foras Taluntais, Dublin, 1971.

45.2% and 46.6%, respectively, 47.5 and 47.7% from 8 to 21 months of age, 48.7% and 78.6% from 8 to 23 months of age. There was no significant difference in animal feed intake between the groups. The live weight of animals and their average daily weight gain from birth to 18, 21 and 23 months of age were determined. Live weight was determined by individual weighing at the end of each month in the morning before feeding. At 8-, 12-15-, 18-, 21-, 23-month of age, bull calves were weighed for two consecutive days with the deduction of average weight.

The animals were slaughtered at Cherkasy meat processing plant. Before that, they were weighed before and after 24 hours of starvation (pre-slaughter live weight) with free access to water. To analyze the results of slaughter, animals were grouped by the method of balanced analogue groups<sup>26</sup>. The difference between animals by age in the groups was up to 5%. After slaughter, the slaughter mass (paired carcass) was determined<sup>27</sup>. In relation to its pre-slaughter live weight, the slaughter yield (carcass yield) was calculated. Net weight gain (Ng) for each day of life was determined according to ICAR<sup>28</sup> using the formula (4.1).

$$Ng = \text{slaughter weight (carcass), kg} \times 1000 / \text{age at slaughter, day} \quad (4.1)$$

After cleaning the carcasses, the absolute mass of the cut-offs was weighed and their proportion to the mass of the carcass was determined. Later, boning of the left half-carcasses of bull calves was made. After that, bones, muscle tissue, tendons and ligaments, and fat tissue were weighed. The right half-carcasses of categories I and II of fatness were divided into eleven cuts (fig. 4.1). Beef in accordance with GOST 7595-79 was divided into three grades: the highest, first and second. The first class includes hip (1), lumbar (2), dorsal (3), scapular (4), shoulder (5) and thoracic (6) cuts. The second class includes neck cut (7) and armpit (8). The third grade includes cut (9), front gaskin (10) and rear gaskin (11).

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<sup>26</sup> Ovsianikov A. I. Fundamentals of experimental business in animal husbandry. Study guide. M: Kolos, 1976, 304 p.

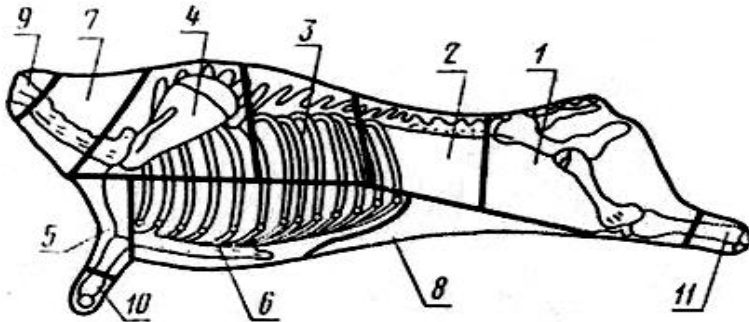
<sup>27</sup> Ugnivenko A.M., Antonyuk T. A., Koropets L.A., Nosevych D.K. et al. Workshop on specialized meat cattle breeding. K: "Agrarian education", 2010, 265 p.

<sup>28</sup> International Committee for Animal Recording (2009). De international consensus of recordices practices / Approbata a Goentum Assembly held in Niagara Falls, USA, on 18 June 2008. P. 91-189.

Table 4.2

**Feed consumption by bull calves and diet structure<sup>29</sup>**

Feed, kg	Test period, months.											
	from 8 to 18 months				from 8 to 21 months				from 8 to 23 months			
	Expression of meat forms, points											
	57,8 (n=4)		51 (n=4)		58,0 (n=3)		54,2 (n=3)		56,7 (n=3)		53,5 (n=3)	
	Feed unit	%	Feed unit	%	Feed unit	%	Feed unit	%	Feed unit	%	Feed unit	%
Rough	470	16.4	476	16.5	900	21.0	907	20.8	853	15.4	942	17.1
Juicy	428	14.8	406	14.1	655	15.3	707	16.3	816	14.7	830	15.1
Green	677	23.6	659	22.8	691	16.2	685	15.8	1173	21.2	1059	19.2
Concentrated	1298	45.2	1345	46.6	2031	47.5	2049	47.1	2703	48.7	2678	48.6
Total	2873	100.0	2886	100.0	4277	100.0	4348	100.0	5545	100.0	5509	100.0
Costs per 1 kg of weight gain	8.68	-	8.64	-	11.73	-	10.83	-	13.95	-	13.15	-



1 – hip, 2 – lumbar, 3 – dorsal, 4 – scapular, 5 shoulder, 6 thoracic, 7 – neck cut, 8 – armpit; 9 – sticking, 10 – front gaskin, 11 – rear gaskin

**Fig. 4.1. Scheme of retail cutting of beef carcasses into cuts (GOST 7595-79)**

<sup>29</sup> Ugniyvenko A.N. Productivity and reproducibility of bull calves with different expressions of meat forms. Zootechnical science is an important factor for European-type agriculture. Maksimovka, Moldova, 2016. Pp. 741-750.



Fat tissue in accordance with DSTU 3938-99 was divided into slaughter fat (subcutaneous) and intermuscular. In accordance with DSTU 3938-99, various types of internal fat tissue were studied in animals, in particular, adrenal, intestinal, pre-gastric and pericardial. Adrenal fat was separated from the kidneys and from the inside of the lower back and pelvis. The fat covering the paunch is the fat of the omentum. Fat from the intestines is fat that is deposited in the mesentery surrounding the intestines. They were weighed to compare subcutaneous and intermuscular fat tissue. Total fat tissue mass was defined as the sum of internal fat and fat from the carcass.

After deboning, the muscle-bone ratio, meat index, and muscle tissue index were determined. The muscle-bone ratio was calculated as the ratio of muscle tissue to bone<sup>30</sup>. The index of muscle tissue was determined by the ratio of muscle tissue to the mass of bones, fat tissue and tendons and ligaments<sup>31</sup>. The meat index was defined as the ratio of muscle, connective and fat tissue to bones<sup>32</sup>. After slaughter, the paired hide was removed and its mass was determined on the scale in its pure form without remnants of muscle and fat tissue, blood clots and dirt and "hide manure". The length of the hide was measured along the spine from the upper edge of the neck in the middle between the horns to the line connecting the ends of the sciatic tubercles. The width was measured along a line located in the middle third of the hide. Before measuring, the hide was spread out on a table; creases and other irregularities were straightened out without stretching the length and width.

The mass and yield of carcasses and internal fat, as well as the net growth of bull calves depend on the expression of their meat forms<sup>33 34 35</sup>

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<sup>30</sup> Berg R.T., Butterfield R.M. *New Concepts of Cattle Growth*. Sydney University Press, Sydney, 1976. 240 p.

<sup>31</sup> Tkachuk V.M. Muscle tissue index as a criterion for assessing the meat content of animals. *Scientific Bulletin of the National Agrarian University*, 2000. Issue 21. P. 106 – 111.

<sup>32</sup> Cherkashchenko I.I. Assessment of cattle by morphological characteristics. *Meat industry*. 1972. No. 11. P. 27-34.

<sup>33</sup> Ugnivenko A. M. Morphological composition of carcasses of the bull calves of Ukrainian meat breed with different expression of meat forms. *Bulletin of Sumy NAU*. 2015. Issue 6 (28). Pp. 157-160.

<sup>34</sup> Ugnivenko A.M. Morphological composition of anatomical parts of half-carcasses of the bull calves with different expression of meat forms. *Scientific paper Sworid*, 2015b. Vol. 11. Issue 3 (40). "Agriculture". Ivanovo: "Nauchnyi Mir" pp. 31-35.

<sup>35</sup> Kolisnyk O.I., Ugnivenko A.M., Antonyuk T.A., Prudnikov V.G. *Meat productivity of cattle: Monograph*. K.: TsP "Kompint". 2018. 429 p.

<sup>36 37</sup> (table 4.3). At the age of 18 and 21 months, bull calves with better meat forms tend to have a 5.0 and 2.6% advantage in carcass yield over less rounded peers. In terms of net growth, advantage is 2.1 and 6.4 %. Animals with better meat forms have a higher internal fat yield at the age of 21 and 23 months, i.e.9.1 and 25.9 %.

Table 4.3

**Traits of slaughter of bull calves  
by different expression of meat forms**

Trait	Age of slaughter, months					
	18		21		23	
	Expression of meat forms, points					
	57.8 (n=4)	51.8 (n=4)	58.0 (n=3)	54.2 (n=3)	56.7 (n=3)	53.5 (n=3)
Actual live weight, kg	566±23.3	588±19.0	639±7.79	605±32.6	654±22.2	650±12.8
Live weight after starvation, kg	538±21.2	553±22.9	604±15.8	568±27.0	620±28.7	623±14.5
Carcass weight, kg	336.2±17.4	328.8±14.9	385.7±9.2	354.2±20.7	367.7±11.2	383.2±26.1
Carcass output, %	62.5±0.98	59.5±1.21	63.9±0.96	62.3±0.96	59.3±1.15	61.6±4.10
Internal fat, kg	11.8±1.36	13.4±1.48	14.7±3.24	12.5±0.85	20.9±6.91	17.1±3.66
Internal fat, %	2.2±0.31	2.4±0.36	2.4±0.55	2.2±0.07	3.4±1.03	2.7±0.60
Net gain, g	619±16.5	607±33.8	595±23.6	559±27.6	523±11.9	539±41.9

Comparing the slaughter yield in animals with different meat forms is not of practical importance if the reasons underlying the difference in productivity between the groups are not known. Other factors that affect the slaughter yield also include the mass of organs and body parts of animals that are not part of carcasses, such as the head, legs, internal organs, etc. (table 4.4). Bull calves, which are characterized by better meat forms, tend to have lower absolute and relative head weights.

<sup>36</sup> Ugniyenko A.N. Productivity of bulls with different expressions of meat forms. Current problems of intensive development of animal husbandry. Gorki, 2017. Part 2. Pp. 256-260.

