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Manifestation of living and post-slaughter traits of productivity in inbred and outbred bull calves of Ukrainian meat cattle breed

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ABSTRACT

Selection in meat cattle herds requires caution due to the manifestation of inbred depression in traits that affect the economics of this livestock industry. This paper analyses the productivity of inbred and outbred bull calves of the Ukrainian meat cattle breed and justifies methods of pair selection in purebred herds with natural pairing. In bull calves, the growth of animals and traits of their meat productivity after slaughter were considered. Inbreeding was determined based on their pedigree. Inbred animals tended to have a growth rate of 10.2% from birth to 8 months of age. Afterwards, their average daily gain in live weight decreases sharply compared to outbred peers, who grow faster over a more extended period. From 8 to 18 months of age, it is probably ($p > 0.95$) higher by 27.3% compared to inbred animals. Inbred bull calves have higher variability (Cv,%) in average daily gains. This indicates different adaptations to the environment during the suckling period and after weaning. Outbred animals tend to gain 2.3% of body weight at 12 months, 4.7 at 15 months, and 10.3% at 18 months. Its variability with age decreases by 7.4 points in inbred bull calves and 0.4 points in outbred ones, from 8 to 18 months. The inbred animals spent 29.5% more feed per kg of gain ($p > 0.95$) than the outbred ones. Inbred bull calves vs outbred ones at 15 and 18 months of age tend to improve the expression of meat forms by 1.3 and 2.7%. They are relatively shorter and have a more rounded barrel. As a result, they have a shorter period of rapid growth. With the small size of the Ukrainian meat cattle population, one of the most important problems is reducing genetic variation in beef productivity traits and manifesting inbred depression in them. In purebred commercial herds, the mating of close animals should be avoided. To do this, an "order" for bulls should be made, and pairs should be selected without using inbreeding at different grades. Thus, outbred bull calves will reach live weight more quickly, spending less feed per growth unit, and have better basic slaughter traits.

Keywords: inbreeding, outbreeding, meat productivity, bull calves, selection, "order" for sires.

INTRODUCTION

The Ukrainian meat cattle breed was bred in 1993 by complicated reproductive crossbreeding of the Chianina (3/8), the Charolais (3/8), the Simmental (1/8), and the Ukrainian Grey (1/8) [1]. Animals of this breed are characterised by significant variability in growth, milk production, and reproductive ability. In terms of average daily gain and slaughter traits alone, they are not inferior to representatives of other meat cattle breeds. For this, cattle have attracted the attention of beef manufacturers. Close breeding and intensive selection by traits are often used when working with the Ukrainian meat cattle breed. This allows the formation of the desired type and reduced variability inherent in multibreeding. Among sires derived from close breeding, due to their more intensive selection, there are more prepotent improvers in terms of growth rate [2]. Females with a lower culling percentage show inbred depression in weight growth, reproductive capacity, and milk production. The most significant deterioration in productivity occurs in cows derived from intralineage inbreeding.

The decline in these traits is of great concern, as it is possible to lose the advantages of these cattle over other meat cattle breeds in Ukraine. The impact of inbreeding on the meat productivity of animals obtained through

complex reproductive crossbreeding remains insufficiently studied. Vital importance should be given to the justification of parental pair selection. There is a high risk of spontaneous inbreeding when purebred breeding is used, especially in natural mating conditions. Close breeding leads to negative effects, such as inbred depression on the viability and productivity of cattle [3]. It is relevant to investigate the manifestation of meat productivity traits in inbred and outbred bull calves based on the importance of their livestock in beef production and to substantiate methods of pair selection in purebred herds.

Analysis of literature sources. A high level of close breeding leads to a decrease in the genetic diversity of traits [4] and increased homozygosity [5] and is one of the most important issues in cattle populations. Inbreeding negatively affects the reproductive capacity of bull calves, especially their sperm morphometry [6]. The inbreeding coefficient correlates most negatively ($p > 0.99$) with their length ($r = -0.1449$) and width ($r = -0.2494$). Inbred ($F_x > 3.5\%$) bull calves have a higher percentage of highly active but non-progressive spermatozooids [7], which increases the interval between calving in cows.

In dams, the degree of inbreeding prolongs the age of first calving [8] and reduces the number of unfertilized oocytes [9], increasing dystocia in firstborns and stillbirths [10], [11]. The 1% increase in the inbreeding coefficient leads to a decrease in live weight: newborns by 0.103 kg [12], at 205 days by 0.24 kg [13], at 365 days by 0.514 and 0.57 kg [14]. As for the impact of inbreeding on meat productivity, the published data are contradictory. In Carolino & Cama [10], inbred depression with carcass traits is extremely low and insignificant.

It has been proven that inbred depression is affected not only by the inbreeding of the animal but also by its mothers [15]. Maternal and calf inbreeding increases prenatal neonatal mortality with 3.4% and 6.3% of firstborns, respectively [16]. Each 1% increase in the inbreeding rate of a cow and calf increases the age at first calving by 1.4 and 0.8 days, respectively. Parental inbreeding has limited effects [17]. The average inbred depression with a 1% increase in inbreeding is 0.269% for weight gain and 0.174% for reproductive traits [18].