<sup>37</sup> Ugniyenko A.N. The expediency of growing bulls with different expressions of meat forms for the production of commercial and breeding products. Lucrări științifice: [în vol.]. Univ. Agrarăde Stat din Moldova; red.-șef: Gh. Cîmpoieș. Chișinău: UASM, 20156. Vol. 44. P. 148-152.

Table 4.4

**Mass of organs and body parts of bull calves  
that are not part of the carcass<sup>38 39</sup>, M ± m**

Organ  1	Age of bull calves, months					
	18		21		23	
	Expression of meat forms, points					
	57.8 (n=4) 2	51.8 (n=4) 3	58.0 (n=3) 4	54.2 (n=3) 5	56.7 (n=3) 6	53.5 (n=3) 7
Head, kg	18.0±1.42	19.6±1.41	19.4±0.47	19.6±0.31	19.5±1.00	20.1±0.41
— // —, %	3.4±0.15	3.5±0.12	3.2±0.15	3.5±0.11	3.2±0.08	3.2±0.08
Liver, kg	6.4±0.44	6.5±0.65	6.4±0.41	6.2±0.13	6.6±0.20	6.5±0.29
— // —, %	1.2±0.05	1.2±0.06	1.1±0.08	1.1±0.07	1.1±0.08	1.0±0.08
Lungs, kg	4.0±0.14	4.1±0.43	4.8±0.12	5.1±0.12	5.0±0.29	5.5±0.67
— // —, %	0.7±0.03	0.7±0.10	0.8±0.07	0.9±0.07	0.8±0.07	0.9±0.14
Heart, kg	1.7±0.11	1.9±0.04	2.2±0.22	2.0±0.11	2.0±0.18	2.1±0.34
— // —, %	0.3±0.01	0.4±0.01	0.4±0.04	0.4±0.03	0.3±0.01	0.3±0.06
Diaphragm, kg	1.6±0.34	1.6±0.27	2.3±0.17	2.1±0.39	2.7±0.43	2.6±0.32
— // —, %	0.3±0.07	0.3±0.07	0.4±0.04	0.4±0.04	0.4±0.08	0.4±0.07
Kidneys, kg	1.0±0.17	1.1±0.15	0.9±0.18	1.0±0.00	0.9±0.09	0.9±0.04
— // —, %	0.2±0.03	0.2±0.05	0.1±0.04	0.2±0.00	0.1±0.04	0.1±0.00
Intestines, kg	9.6±2.05	8.5±0.42	9.1±0.61	8.7±0.55	7.8±1.47	9.3±1.09
— // —, %	1.9±0.35	1.6±0.00	1.5±0.14	1.6±0.11	1.2±0.16	1.5±0.15
Rear hoof, kg	3.0±0.14	2.9±0.21	3.0±0.14	3.2±0.07	3.3±0.16	3.6±0.31
— // —, %	0.6±0.00	0.6±0.07	0.5±0.00	0.6±0.04	0.5±0.04	0.6±0.04
Metatarsal bone, kg	2.6±0.07	2.6±0.25	2.5±0.08	2.7±0.14	2.5±0.15	2.6±0.58
— // —, %	0.5±0.00	0.5±0.00	0.4±0.00	0.5±0.04	0.4±0.00	0.4±0.07
Front hoof, kg	3.2±0.07	3.3±0.21	3.3±0.27	3.6±0.15	3.6±0.12	3.8±0.19
— // —, %	0.6±0.00	0.7±0.07	0.6±0.04	0.6±0.04	0.6±0.00	0.6±0.00
Metacarpal bone, kg	1.8±0.14	1.7±0.28	1.8±0.11	1.9±0.08	1.7±0.12	1.9±0.19
— // —, %	0.4±0.07	0.4±0.07	0.3±0.00	0.3±0.00	0.3±0.00	0.3±0.00
Paired hide, kg	45.5±1.98	50.3±3.09	52.7±1.47	53.8±3.09	54.0±1.84	52.0±2.45
— // —, %	8.5±0.03	9.1±0.35	8.7±0.15	9.5±0.37	8.7±0.25	8.3±0.50
Tail, kg	1.3±0.18	1.3±0.20	1.2±0.29	1.3±0.30	1.5±0.14	1.0±0.04
— // —, %	0.2±0.04	0.2±0.04	0.2±0.05	0.2±0.07	0.3±0.02	0.2±0.00

<sup>38</sup> Kolisnyk O.I., Ugnivenko A.M., Antonyuk T.A., Prudnikov V.G. Meat productivity of cattle: Monograph. K.: TsP "Kompint". 2018. 429 p.

<sup>39</sup> Ugnivenko A. M. Signs of the slaughter of bulls of the Ukrainian meat breed with different expression of meat forms. Collection of scientific works of Bilotserkivskiyi NAU. 2015. No. 1 (116). Pp. 131-135.

Закінчення табл. 4.4

1	2	3	4	5	6	7
Spleen, kg	1.4±0.39	1.0±0.38	1.2±0.30	1.1±0.02	1.6±0.00	0.9±0.07
— // —, %	0.2±0.07	0.2±0.07	0.2±0.05	0.2±0.01	0.3±0.01	0.2±0.01
Trimblings, kg	5.9±0.60	5.3±0.45	5.5±0.71	4.4±1.3	5.5±0.64	4.6±0.07
— // —, %	1.0±0.06	0.9±0.09	0.9±0.16	0.8±0.10	1.1±0.09	0.9±0.04
Rennet stomach + tripe, kg	11.9±0.43	13.2±0.41	12.6±0.78	11.9±0.90	11.4±0.35	12.3±0.07
— // —, %	1.9±0.06	2.1±0.09	2.1±0.12	2.1±0.09	2.2±0.01	2.3±0.06
Tongue, kg	1.5±0.07	1.4±0.11	1.6±0.08	1.5±0.05	1.6±0.08	1.7±0.18
— // —, %	0.3±0.01	0.3±0.01	0.3±0.01	0.3±0.01	0.3±0.01	0.3±0.03

At 21 and 23 months of age, the animals with better meat forms have lower absolute and relative lung weights. Bull calves with rounded body shapes have an average of 13.0...24.3% more trim fat and muscle tissue from the carcass than peers with worse meat forms. Thus, bull calves with better meat forms show a tendency to increase net growth (up to 18 and 21 months of age), the carcasses yield (at 18 and 21 months of age), internal fat (at 21 and 23 months of age), cut of slaughter fat and meat from the carcass (at 18, 21 and 23 months of age) and feed costs for live weight gain after 8 months of age, reduction of head and lung weight in all age periods studied. Bull calves with more rounded body shapes have worse development of abomasum and rumen than their peers, who had worse meat forms.

The proportion of muscle tissue in carcasses of bull calves with better meat forms increases, in particular the highest grade and the bone content decreases, which is characteristic of early-maturing animals<sup>4041424344</sup>

<sup>40</sup> Ugnivenko A. M. Morphological composition of carcasses of the bull calves of Ukrainian meat breed with different expression of meat forms. Bulletin of Sumy NAU. 2015. Issue 6 (28). Pp. 157-160.

<sup>41</sup> Ugnivenko A.M. Morphological composition of anatomical parts of half-carcasses of the bull calves with different expression of meat forms. Scientific paper Sworid, 2015b. Vol. 11. Issue 3 (40). "Agriculture". Ivanovo: "Nauchnyi Mir" pp. 31-35.

<sup>42</sup> Ugnivenko A. M. Signs of the slaughter of bulls of the Ukrainian meat breed with different expression of meat forms. Collection of scientific works of Bilotserkivskyi NAU. 2015. No. 1 (116). Pp. 131-135.

<sup>43</sup> Kolisnyk O.I., Ugnivenko A.M., Antonyuk T.A., Prudnikov V.G. Meat productivity of cattle: Monograph. K.: TsP "Kompint". 2018. 429 p.

<sup>44</sup> Ugnivenko A.N. To the problem of using the evaluation of meat forms in the selection of meat cattle. Vestnik Brianskoi GSHA. Kokino, Ed. FG OU VPO "Briansk State Agricultural Academy". 2015. No. 3-1. P. 12-15.

(table 4.5). They also have more internal fat and fat in the carcass and a higher slaughter yield. Excess fat tissue is cut off during carcass stripping, which significantly reduces their advantage in carcass yield compared to bull calves, which have worse meat forms.

Table 4.5

**Morphological composition of bull calves carcasses with different expression of meat forms, M±m**

Tissue	Age of slaughter, months					
	18		21		23	
	Meat forms, points					
	57.8 (n=4)	51.8 (n=4)	58.0 (n=3)	54.2 (n=3)	56.7 (n=3)	53.5 (n=3)
Half-carcass weight, kg	167.4±6.29	164.5±4.01	188.3±4.71	180.0±9.57	189.7±16.07	198.7±5.40
Muscle, kg	127.4±6.19	124.1±5.49	142.5±5.96	135.3±8.48	142.1±13.98	146.8±2.21
Muscular, %	76.1±0.89	75.4±1.98	75.7±1.47	75.2±0.96	74.9±1.56	73.9±0.88
Including the highest grade, kg	25.4±2.14	22.2±2.40	40.1±5.53	32.2±1.07	44.2±11.64	39.2±9.37
--/--, %	19.9±2.62	17.9±2.38	28.1±2.52	23.8±1.23	31.1±5.51	26.7±4.07
first, kg	54.2±8.43	52.6±8.07	51.8±0.66	56.6±6.78	51.3±5.31	56.3±4.53
--/--, %	42.6±4.81	42.4±4.94	36.4±1.70	41.8±2.37	36.1±4.75	38.4±2.22
second, kg	47.8±3.00	49.3±2.66	50.6±1.37	46.5±1.73	46.6±10.82	51.3±5.95
--/--, %	37.5±2.80	39.7±2.97	35.5±0.90	34.4±1.68	32.8±8.02	34.9±3.89
Bone, kg	27.0±0.72	29.1±1.25	30.5±0.49	32.3±2.11	30.4±0.72	35.2±4.11
--/--, %	16.2±0.79	17.7±0.84	16.2±0.39	18.0±1.21	16.2±0.99	17.7±1.58
Connective, kg	5.6±0.78	6.2±0.94	9.3±1.31	7.1±1.04	7.7±0.68	8.8±1.16
--/--, %	3.3±0.63	3.8±0.65	4.9±0.73	3.9±0.78	4.1±0.27	4.4±0.47
Fat, kg	7.4±0.99	5.2±1.21	6.0±0.95	5.2±1.62	9.4±2.49	7.8±2.55
--/--, %	4.4±0.50	3.2±0.78	3.2±0.58	2.9±0.71	5.0±1.26	3.9±1.31
Muscle-bone ratio	4.7±0.29	4.3±0.29	4.7±0.21	4.2±0.34	4.7±0.34	4.2±0.41
Muscle tissue index	3.2±0.15	3.1±0.32	3.1±0.24	3.0±0.10	3.0±0.24	2.8±0.13
Meat content index	5.0±0.33	4.5±0.25	4.9±0.19	4.4±0.38	5.0±0.37	4.4±0.43

There is also an increase in the mass of muscle tissue, along with an increase in the total mass of half-carcasses in older bulls. In 23-month-old bull calves with better expressed meat forms compared with 18-month-old bull calves, its quantity increases by 1.12 times, and by 1.18 times in bull calves with worse expressed meat forms. Relative muscle mass is highest (76.1 and 75.4 %) in 18-month-old bull calves. By the age of 23 months, the percentage of muscle tissue in the carcass decreases by 1.2% and 1.5 %. In bull calves with better expressed meat forms, the yield of muscle tissue of the highest grade averages from 19.9 to 31.1%, and less than 2.0 to 4.4 points in bull calves with worse expressed meat forms. Its content tends to increase with age. In young animals at the age of 23 months, the yield of second-class muscle tissue is significantly reduced.

The proportion of bones in the half-carcasses of bull calves depends on the expression of their meat forms and ranges from 16.2 to 18.0 %. As they worsen, the bone content increases. Thus, the carcass in its components is an extremely variable feature. In animals with better meat forms, fat accumulation occurs with a lower mass than in cattle with worse meat forms, which contain more bones and less fat and muscle tissue in carcasses. Bull calves with worse meat forms retain muscle growth for a longer time than the deposition of fat in fat depots in large quantities will begin.

Bull calves that have better expression of meat forms are characterized by significantly better indices of muscle-to-bone ratio, meat content and muscle tissue. The values of these indices tend to increase with improving meat forms in animals. There are no significant features of changes in the muscle tissue index. In all age periods, it is slightly higher in animals with better meat forms. As meat forms in animals improve, there is a tendency to increase the muscle-to-bone ratio. In the postnatal period, their muscles grow relatively faster than their bones, and they have more muscle tissue relative to bone mass during the study periods.

Cattle with better meat forms of the exterior do not have significant advantages in the morphological composition of carcasses. Animals with better forms have more fat tissue in the carcass. They have an advantage in the yield of premium pulp, which is associated with higher fat content. Despite the difference in body structure, there is virtually no difference between groups of animals in terms of the percentage of muscle tissue.

In animals with better meat forms, there is a slight advantage in the ratio of muscle tissue to bones, connective tissue and fat. There is a perceptible difference in the distribution of fat in the carcass. Well-

muscled animals with a higher fat content in the carcass have a higher muscle content and less bone content.

Brännäng was one of the first to study the features of fat deposition in depots that are not part of the carcass<sup>45</sup>. The amount of fat tissue in the body of animals varies depending on their species<sup>46</sup>, breeds and pedigrees<sup>47 48</sup>, lines<sup>49</sup>, age<sup>50</sup>, gender<sup>51</sup>, feeding conditions<sup>52</sup>, and housing<sup>53 54</sup>. It should be noted that the problem of the growth of internal fat tissue, which has a low nutritional value in the body of animals with better and worse meat forms, is not sufficiently revealed. Usually,<sup>55</sup> fat

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<sup>45</sup> Brännäng, E. Studies on monozygous cattle twins. 18. The effect of castration and age of castration on the growth rate, feed conversion and carcass traits of Swedish Red and White cattle. *Lantbrukshögskolans Annaler*, 1966. 32. 329-415.

<sup>46</sup> Berg R.T., Butterfield R.M. *New Concepts of Cattle Growth*. Sydney University Press, Sydney, 1976. 240 p.

<sup>47</sup> Casas E., Thallman R. M., Kuehn L. A., Cundiff L. V. Postweaning growth and carcass traits in crossbred cattle from Hereford, Angus, Brangus, Beefmaster, Bonsmara, and Romosinuano maternal grandsires. *Journal of animal science*, 2010. 88(1). 102-108.

<sup>48</sup> Lavrynyuk O.A. Assessment of cattle meat productivity. Collection of scientific works of RUP scientific and practical center of the National Academy of Sciences for animal husbandry, Zhodino, 2013. S.

<sup>49</sup> Ilitskaia E.Yu. Formation of meat products of bulls of the Carpathian intra-breed type of the Ukrainian red-mottled dairy breed. Collection of scientific papers of RUP Scientific and practical center of the National Academy of Sciences of Belarus for animal husbandry, 2013. P. 92-93.

<sup>50</sup> Shevchenko N.I. Fat tissue of cattle at some stages of ontogenesis. Scientific foundations of beef production. Papers of the Beef Livestock Experimental Station of the Ukrainian Agricultural Academy, 1968. Vol. 11. P. 79-83.

<sup>51</sup> Levantine, D.L. Theory and practice of increasing meat productivity in cattle breeding. M: Kolos, 1966, 408 p.

<sup>52</sup> Svechin K.B., Shevchenko N.I. Fat deposits in the bodies of cattle depending on their age and feeding level. Collection of "Feed and feeding of agricultural animals". K: Urozhay, 1964. Issue 1.

<sup>53</sup> Belovodova A.K. Development and chemical composition of fat tissue of castrates kept at high and low levels of feeding. Scientific works of USHA. Issue 45. Intensification of beef production. Papers of the Beef Livestock Experimental Station of the Ukrainian Agricultural Academy, 1971. Vol. 111. P. 100-102.

<sup>54</sup> Mc Parland S., Kearney J.F., MacHugh D.E., Berry D.P. Inbreeding effect on post weaning production traits, conformation and calving performance in Irish beef cattle. *Journal of Animal Science*, 2008. 86. 3338-3347.

<sup>55</sup> Zhao G., Zhang T., Liu Y., Wang Z., Xu L., Zhu B., ... Xu L. Genome-wide assessment of runs of homozygosity in Chinese wagyu beef cattle. *Animals*, 2020. 10(8), 1425.

tissue under the skin, between the muscles and intramuscular fat tissue are studied. Recently, few data have been published on the distribution of fat by the fat depot in better and worse meat forms of cattle. This indicates gaps in our knowledge, as the amount and distribution of fat can significantly affect the mass of the carcass. The low cost of fat from various depots also does not encourage research in this direction. This kind of information would be useful to explain the differences in different levels of slaughter yield (carcasses). Features of fat tissue deposition in bull calves with better and worse meat forms should be known in order to effectively and purposefully produce beef with a higher yield of valuable components.

Features of fat tissue formation in bull calves of the Ukrainian meat breed, with different expressions of meat forms were studied<sup>56</sup>. It was found that the deposition of fat in different parts of the body of animals with different expressions of meat forms is uneven<sup>57 58</sup> (table 4.6). The amount of total fat from the carcass and internal fat varies significantly under the influence of the expression of meat forms. Absolute indices of their mass indicate that bull calves with better forms have more internal fat, and less in the carcass.

Animals with better meat form expression at 18 and 23 months of age have 36.8% and 3.8% more slaughter fat and 21.4% and 56% more intermuscular fat deposition respectively. Obesity of bull calves with better meat forms leads to an increase in feed consumption by 1 kilogram of growth (see table 3.2) because cattle spend about 2-2.5 times more nutrients on the formation of fat tissue than on muscle tissue. Unfortunately, the desired meat forms significantly affect the size of fat depots, that is, a factor that is increasingly incompatible with the high yield of marketable products, since consumers do not want to buy fat at the price set for beef.

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<sup>56</sup> Ugnivenko A. M. Distribution of bones in the anatomical parts of half-carcasses of bull calves, which have different expressions of meat forms. *Nauk. Vestnik NUBiP Ukrainy. Series: "Technology of production and processing of livestock products"*, 2016b. Issue 250. Pp. 200-204.

<sup>57</sup> Ugnivenko A.M., Petrenko S.M., Nosevych D.K., Tokar Yu.I. Scientific foundations of the development of meat cattle breeding in Ukraine. Monograph. K: Komprint, 2016, 330 p.

<sup>58</sup> Kolisnyk O.I., Ugnivenko A.M., Antonyuk T.A., Prudnikov V.G. Meat productivity of cattle: Monograph. K.: TsP "Kompint". 2018. 429 p.