This review of literature sources highlights that inbred depression is a growing problem and a need for inbreeding management in beef cattle breeds originated in Ukraine.

Scientific Hypothesis

The study of inbreeding impact on productivity traits of bull calves of the Ukrainian meat cattle breed during life and after slaughter and justification of the methods of pair selection at these cattle breeding will help to prevent the appearance of inbred depression.

MATERIAL AND METHODOLOGY

Samples

The study was conducted on inbred (Figure 1) and outbred bull calves of the Ukrainian meat cattle breed.

Animals and Biological Material

Inbred and outbred bull calves of the Ukrainian meat cattle breed were studied.

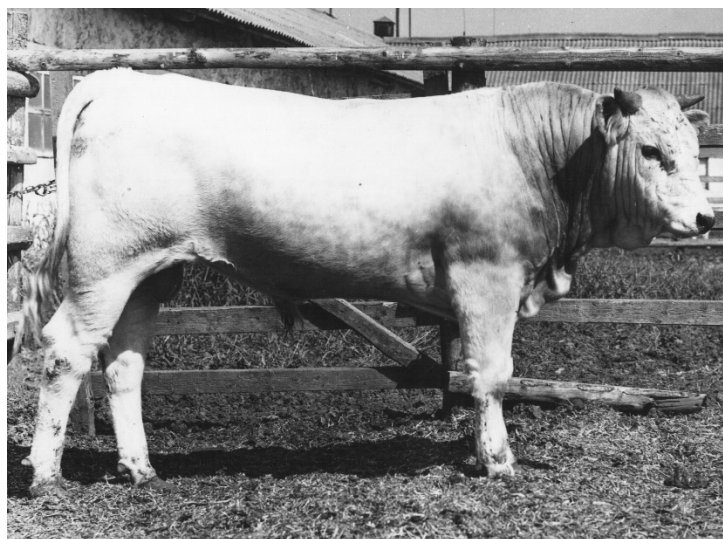


Figure 1 Inbred bull calves.

Instruments

Electronic analytical scale (KERN ABS 120-4, SE “Khimtex”, Ukraine).
 Laboratory ruler (ElizLabs 68933, Ukraine)
 Measuring tape (Schweikin, Ukraine).

Laboratory Methods

Live weight was determined by individual weighing at the end of each month in the morning before feeding. Net weight gain (Ng) for each day of life was determined according to ICAR [19] using the formula:

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

Fat tissue was divided into slaughter fat (subcutaneous) and intermuscular one following DSTU 3938-99 [20]. Muscle tissue index (MTI) was determined by the ratio of muscle tissue to bone mass, adipose tissue and tendons and ligaments.

Description of the Experiment

Sample preparation: The work was carried out on the Ukrainian meat cattle breed animals. The slaughter of cattle was managed at Volia" breeding plant, Zolotonosha district, Cherkasy region. In the herd, five well-developed inbred and outbred newborn bull calves were selected by balanced analog groups. The difference in their live weight and age between the groups was up to 5%. Inbreeding was determined using five generations of pedigrees

Number of samples analyzed: Five well-developed inbred and outbred newborn bull calves were selected by balanced analog groups in the herd.

Number of repeated analyses: 5.

Number of experiment replication: 3.

Design of the experiment: The five well-developed inbred and outbred newborn bull calves selected for the study were tested for origin reliability by blood group factors. Until 6-7 months of age, they were raised near their mothers with the use of suckling. After weaning until they were 8 months of age, they were accustomed to a typical diet and housing conditions. Intensive bull calves were reared from 8- to 18 months of age on a leash. Their general level of feeding was calculated to produce an average daily gain of 1,000 to 1,200 g. During this period, the bull calves were fed a feed according to rations prepared as indicated in the standards. The weight of feed eaten by each bull calf was counted every decade (two days in a row) by weighing the given fodder and its residues. Their energy value (in-feed units) and costs per 1 kg of live weight gain were calculated based on the feed consumed. There was no significant difference in feed consumption between the groups from 8 to 18 months (Table 1).

Table 1 Feed consumption by inbred and outbred bull calves from 8 to 18 months, M ±m.

Feed	Inbred (n = 5)		Outbred (n = 5)	
	feed units	%	feed units	%
Concentrated	1369 ±50.9	45.6 ±0,56	1328 ±55.8	45.8 ±0.10
Rough	570 ±86.7	19.0 ±1,73	558 ±35.2	19.2 ±1.11
Juicy	461 ±51.4	15.4 ±0,50	387 ±31.5	13.3 ±0.41
Green	599 ±26.8	20.0 ±0,24	630 ±66.9	21.7 ±1.44
Total feed units	2999 ±88.0	100.0	2903 ±104.8	100.0
Feed costs per 1 kg of grain, feed units	10.1 ±0.36		7.8 ±0.67*	

Note: *) $p > 0.95$.