Table 4.6

**The content of fat tissue in the fat depots of bull calves  
with different expression of meat forms<sup>59</sup>, M ± m**

Fat tissue	Age of slaughter, months					
	18		21		23	
Meat forms, points	57.8 (n=4)	51.8 (n=4)	58.0 (n=3)	54.2 (n=3)	56.7 (n=3)	53.5 (n=3)
Raw fat, kg Per 1 kg of live weight, g	18.7±1.09 34.9±2.30	18.5±2.45 34.0±5.68	20.8±3.96 34.5±6.88	19.4±1.80 31.0±2.93	30.3±8.95 73.3±14.16	24.9±6.20 40.0±10.01
Incl. from caul fat, kg -/-,% Per 1 kg of live weight, g	2.7±0.77 13.9±3.73 5.1±1.60	3.5±0.81 18.3±2.44 6.5±1.71	3.9±1.34 18.2±3.39 6.5±2.30	3.0±0.27 17.4±1.59 5.3±0.29	6.2±1.51 20.9±1.54 9.9±2.45	5.1±1.26 20.6±0.96 8.2±2.01
Pericardial, kg -/-,% Per 1 kg of live weight, g	0.8±0.20 4.6±1.35 1.5±0.36	1.0±0.19 6.1±1.75 1.9±0.28	0.9±0.09 4.3±0.82 1.4±0.19	1.1±0.18 6.2±1.51 1.9±0.35	1.3±0.41 4.1±0.21 2.0±0.64	0.5±0.25 2.6±1.75 0.8±0.39
Paranephritis, kg -/-,% Per 1 kg of live weight, g	2.4±0.60 12.8±2.87 4.6±1.24	2.6±0.94 13.0±3.22 4.8±1.93	3.4±0.88 16.0±1.19 5.6±1.50	2.7±0.57 15.0±2.20 4.7±0.90	5.7±2.46 17.4±4.24 9.3±4.18	4.8±2.09 18.0±3.64 7.6±3.33
From the intestines, kg -/-,% Per 1 kg of live weight, g	5.9±0.54 31.3±1.73 10.9±0.74	6.3±0.31 35.6±5.79 11.5±0.66	6.6±1.11 31.9±0.70 11.0±1.95	5.7±0.32 32.8±2.57 10.1±0.12	7.8±3.10 25.4±5.9 8.9±2.21	6.6±0.64 28.2±4.85 10.7±1.24
Subcutaneous, kg -/-,% Per 1 kg of live weight, g	5.2±0.99 28.3±5.92 9.6±1.50	3.8±0.91 20.2±4.64 6.9±1.66	4.4±0.72 21.3±1.54 7.3±1.29	3.3±0.54 18.5±1.80 5.2±0.99	5.5±1.14 19.9±5.27 8.9±2.21	5.3±1.75 20.8±2.85 8.6±2.85
Intermuscular, kg -/-,% Per 1 kg of live weight, g	1.7±0.60 9.2±3.3 3.2±1.21	1.4±0.58 6.8±2.17 2.6±1.19	1.7±0.32 8.2±1.69 2.8±0.60	2.0±1.19 5.3±7.4 3.3±1.91	3.9±1.56 12.2±2.16 5.8±4.88	2.5±0.87 9.8±1.07 4.0±1.38
The ratio of the proportion of subcutaneous fat to intermuscular fat	3.1	2.7	2.6	1.7	1.4	2.1

<sup>59</sup> Ugniyenko A.N. Distribution of fat tissue in the body of bull calves that have a different expression of meat. Scientific papers of Sworld, 2016. Vol. 6. Issue 2 (43). Ivanovo: Nauchnyi mir. P. 39-43.

Internal fat deposited early does not affect the expression of meat forms. In 18- and 21-month-old bull calves, their expression is more affected by subcutaneous fat, which is deposited late, and in 23-month-olds also by intermuscular fat. Differences in the percentage of fat in the carcass are mainly due to the different timing of the beginning of its accumulation, and not the rate of accumulation in this phase. The stronger the breed is selected at 18 and 21 months of age in terms of meat quality, the higher the deposition of subcutaneous and intermuscular fat. During the accounting age period from 18 to 23 months in bull calves with better meat forms, subcutaneous (slaughter fat) tissue increases by 3.8 % (table 4.7). The amount of fat tissue between the muscles increases by 56% during this period.

Table 4.7

**Advantages of fat distribution in the depot in bull calves with improved meat forms<sup>60 61</sup>, %**

Depot	Age, months		
	18	21	23
Total fat tissue	1.1	7.2	21.7
Internal fat	- 88.1	19.4	23.5
Including from forestomach	- 77.1	30.0	21.6
- //- pericardial	- 80.0	- 81.8	2.60
- //- from kidneys	- 92.3	25.9	18.8
- //- from intestines	- 93.7	15.8	18.2
In carcass, including under the skin	36.8	33.3	3.8
- //- intermuscular	21.4	17.6	56.0

Bull calves with better meat forms have a higher percentage of subcutaneous fat already at the age of 18 months. The more animals are

<sup>60</sup> Kolisnyk O.I., Ugnivenko A.M., Antonyuk T.A., Prudnikov V.G. Meat productivity of cattle: Monograph. K.: TsP "Kompint". 2018. 429 p.

<sup>61</sup> Ugnivenko A. M. Productivity of bull calves of Ukrainian meat breed with different expression of meat forms. Collection of scientific works of Vinnytsia Agrarian University. Series: "Agricultural Science and food technologies" 2016. Issue 2 (92). Pp. 174-177.

selected according to traditional meat forms, the higher their ratio of subcutaneous fat to intermuscular fat. Bull calves with better meat forms deposit more fat in the subcutaneous depot than bull calves with worse ones. Nutrient consumption for muscle and bone growth does not differ between the worse and better meat forms of bull calves. Individuals with worse meat forms retain muscle and bone growth longer than their peers. Since bull calves use nutrients for muscle and bone growth due to their worse meat forms, the beginning of fat deposition in them occurs later. Fat between muscles, like other fat deposits, is deposited last because of excess energy.

Analysis of the level of lipogenesis in the bodies of animals shows the advantage of representatives of better forms in terms of internal fat gain. 18-month-old bull calves have almost 6 times more fat tissue from the intestines per 1 kg of live weight than the pericardial one. A specific feature of young Ukrainian beef bulls with better meat forms is their ability to deposit fat mainly between the muscles, which provides beef with high taste, culinary and technological properties. In 23-month-old bull calves, there are 8.9 g of fat under the skin and 5.8 g of inter-muscular fat per 1 kg of live weight. A characteristic feature of the animals of this breed is the retarded growth of subcutaneous fat tissue in the carcass, which affects the exterior of animals.

Animals accumulate a large proportion (about 70%) of internal fat to reserve nutrients during intensive feeding and to use up during unfavorable periods. The desired exterior shapes of meat cattle depend on the size of fat depots, that is, on a factor that is incompatible with the high yield of marketable products. Consideration of the 'slope towards excessive waste' of different types of cattle is part of the animal evaluation system. The particular distribution of fat in the different parts of the fat depot can be a sign of selection, as animals of some dairy breeds achieve a desirable level of fat deposition between the muscles with little slaughter fat. Therefore, carcass stripping will result in the minimal loss while achieving the desired level of fat between and within the muscles.

The bull calves with better meat forms differ in beef chemical composition. They show a tendency to have lower dry matter content and lower fat content (Table 4.8).

An important feature that characterizes the quantitative and qualitative aspects of meat productivity of cattle is the ratio of individual anatomical parts in their carcasses. The lumbar and hip parts are the most valuable in terms of taste and nutrition among the anatomical parts. The highest

percentage (more than 32 %) of the weight of the half-carcass is the hip part (table 4.9).

Table 4.8

**Chemical composition of bull calves meat  
with different expression of meat forms,  $m \pm m$**

Meat forms at 15 months of age, points		Protein	Fat	Moisture	Ash
n	M±m				
3	53,8±0,66	20.83±0.53	0.37±0.17	76.94±0.42	1.12±0.04
3	47,8±0,68	20.26±0.7	0.65±0.19	77.22±0.13	1.04±0.02

Table 4.9

**Morphological composition of anatomical parts of carcasses  
of bull calves with various meat forms**

Carcass part and tissue	Slaughter age, months											
	21						23					
	Expression of meat forms, points											
	58,0±0,0 (n=3)			54,2±0,74 (n=3)			56,7±0,41 (n=3)			53,5±0,94 (n=3)		
	weight, kg	% by weight of a part	% by weight of a half carcass	weight, kg	% by weight of a part	% by weight of a half carcass	weight, kg	% by weight of a part	% by weight of a half carcass	weight, kg	% by weight of a part	% by weight of a half carcass
1	2	3	4	5	6	7	8	9	10	11	12	13
Pelvic-femoral	61.1±1.85	100.0	32.4	57.7±2.83	100.0	34.3	62.8±4.45	100.0	32.3	62.5±5.26	100.0	32.1
including muscle, fat, and connective tissue	51.0±1.64	83.5	27.0	47.5±3.19	82.2	28.2	52.8±3.89	84.0	27.1	51.3±1.45	82.8	26.4
Bones	10.1±0.32	16.5	5.4	10.2±0.90	17.8	6.1	10.0±0.67	16.0	5.1	11.2±1.49	17.2	5.8
Lumbar	14.7±1.52	100.0	7.8	12.3±1.37	100.0	7.3	12.0±2.03	100	6.2	13.4±0.66	100.0	6.9
including muscle, fat, and connective tissue	12.8±1.46	86.9	6.8	9.9±1.35	80.4	5.9	10.0±2.16	82.6	5.1	11.1±0.35	82.7	5.7
Lumbar bone	1.9±0.07	13.1	1.0	2.4±0.25	19.6	1.4	2.0±0.23	17.4	1.0	2.3±0.96	17.3	1.2
Dorsal	38.5±0.95	100.0	20.4	32.8±2.95	100.0	19.5	41.5±1.85	100.0	21.6	42.2±1.49	100.0	21.7
including muscle, fat, and connective tissue	30.4±0.63	79.0	16.1	23.9±3.19	72.4	14.2	33.5±2.29	80.4	17.2	30.9±3.37	73.0	15.9
Bones	8.1±1.07	21.0	4.3	8.9±0.52	27.6	5.9	8.0±0.68	19.4	4.1	11.3±1.98	28.0	5.8
Shoulder-scapular	31.9±1.46	100.0	16.9	27.9±1.81	100.0	16.6	34.8±2.03	100.0	17.9	35.7±1.44	100.0	18.4
incl. muscle, fat, and connective tissue	26.1±1.47	81.6	13.8	22.2±1.70	79.5	13.2	28.9±1.78	83.1	14.8	29.8±10.15	82.9	15.3

Закінчення табл. 4.9

1	2	3	4	5	6	7	8	9	10	11	12	13
Bones	5.9±0.08	18.4	3.1	5.7±0.25	20.5	3.4	5.9±0.25	16.9	3.0	5.9±0.54	17.1	3.0
Thoracic	14.4±0.99	100.0	7.6	11.3±1.42	100.0	6.7	12.4±0.56	100.0	6.4	13.0±1.39	100.0	6.7
incl. muscle, fat, and connective tissue	11.9±1.17	82.0	6.3	8.8±1.18	77.8	5.2	10.0±0.40	81.0	5.1	10.4±1.39	79.9	5.3
Bones	2.6±0.27	18.0	1.4	2.5±0.24	22.2	1.5	2.4±0.27	19.0	1.2	2.6±0.29	20.1	1.3
Neck	23.1±1.64	100.0	12.2	22.3±0.54	100.0	13.3	24.0±0.48	100.0	12.3	23.0±1.20	100.0	11.8
including muscle, fat, and connective tissue	21.1±1.67	91.3	11.2	19.7±0.04	88.4	11.7	21.8±2.90	90.8	11.2	20.1±1.49	87.1	10.3
Bones	2.0±0.25	8.7	1.1	2.6±0.55	11.6	1.5	2.2±0.31	9.2	1.1	2.9±0.88	12.8	1.5
Belly	4.9±0.0	100.0	2.6	3.9±0.64	100.0	2.3	7.2±2.39	100.0	3.7	4.7±0.98	100.0	2.4
Half-carcass	188.6±4.71	100.0		168.2±9.57	100.0		194.7±16.01			194.5±5.40	100.0	
including muscle, fat, and connective tissue	158.0±5.96	83.8		135.9±8.48	80.8		164.2±13.98	84.3		158.3±2.21	81.4	
Bones	30.6±0.49	16.2		32.3	19.2		30.5±0.72	15.7		36.2±4.11	18.6	
Meat content index (MCI)	5.2±0.19			4.2±0.38			5.4±0.37			4.4±0.49		

The difference in the ratio of pulp, bone and tendon yield in the anatomical parts of half-carcasses of young cattle is due to the peculiarities of the expression of meat forms. Animals of Ukrainian meat breed with better meat forms prevail at 21 months of age cattle with worse meat forms by traits of meat productivity, body proportions, development of muscle tissue in general and especially in the most valuable anatomical parts of the body, i.e. lumbar, back, shoulders and scapular. The accumulation of more fat and muscle in the same parts is characteristic of beef breed animals at 23 months of age, in bull calves with worse meat forms. They differ from each other both in the formation of meat productivity and in the quality of meat, and in the morphological composition of the anatomical parts of half-carcasses.

The neck part of bull calves at the age of 21 months is 12.2 % (with better meat forms) and 13.3 % (with worse meat forms) of the half-carcass mass. A 1.1-point lower bone yield in this part is observed in young animals with better meat forms. The bone yield of the animals with better meat forms is slightly lower.

The neck part of bull calves of the breed (91.3% pulp, 8.7% bones) has the best traits of morphological composition. The worse meat forms (88.4 and 11.7%, respectively).

The shoulder-scapular part is 18.4% of the weight of half-carcasses in animals at 23 months of age with a worse expression of meat forms, which

is 0.5 points more. The lumbar part at 21 months is from 7.8 (better meat forms) to 7.3 % (worse meat forms) of the half-carcass mass. The hip part of 21-month-old young meat breed is 32.4% of the half-carcass mass (better meat forms) and 34.3% (worse meat forms). The yield of pulp in it is in the range of 83.5 and 82.2 %. The yield of bones is in the range of 16.5-17.8 %.

With age, the morphological composition of the anatomical parts of the half-carcasses of meat bull calves changes. Thus, at the age of 23 months compared with 21 months of age, the mass of the cervical part in half-carcasses increases by 3.9 and 3.1 %. That is, it is 12.3 and 11.8 %. In bull calves with better meat forms, the yield of pulp in this part is 90.8, and the yield of bones is 9.2 %. In bull calves with worse meat forms, it is 87.1 and 12.8, respectively. High rates of pulp, fat and connective tissue yield in meat bull calves are observed in the lumbar and hip parts of the half-carcasses. At 21 months of age, the yield of pulp in the lumbar region ranges from 86.9 % (better forms) to 80.4 % (worse ones), and the yield of bone ranges from 13.1 to 13.6 %. Young animals with better meat forms are characterized by the highest yield of pulp in the hip part.

The rate of skeletal growth during the post-embryonic period in animals is lower than that of muscle, fat and live mass. From 21 to 23 months of age, the relative mass of the skeleton in relation to the mass of the carcass decreases from 0.5 points (better forms) to 0.6 points (worse forms). Bone tissue performs a musculoskeletal-trophic function and is important in the metabolism of minerals. The creation of conditions for proper bone formation requires special attention, as inadequate levels of feeding disturb mineral metabolism and inhibit the growth of bone tissue, especially the osseous skeleton. The bones of the chest and ribs in young animals grow faster, and therefore the growth of the peripheral skeleton is retarded less. Muscle tissue in young cattle grows most intensively at 12-18 months of age. After 18 months of age, the absolute and relative muscle gain decreases, and the relative mass of individual muscle groups also changes. The growth of the muscles of the back of the barrel is more intense than that of the front. After the age of 14 months, the muscles of the limbs and the axial skeleton grow more slowly.

The ratio of bones in certain anatomical parts of cattle carcasses is an important trait that characterizes its meat productivity. The bone content in anatomical parts of carcasses of Ukrainian beef cattle with different expressions of meat forms was established. The skeleton was studied after animals were slaughtered and all muscles, ligaments and tendons were removed. In bull calves, which have different expressions of meat forms,

the highest percentage of the mass of half-car casses is made up of hip bones (table 4.10).

Table 4.10

**Distribution of bones by anatomical parts  
of half-car casses of bull calves<sup>62 63</sup>**

Part of car casses, bones	Age of slaughter, months											
	21						23					
	Expression of meat forms, points											
	58,0 (n = 3)			54,2 (n = 3)			56,7 (n = 3)			53,5 (n = 3)		
	Weight, kg	% to part	% to half-car cass	Weight, kg	% to part	% to half-car cass	Weight, kg	% to part	% to half-car cass	Weight, kg	% to part	% to half-car cass
Coxal	10.2	16.5	5.4	10.2	17.8	6.1	10.0	16.0	5.1	11.2	17.2	5.8
including the pelvic bone	2.4	3.9	1.3	2.4	4.2	1.4	2.5	4.0	1.3	2.7	4.1	1.4
- //- femoral	3.0	5.0	1.6	3.0	5.3	1.8	2.9	4.6	1.5	3.4	5.3	1.7
- //- tibia	3.2	5.1	1.7	3.2	5.5	1.9	3.1	5.0	1.6	3.3	5.0	1.8
- //- sacral	1.6	2.5	0.8	1.6	2.8	1.0	1.5	2.4	0.7	1.8	2.8	0.9
Lumbar	1.9	13.1	1.0	2.4	19.6	1.4	2.0	17.4	1.0	2.3	17.3	1.2
Dorsal	8.1	21.0	4.3	8.9	27.6	5.9	8.0	19.4	4.1	11.3	27.0	5.8
Shoulder- scapular	5.9	18.4	3.1	5.7	20.5	3.4	5.9	16.9	3.0	5.9	17.1	3.0
including scapular	1.2	3.7	0.6	1.1	3.9	0.6	1.2	3.4	0.6	1.2	3.4	0.6
- //- humerus	2.4	7.5	1.3	2.3	8.3	1.4	2.4	6.8	1.2	2.5	7.2	1.3
- //- radius	2.3	7.2	1.2	2.3	8.3	1.4	2.3	6.7	1.2	2.2	6.5	1.1
Thoracic	2.6	18.0	1.4	2.5	22.2	1.5	2.4	19.0	1.2	2.6	20.1	1.3
Neck	2.0	8.7	1.1	2.6	11.6	1.5	2.2	9.2	1.1	2.9	12.8	1.5
Total	30.6	—	16.2	32.3	—	19.2	30.5	—	15.7	36.2	—	18.6

<sup>62</sup> Ugniyenko A.N. Growth of bones of the axial and peripheral skeleton in bull calves with different expression of meat forms. Scientific papers of Sward, 2016. Vol. 6. Issue 2 (43). Ivanovo: Nauchnyi mir. P. 17-21.

<sup>63</sup> Kolisnyk O.I., Ugniyenko A.M., Antonyuk T.A., Prudnikov V.G. Meat productivity of cattle: Monograph. K.: TsP "Kompint". 2018. 429 p.

Bone yield in parts ranges from 8.7 and 12.8 % (cervical) to 21.0 and 27.6 % (dorsal). It is lower in bull calves with better meat forms by 2.9, 2.3, 5.6 and 7.6%, respectively. At the age of 21-23 months, young animals with better meat forms have a higher bone content in the dorsal and hip parts than their peers with worse meat forms. In the dorsal part, the advantage is 1.7 points; 0.8 and 0.7 points in the hip part, respectively. The relative mass of the skeleton to the mass of half-carcasses of bull calves with worse meat forms is higher. This is a consequence of the worse meat qualities of animals in this group. The skeletal content decreases with age.

The expression of meat forms of animals has an effect on the ratio of muscle, fat and connective tissues to bones in the anatomical parts of the half-carcasses. In 23-month-old bull calves, the meat content index is lower than in 21-month-old cattle (table 4.11). In animals with better meat forms, it is higher by 23.8 and 22.7% compared to peers with worse meat forms. There is a significant difference in bone mass in different parts of the body between bull calves with better and worse meat forms.

Table 4.11

**Distribution of bones by carcass parts in bull calves according to different expression of meat forms, % of carcass weight<sup>64 65</sup>**

Tissue	Age of slaughter, months											
	21						23					
	front		rear		medium		front		rear		medium	
	Expression of meat forms, points											
	58.0	54.2	58.0	54.2	58.0	54.2	58.0	54.2	58.0	54.2	58.0	54.2
Bones	5.6	6.1	5.4	6.1	5.3	6.7	5.39	5.86	5.14	5.76	5.14	6.99
Meat content index	6.57	5.6	6.35	4.93	4.81	2.99	5.77	5.29	5.27	4.58	5.06	3.43

The reduction of bone content in the front and back of carcasses is less in cattle with better meat forms compared to their peers with less developed meat forms. The meat content index in the middle part of

<sup>64</sup> Ugniyenko A.N. Growth of bones of the axial and peripheral skeleton in bull calves with different expression of meat forms. Scientific papers of Sworld, 2016. Vol. 6. Issue 2 (43). Ivanovo: Nauchnyi mir. P. 17-21.

<sup>65</sup> Kolisnyk O.I., Ugniyenko A.M., Antonyuk T.A., Prudnikov V.G. Meat productivity of cattle: Monograph. K.: TsP "Kompint". 2018. 429 p.



carcasses in animals with worse meat forms is lower. They also have more bones in the backbone area, which affects quality to a certain extent. In cattle with better meat forms, the period of intensive skeletal growth is shorter. In animals with worse meat forms, this feature is not observed. The relative content of bones up to 23 months of age decreases in all groups, and naturally, the greatest mass of them is found in bull calves with worse meat forms. The relative mass of the bones of the anterior and posterior parts of the half-carcasses to the skeleton in bull calves is almost the same. The relative mass of the skeleton of the anterior part decreases by 3.5 and 4.1 %, and the posterior part by 5.1 and 5.2%. In absolute terms, the greatest increase is in the thoracic parts and the smallest in the lumbar part.

Bull calves of Ukrainian meat breed with different expression of meat forms have the highest bone content in the dorsal and hip parts of carcasses. Animals with better expressed meat forms have a lower absolute and relative weight of bones. In peers with worse meat forms, meat in the lower back contains more bones, which to a certain extent affects its quality. The relative mass of the animal skeleton decreases with age. Because of the different growth rates of the axial and peripheral skeletons in postembryogenesis of animals, the ratio between these parts changes significantly. In bull calves, which have different expressions of meat forms, the highest percentage of the mass of half-carcasses is made up of hip bones. Young animals with better meat forms have a higher bone content, especially in the dorsal and hip parts, than peers with worse meat forms (table 4.12). In the dorsal part, the advantage is 1.7 points, in the hip is 0.8 and 0.7 points, respectively.

There is a large difference in bone mass in different parts of the body. Cattle with better meat forms have less bone content in the front and rear parts of the carcasses compared to peers with worse meat forms. The thoracic vertebrae and ribs have the largest proportion in the animals with worse meat forms. In the latter, meat in this part of the skeleton contains more bones, which to a certain extent affects its quality.

Table 4.12

**Mass of axial and peripheral skeleton bones of bull calves<sup>66 67</sup>**

Bones of parts of the skeleton	Age of slaughter, months									
	21					23				
	Expression of meat forms, points									
	58,0 (n = 3)		54,2 (n = 3)		56,7 (n = 3)			53,5 (n = 3)		
	weight, kg	% to the skeleton	weight, kg	% to the skeleton	weight, kg	± up to 21 months, %	% to the skeleton	weight, kg	± up to 21 months, %	% to the skeleton
Peripheral										
Pelvic	2.4	7.8	2.4	7.4	2.5	4.2	8.2	2.7	12.5	7.5
Femoral	3.0	9.8	3.0	9.3	2.9	-3.3	9.5	3.4	13.3	9.4
Tibia	3.2	10.4	3.2	9.9	3.1	-3.1	10.2	3.3	3.1	9.1
Scapular	1.2	3.9	1.1	3.4	1.2	0.0	3.9	1.2	9.1	3.3
Shoulder	2.4	7.8	2.3	7.1	2.4	0.0	7.9	2.5	8.7	6.9
Radius	2.3	7.5	2.3	7.1	2.3	0.0	7.5	2.2	-4.3	6.1
Total in part	14.5	47.2	14.3	44.2	14.4	-0.7	47.2	15.3	7.0	42.3
Spine (without head)										
Sacral	1.6	5.2	1.6	5.0	1.5	-0.4	4.9	1.8	12.5	5.0
Lumbar vertebrae	1.9	6.2	2.4	7.4	2.0	5.3	6.6	2.3	-4.2	6.3
Thoracic vertebrae and ribs	8.1	26.4	8.9	27.6	8.0	-1.2	26.2	11.3	27.0	31.2
Sternum	2.6	8.5	2.5	7.7	2.4	-7.7	7.9	2.6	4.0	7.2
Cervical vertebrae	2.0	6.5	2.6	8.1	2.2	10.0	7.2	2.9	11.5	8.0
Total in part	16.2	52.8	18.0	55.8	16.1	-0.6	52.8	20.9	16.0	57.7
Total skeletal bones	30.7	100.0	32.3	100.0	30.5	-	100.0	36.2	-	100.0

<sup>66</sup> Ugniyenko A.N. Growth of bones of the axial and peripheral skeleton in bull calves with different expression of meat forms. Scientific papers of Sworld, 2016. Vol. 6. Issue 2 (43). Ivanovo: Nauchnyi mir. P. 17-21.

<sup>67</sup> Kolisnyk O.I., Ugniyenko A.M., Antonyuk T.A., Prudnikov V.G. Meat productivity of cattle: Monograph. K.: TsP "Kompint". 2018. 429 p.

Animals with better meat forms have the lowest bone mass. This is a consequence of the higher meat quality of these bull calves, i.e. the increase of muscle tissue during their growth is more active. The relative mass of the peripheral and spinal skeleton of the animals with better meat forms in 23-month-old bull calves decreases. Because of different growth rates of the spinal and peripheral skeletons in postembryogenesis of animals, the ratio between these parts changes significantly. At 21 and 23 months of age, the difference in favour of the outer skeleton in animals with better meat forms is 5.6%. For worse forms, this difference is 11.6 and 15.4%.

This is due to the predominance of the growth of the outer skeleton in cattle over the peripheral one in the postnatal period of ontogenesis. The bones of the pelvic limbs increase mass faster than the thoracic ones. There is a difference in the growth of the outer and peripheral parts of the skeleton. Bull calves with better meat forms under the same conditions show a greater early maturity of skeletal growth. The relative growth of the axial and peripheral parts in them stops earlier than in animals with worse forms. Therefore, it should be assumed that with a high level of feeding of bull calves of Ukrainian meat breed, the period of increased skeletal growth is shorter in animals with better meat forms. In worse forms, this feature is not observed.

The relative mass of spinal and thoracic bones increases by 23 months of age in animals with worse development of meat forms, and naturally, their mass decreases in bull calves with better forms. The relative mass of pelvic limb bones to the entire skeleton in bull calves is almost the same. In general, the relative mass of the peripheral skeleton decreases by about 0.7%, the outer skeleton by 0.6% in animals with better meat forms. In absolute terms, the thoracic vertebrae and ribs have the greatest growth, while the radius and lumbar vertebrae have the least. In cattle with worse meat forms, the period of increased skeletal growth is longer. The growth of the outer and peripheral parts of the skeleton occurs at a later age. Within the peripheral skeleton in the same age period of animals, the bones of the forelimbs and hind limbs grow at different rates.

In bull calves with lower meat form grades at 23 months of age, the relative skeletal mass of the thoracic limbs increases less and that of the pelvic limbs more. Bull calves have the largest parts of the spine (thoracic, lumbar and sacral) that determine the meat quality of the animals. Bull calves of Ukrainian beef breed with worse expressed meat forms have more bones in relation to parts of carcasses (dorsal, hips). Animals with

better expressed meat forms have lower absolute and relative weight of bones.

### **5. Reproductive ability of bull calves with different expression of meat forms**

If the functional efficiency of organisms of animals is to be maintained during evolution, then it is necessary to change their forms with the knowledge of the effect they have on the function of the organism. For the development of beef cattle breeding, it is necessary to evaluate the exterior in relation to the traits during conception, pregnancy, birth, calf feeding in the suckling period and subsequently in all periods of young-stock breeding.

The economics of beef production, in addition to the rapid growth of animals associated with the efficiency of feed use and the tendency to obesity at a later age, requires a high reproductive capacity of bull calves. Whether there is a negative relationship between excessively large animals and their adaptability, fecundity and survival remain an open question. The selection of cattle for muscular development leads to problems in numerous functional traits.

Bulls are evaluated according to the characteristics of reproduction, which are divided into<sup>68</sup> indirect (anatomical structure of the genitals, testicular size, scrotum circumference, age of puberty, expression of sexual dimorphism) and direct (sexual activity, sperm productivity, fertilizing ability of sperm). The physiological maturity of bulls lasts from 2 to 5 years of age<sup>69</sup>. In addition to the desired origin, exterior and constitution, the sire must show high sexual activity and produce high-quality sperm. During natural mating or receiving sperm on an artificial vagina, sires exhibit five basic sexual unconditional reflexes: attraction, hugging, erection, mating, and ejaculation. Bull calves show sexual desire and hugging reflex not only on a female, but also on a dummy cow, which ensures the receipt of sperm in the artificial vagina. Not all sires quickly mount a dummy cow, which is due to conditioned reflexes. Mass, physical and morphological aspects of sperm<sup>70</sup> do not affect on the sexual

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<sup>68</sup> Savchuk D.I. The technology of breeding bulls. K: Urozhay, 1985, 216 p.

<sup>69</sup> Naumenko V.V., Dyachinsky A.S., Demchenko V.Yu., Derevianko I.D. Physiology of farm animals: textbook. K: Center for educational literature, 2009. 568 p.

<sup>70</sup> De Oliveira, C.B., Guimaraes, J. D., da Costa, E.P., Sisueira, J.B., Torres, C.A.A., de Carvalho, G. R.,Guimaraes, S. E. F. Avali acao do comportamento sexual

behaviour of the sires. It depends on the parameters of the testes, which are determined by measuring and calculating the volume of the scrotum<sup>71</sup>.

The sexual behaviour of bull calves during natural mating does not always coincide with the manifestation of libido in the arena. It can be affected by the dominance of other sires and stress, which worsens the results. Bulls that show a strong libido provide a higher level of pregnancy and sperm volume compared to low and medium manifestations. It is important to identify bulls with low activity of sexual behaviour in the arena when taking sperm into an artificial vagina.

In bull calves, sexual behaviour was studied when taking sperm on an artificial vagina and traits of reproductive ability. To test the libido of bull calves in the arena, a dummy cow was used. They were tested individually and classified into three main degrees of sexual activity (active, calm, and moderate). Active – a high degree of sexual activity was characterized by a short duration (10 to 60 s) of all sexual reflexes before mounting. Moderate – a degree of manifestation of sexual activity was characterized by a slightly longer course of reflexes before mounting. It lasted from 60 to 120 seconds. Calm – a relatively low degree of sexual activity, during which the time from bringing the animal to a dummy cow and attempts to mount lasted more than 120 seconds.

After taking sperm on an artificial vagina, the volume of ejaculate and the concentration and motility of sperm were evaluated. Thereafter, the duration of the productive use period, the number of bringing to a dummy cow and attempts to mount it and the number of obtained and culled ejaculates were recorded. The reproductive capacity of bull calves was determined and evaluated (both their own and their offspring, i.e. cows and heifers). The criteria for evaluating the bull's own reproductive ability included its behaviour during mating and the perception of the artificial vagina. The criterion for determining the quality of bull sperm was determining its volume, density and straight-line reciprocal movement of spermatozoa after cryopreserved sperm thawing.

Sperm quality is a summary trait including ejaculate volume, concentration and motility of spermatozoon in fresh sperm, proportion of live spermatozoon, and survival rate after thawing. Sperm quality was

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em touros Nelare: compare acao entre os testes da libido em currale do comportamento sexual a compo. *Revisita Brasileira Zootecnica*, 2007. Vol. 36. No.1. P. 32-42.

<sup>71</sup> Hyppolito M., Zorzetto M. F., da Silva E. R., Tironi S.M. T., Souza A.G., Cjdognoto V.M., Vieira A. F., Salgado L. C., Marques N.F.S., Oba T. Testicular Parameters and its influence in Buffaloes (*Bubalus buballis*) Sexual Behaviour. *Acta Scientiae Veterinariae*, 2019. Vol. 47. P. 7.

determined by counting the total number of spermatozoon with rectilinear motion in 1 ml of fresh sperm, motility, survival rate and a number of spermatozoa in thawed sperm under a microscope and in a Goriaev chamber in each ejaculate of boogeyman sperm. The undiluted fresh sperm was evaluated by the concentration of spermatozoa in 1 cm<sup>3</sup>. It could be thick (more than 1 billion spermatozoa), medium (0.6 to 1 billion spermatozoa) and liquid (less than 0.6 billion spermatozoa). Liquid sperm was not allowed for use. Sperm motility was evaluated on a 10-point scale. A score of 10 means that all spermatozoa have rectilinear movement. Minimum quality requirements for thawed sperm after deep freezing: sperm motility is 3 points (35% live), sperm survival is 5 points. Sperm quality was evaluated at 12 months of age. Each ejaculate was evaluated by sperm volume and colour. It was examined under the microscope for other indicators.

Fertilizing sperm capacity (%) was calculated by dividing the number of heifers or cows fertilized after the first insemination by the number of inseminated females. Post-natal litter mortality was determined by the ratio (%) of the number of dead calves in the suckling period to the total number of births. The data were processed using variation statistics. We determined the mean values of the groups, the statistical error of the mean, and the difference between the means and their probability. The coefficient of variability (Cv, %) was calculated as the ratio of the mean square deviation to the group mean.

Sexual activity of bull calves does not depend much on the expression of meat forms (Table 5.1).

The share of high sexual activity tends to increase by 3.9 points in bull calves with worse meat forms compared to peers with better meat forms. This is because compact forms are characteristic of early-maturing animals. That is, they reach physiological maturity at an earlier age, which to a certain extent negatively affects sexual activity. Bulls with better meat forms receive a worse score for sexual activity (8.4% "active"), which is probably due to the high content of fat tissue in their bodies. This affects the fact that the share of active manifestations of sexual reflexes that show libido in bull calves with better meat forms is 4.1% less. The results prove that better meat forms slightly reduce the sexual activity of bulls. It was also found that the distribution of bulls with a moderate and calm manifestation of sexual reflexes tends to increase with better development of meaty forms. The largest share is moderate sexual activity. Specific trends are observed within groups. The time of manifestation of high

sexual activity ("active") is less by 17.1% in animals with better meat forms.

Table 5.1

**Sexual activity of bull calves  
with different expression of meat forms<sup>72 73</sup>**

Indicator	n	Degree of sexual activity		
		active	moderate	calm
Better expression of meat forms				
Share of bulls, %	20	8.4±0.2	71.4±2.1	20.2±1.0
Average duration of reflexes, sec.	20	36.9	77.7	89.1
Worse expression of meat forms				
Share of bulls, %	20	12.3±0.4	69.7±1.9	18.0±0.9
Average duration of reflexes, sec.	20	43.2	67.6	114.4

Bulls with better meat forms tend (by 9.1%) to increase the duration of productive use (table 5.2). This is partly due to their higher evaluation rates based on meat productivity.

Bull calves with better meat forms tend to increase the number of bringing to a dummy cow and mounts on the artificial vagina. They have a longer duration of productive use.

According to the share of mountings from the total number of bringing, bull calves with worse meat forms predominate, and no significant difference was observed in the percentage of rejected ejaculates. Thus, there are no grounds for limiting the use of bulls with good muscle and subcutaneous tissue development due to the deterioration of traits of their reproductive ability. Compact bulls, which are associated with a tendency to early maturity, have a slightly lower age of first sperm collection.

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<sup>72</sup> Ugnivenko A.M., Koropets L.A. Sexual activity of bull calves of meat breeds and features of their use with different expression of meat forms. Materials of Intern. Scientific and practical conference "Scientific and technological challenges of animal husbandry in the XXI century", March 12-14, 2020. P. 56-58.

<sup>73</sup> Ugnivenko A.M., Koropets L.A. Influence of the body structure and expression of meat forms of bull calves on their sexual activity. Animal Science and Food Technology. 2021. Vol. 12. No. 1. P. 56-61.

Table 5.2

**Use of bulls with different expressions of meat forms** <sup>74 75</sup>

Genotype by pedigree	Expression of meat forms			
	better		worse	
	n	M±m	n	M±m
Age of first sperm collection, days	20	616±59.2	20	654±88.2
Number of bringing to an artificial vagina, times	20	164±21.3	20	125±15.6*
Number of mounting, times	20	135±19.2	20	99±14.7*
Lack of sperm, %	20	8.11±2.4	20	9.29±3.2
Age of life, days	20	1165	20	1068
Duration of the productive period, days	20	550±72.6	20	416±47.0

Note:\* P>0.95

Animals with better meat forms have worse sperm productivity indicators. They show a tendency to reduce the volume of ejaculate, motility and concentration of spermatozoa (table 5.3).

Table 5.3

**Sperm productivity of bull calves with different expression of meat forms**<sup>76</sup>, M ± m

Meat forms in 15 months of age, points		Ejaculate volume, cm <sup>3</sup>	Sperm motility, points	Sperm concentration, billion/cm <sup>3</sup>
n	M±m			
14	53.8±0.66	4.54 ±0.28	7.16±0.25	1.21±0.07
11	47.8±0.68	4.56 ±0.24	7.38±0.18	1.27±0.09

<sup>74</sup> Ugnivenko A.M., Koropets L.A. Sexual activity of bull calves of meat breeds and features of their use with different expression of meat forms. Materials of Intern. Scientific and practical conference "Scientific and technological challenges of animal husbandry in the XXI century", March 12-14, 2020. P. 56-58.

<sup>75</sup> Ugnivenko A.M., Koropets L.A. Influence of the body structure and expression of meat forms of bull calves on their sexual activity. Animal Science and Food Technology. 2021. Vol. 12. No. 1. P. 56-61.

<sup>76</sup> Ugniyenko A.N. Reproducibility of bulls with different expressions of meat forms. Current problems of intensive development of animal husbandry. Collection of scientific papers of Belarusian Agricultural Academy. Gorki, 2017. Issue 20. Part 2. Pp. 144-150.



Bull calves with better developed meat forms are inferior in testes mass to those with worse meat forms between 18- and 23 months of age (Table 5.4).

Table 5.4

**Mass of testes of bull calves  
with different expression of meat forms, g<sup>77</sup>**

Age, months	Expression of meat forms					
	Better			Worse		
	n	points	M±m	n	points	M±m
18	4	57.8	538±116.7	4	51.8	595±77.8
21	3	58.0	677±72.6	3	54.2	678±52.5
23	3	56.7	503±17.4	3	53.2	620±36.7

Sires with worse meat forms have better fertilizing ability of sperm from the first insemination (table 5.5).

Table 5.5

**Fertilizing ability of bull sperm from the first insemination  
with different expression of meat forms<sup>78</sup>**

Number of bull calves in a group	Expression of meat forms, points	Number of inseminated cows, heads	Number of fertilized cows after the 1st insemination, heads	Fertilized, %
3	55.3	1033	453	43.9
4	49.5	881	407	46.2

On average, it is 46.2% for this group, which is 2.3 points higher than for peers with better meat forms. This is due to a lower concentration of sperm and worse mobility in bulls, which have better meat forms.

The use of sires with better meat forms contributes to a tendency to worsen the safety of their offspring before weaning by 5.2 points (table 5.6).

<sup>77</sup> Ugnivenko A.M., Koropets L.A., Demchuk S.Yu. Scientific bases of livestock reproduction. Monograph. K: CP Komprint., 2017, 400 p.

<sup>78</sup> Ugnivenko A.M. Results of using the expression of meat forms in the selection of meat bull calves. Scientific works of Sworld, 2015. Vol. 17. Issue 2 (39). P. 38-42.

Table 5.6

**Mortality of calves from bull calves with different expression of meat forms in the suckling period<sup>79</sup>**

Number of fathers in the group, heads	Expression of meat forms in fathers, points	Total calves, heads	Surviving calves before weaning, heads	Mortality of calves during the suckling period, %
5	49.6	702	556	20.8
4	54.4	816	588	27.9

This is because cows that were inseminated with sperm of sires with better meat forms have more difficult calving. This affects the mortality of their calves during the suckling period<sup>80</sup>.

### 6. Analysis and generalization of research results

In the complex of measures to improve the breeding value of bulls of meat breeds, the accent is placed on the selection of animals according to the desired expression of meat forms, which most corresponds to the direction of livestock productivity. We studied traits of slaughter of Ukrainian meat breed bull calves depending on the expression of their meat forms. It was found that animals with better meat forms tend to increase the yield of carcasses (at 18 and 21 months of age), internal fat (at 21 and 23 months of age), net growth (at 18 and 21 months of age), cuts of meat from the carcass (at 18, 21 and 23 months of age), feed costs for live weight gain (from 8 to 18, 21 and 23 months of age) and a decrease in head and lung weight during the studied age periods. These traits are characteristic of relatively more early-maturing cattle, which have a number of features: poor skeletal development and a tendency to excessive fat accumulation. We considered the features of the reproductive ability of bull cattle, depending on the expression of their meat forms. It was found that sires with a better expression of meat forms have less fertilizing ability of sperm and the safety of their offspring before weaning. A negative

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<sup>79</sup> Ugnivenko A.M., Koropets L.A. Reproductive ability of bull calves with different types of body structure and expression of meat forms. *Animal Science and Food Technology*. 2019 Vol. 10. No.3. P. 27-34.

<sup>80</sup> Ugnivenko A.M., Bondarenko G.P. Factors that affect the nature of calving of females of meat breeds and methods for dystocia reduction. *Collection of scientific works of Sworld*. Odessa, 2013. Vol. 37 Selskoe hoziastvo. P. 49-55.

correlation between the expression of meat forms of bull calves at the age of 15 months and live weight and sperm production indices ( $r =$  from  $-0,02$  to  $-0,12$ ) is also the reason for unsuitable use of subjective evaluation of meat forms on a 60-point scale in the selection of beef cattle.

The best sperm production in bull calves with a worse expression of meat forms can be explained by the fact that they can be classified by Durst<sup>81</sup> as respiratory (leptosomal) type of constitution, and with better expression as digestive (aurisomal) type. The basis for dividing bull calves into two constitutional types by body shape is the ratio of growth and differentiation processes in their bodies. Animals belonging to the leptosomal type are characterized by higher lung weight, higher metabolism, lower body fat deposition, higher growth rate and a reduced differentiation process compared to aurisomal type cattle. Animals of digestive type are characterized by an increased tendency to become fat quickly. This is a result of their bodies having a smaller lung mass and not being able to oxidize nutrient residues in a timely manner. In addition to greater subcutaneous fat in these animals, there is also more fat in the scrotum, which results in higher temperatures and lower sperm production traits.

This raises the question of the benefit of using animals with better meat forms for breeding. At the same time as improving the meat forms, their early-maturity increases and their fecundity decreases. When evaluating and selecting bull calves based on their own productivity, it makes no sense to consider the expression of meat forms on a 60-point scale because there is no reliable basis for this.

Cattle with high yields of cuts are better muscled and have thinner slaughter fat on their carcasses. Overfed cattle are poorly muscled and have a lower yield of desired cuts. Animals that differ in meat forms are almost identical in distribution of muscles in carcasses. It is considered<sup>82</sup> that the yield of wholesale cuts depends mainly on the distribution of fat. In animals with better expressed meat forms, the carcasses have a higher proportion of traits characteristic of more early-maturing animals (muscle tissue, including the highest grade) and bone content decreases. In animals with better meat forms, fat accumulation occurs with lower body weight than in cattle with worse meat forms. Indices of muscle-bone ratio and meat content with meat form improvement tend to increase.

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<sup>81</sup> Durst W. Basics of cattle breeding. M: Selkhozgiz, 1936, 445 p.

<sup>82</sup> Luitingh, H. C. Developmental changes in beef steers as influenced by fattening, age and type of ration. The Journal of Agricultural Science, 1962. 58(1). 1-47.

The selection of cattle for masculinization, on the other hand, leads to reproductive problems. As the expression of meat forms increases in animals with better meat forms, their resistance to unfavorable living conditions often decreases. As a result, the susceptibility to disease and the demanding nature of housing and feeding conditions increases; fertility and longevity decrease.

In animals with a better expression of meat forms, early maturity simultaneously increases. By giving preference to those that have a better expression of meat forms during testing, they contribute to an increase in the early maturity of cattle, which leads to a decrease in their reproductive ability. Selection of breeding animals by the results of their own productivity without taking into account the type of exterior does not always provide the increase of live weight of adult individuals<sup>83</sup>. Due to the subjectivity of the evaluation of meat forms on a 60-point scale during bull calves selection, it should not be given dominant importance. More attention should be paid to the values of measurements of height in the sacrum and oblique barrel length that are characteristic of large-sized sires, which positively affect the reproductive ability of animals.

For effective production of marketable and pedigree products, bull calves with worse meat forms are more suitable, which show early maturity of growth rate, which are characterized by increased metabolism and lower ability to deposit fat in the body. In meat cattle breeding, there are two types of early maturity, i.e. growth rate and formation rate<sup>84</sup>. The rate of formation determines the qualitative evaluation of carcasses, and the quantitative evaluation determines the rate of growth and its duration (tall stature). In meat animals, early maturity has negative consequences: they are prone to excessive fat deposition at an early age. At the same time, due to the early ossification of cartilage in early-maturing animals, the carcass has a lower bone content.

Cattle selection aimed at early maturity affects the ability to produce "marbled" meat, high slaughter yield, a tendency to deposit fat at a young age and better grades of meat with a small proportion of bones lead to rapid obesity and an increase in feed costs for growth. With a long-term

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<sup>83</sup> Ugnivenko A.M. Selection methods of creating and improving Ukrainian meat breed: thesis abstract of the dissertation of Doctor of Agricultural Sciences: 06.02.01. NAU. Kyiv, 1999, 38 p.

<sup>84</sup> Kravchenko N. A., Pogrebniak P.L. To justify the creation of a desirable type of meat cattle for intensive meat cattle breeding. Theory and practice of using imported cattle of meat breeds. Collection of scientific papers Experimental station of meat cattle breeding USKHA, 1974. Issue 4. P. 14-24.

selection, animals become stunted and dwarfed. Thus, the question arises about the usefulness of raising early-maturing animals for breeding use.

The breeding of cattle prone to low fat accumulation changes the understanding of the "meat animal". Breeders' efforts to breed meat-type animals are now rejected by much of the specialist community. They tend to produce cattle that are poorly selected by meatiness. The selection of animals by meat forms in recent years as it has been carried out under the influence of exhibitions, combined with a concentrated type of feeding, has done great harm to the beef cattle breeding industry. It is expressed in a deterioration of the reproductive capacity of the animals and an increase in the number of difficult calving. There is no limit to changes in the expression of meat forms. If farmers want to preserve functionally efficient animals, then changes in meat forms should take into account the impact they will have on body functions. Selection for the expression of meat forms leads to problems with its reproduction. Since tall stature, as opposed to early maturing, does not lead to serious defects, this has contributed to betting on it<sup>85</sup> even though the early maturing rate has been reduced somewhat. Preference should be given to sires that have meat forms, which are less than the group average, and a moderate and stable growth rate between 8 and 23 months of age, as they are characterized by a higher reproductive capacity during the evaluation of their productivity. This type of cattle has a long, high-legged body and a large final live mass. Its representatives retain high growth rates for a long time and reach the maximum live weight later than animals of the early-maturing type.

The breeding value of bull calves in terms of meat productivity affects the duration of life use. The selection of animals based on body shape will be more effective if it is focused on traits such as ease of calving in height-selected cattle.<sup>86</sup> The use of animals with better development of meat forms has a number of advantages, but also disadvantages, which are reflected in the functionally related deterioration of individual characteristics of productivity, so it is important to find an optimal balance between them.

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<sup>85</sup> Kravchenko N. A., Pogrebniak P.L. To justify the creation of a desirable type of meat cattle for intensive meat cattle breeding. Theory and practice of using imported cattle of meat breeds. Collection of scientific papers Experimental station of meat cattle breeding USKHA, 1974. Issue 4. P. 14-24.

<sup>86</sup> Berg R.T., Butterfield R.M. New Concepts of Cattle Growth. Sydney University Press, Sydney, 1976. 240 p.

## CONCLUSIONS

1. Bull calves with better meat forms tend to increase their net weight gain (up to 18 and 21 months of age), the yield of carcasses (at 18 and 21 months of age), internal fat (at 21 and 23 months of age), cut of slaughter fat and meat from the carcass (at 18, 21 and 23 months of age), feed costs for live weight gain (from 8 to 18, 21 and 23 months of age), there is a tendency to reduce the weight of a head, lungs and bones, which is typical for early-maturing meat cattle.

2. The negative correlation of the expression of meat forms of bull calves at 15 months of age with live weight and sperm productivity indicators ( $r$  from -0.02 to -0.12) is evidence of the inexpediency of using a subjective evaluation of meat forms on a 60-point scale in the selection of meat cattle.

3. The animals with better meat forms at 18, 21 and 23 months of age have 42.3%, 15.4 and 20.5% more slaughter fat and intermuscular fat deposition, and the yield of muscle tissue in carcasses is increased, including the highest grade.

4. In bulls with better development of meat forms, there is a decrease in the proportion of active manifestation of sexual reflexes and the proportion of mounts made after bringing to the dummy cow, although the duration of their lifetime use is longer.

5. For efficient beef production, bull calves with worse meat forms, which are characterized by early maturity of growth (tall stature) and increased metabolism, are more suitable.

## SUMMARY

One of the main elements of beef cattle breeding is selection to meat forms improve. This process also affects other signs of cattle productivity, because the body functions as a single balanced system. The aim was to investigate how the growth rate, yield of slaughter products and reproduction traits of bulls, depending on the results of selection according to the method of meat forms evaluation, which has been used in Ukraine since 1972. The research was conducted based on data of the Ukrainian beef cattle use. It was found that bulls with better results of meat forms evaluation during the performance evaluation have higher yield of carcasses with lower content of bones, but are characterized by a higher fat content and feed consumption for live weight gain. The best meat forms practically do not affect the live weight of bulls up to the age of 18 months, but in adulthood, these bulls are characterized by lower live weight. After slaughter, bulls with better meat forms receive more trimmings from the

carcass, they also have certain characteristics of internal organs development, fat depots and the release of meat cuts. The sexual activity of bulls does not depend much on meat forms, but bulls with better meat forms are used longer, although they have a tendency to decrease the volume of ejaculate, mobility and concentration of spermatozoa. Bulls with better meat forms has trend to lower sperm fertilizing capacity and higher calf mortality.

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