The live weight of animals and their average daily weight gain from birth to 18 months of age and meat productivity at 18 months after slaughter were determined. Live weight was determined by individual weighing at the end of each month in the morning before feeding. At 8-, 12-, 15-, and 18 months of age, bull calves were weighed on two consecutive days with average weight calculation. The expression of meat forms at 15 and 18 months was assessed using a 60-point scale. The animals were slaughtered at the Cherkasy meat processing plant. Before that, they were weighed before and after 24 hours of starvation with free access to water (pre-slaughter live weight). After slaughter, the slaughter weight (paired carcass) was determined. The slaughter yield (carcass yield) was calculated regarding pre-slaughter live weight.

After cleaning the carcass, the absolute weight of the cut-offs was weighed, and their share of the slaughter weight (carcass) was determined. Boning of the left half-carcasses of bull calves was made. After that, bones,

muscle tissue, including the highest, first, and second grades following GOST 7595-79 [21], tendons and ligaments, and fat tissue were weighed.

They were weighed to compare subcutaneous and intermuscular fat tissue. The weight of total fat tissue was determined as the amount of internal fat and fat from the carcass. After boning, the muscular-bone ratio and the muscular tissue index were determined. Muscle-bone ratio (MBR) was calculated as the ratio of muscle tissue to bone. The Muscle Tissue Index (MTI) was determined by the ratio of muscle tissue to the weight of bones, fat tissue, and tendons and ligaments [22]. After slaughtering, the hide was removed and weighed to determine its net weight, without any residual muscle or fat tissue (if its weight exceeded 500 g), blood clots and contamination, and adhering dung. 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 that connects the ends of the ischial tuberosities. The width was measured along the line 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.

Statistical Analysis

The obtained data were processed using variational statistics methods. We determined the average values by groups, the error of the average, and the difference between the average and its probability. To characterize the degree of variability of traits, the coefficient of variability (CV,%) was calculated as the ratio of the average square deviation to the average value for the group. The statistical analysis data were produced by Microsoft excel and Statistica 15. The accuracy of the experimental data was determined using the Student’s test for a confidence probability of ≤0.05 based on the number of parallel determinations of at least 5. Linear programming problems were solved using the MS Excel spreadsheet processor “Search for a solution” setting Excel Solver

RESULTS AND DISCUSSION

Inbred bull calves are born with a lower live weight than outbred ones (Table 2). Sumreddee, et al. [15] and Hidalgo, et al. [12] also established the manifestation of inbred depression by neonatal weight. There is a tendency to increase the average daily weight gain by 10.2% from birth to 8 months in inbred bull calves. This was probably due to better milk production in their mothers, which balances the detrimental effects of inbreeding on litter growth rate during the suckling period. Due to faster growth during the suckling period, inbreds tend to increase live weight by 8.1% at 8 months of age. This contradicts the data of Hidalgo, et al. [13] according to which inbred litter weight at 240 days of age decreases by 0.685 kg and Fx growth by 1%. Thereafter, the average daily gain decreases compared to outbred animals. Inbred and outbred bull calves maintain a high growth rate until 18 months of age. Outbred cattle grow faster for a longer period. [22], [23], [24]. The average daily live weight gain from 8 to 18 months is probably 27.3% (p >0.95), higher than inbred peers. An advantage in growth rate from 8 to 18 months in outbred animals is also observed in OTHER studies [25], [26], [27], [28].

Table 2 Weight growth of inbred and outbred bull calves.

Trait	Inbred (n = 5)		Outbred (n = 5)	
	M ±m	Cv,%	M ±m	Cv,%
An average daily gain in the period (month) from – to:				
-//- newborns - 8	922 ±59.2	12.8	837 ±26.0	6.2
-//- 8-12	1066 ±86.3	16.2	1301 ±63.7	9.8
-//- 12-15	1097 ±112.9	20.6	1255 ±121.7	19.4
-//- 15-18	703 ±176.8	50.0	1115 ±200.0	35.9
-//- 8-18	967 ±62.6	12.9	1231 ±47.2*	7.7
Live weight at age, (months):				
newborns	31.4 ±1.8	11.4	32.4 ±1.2	7.1
-//-8	255 ±13.3	10.4	236 ±6.9	5.8
-//-12	385 ±10.9	5.7	394 ±9.5	4.8
-//-15	485 ±10.7	4.4	508 ±12.6	5.0
-//-18	553 ±11.6	4.0	610 ±20.5	6.7
The expression of meat forms (points) at age, (months)				
-//- 15.	54.1 ±1.2	4.4	53.4 ±2.9	10.7
-//- 18.	56.3 ±1.8	3.1	54.8 ±2.3	8.3

Note: *) p >0.95.

The trend of a 2.3% live weight preference in outbred animals begins to manifest at the age of 12 months. At 15 months of age, the difference is already 4.7%, and at 18 months, it is 10.3%. Inbred bull calves have higher average daily gain variability than outbred ones. This indicates their unequal adaptation to environmental conditions during the suckling period and after weaning. The coefficient of variation of live weight in inbred bull calves at 15 and 18 months of age tends to decrease compared to outbred ones. Its variability decreases with age in inbred bull calves more significantly (by 7.4 points), and only by 0.4 points in outbred ones.

Consequently, related to high variability in growth rate, inbred animals are prone to stabilization of live weight at older ages. The inbred animals spent 29.5% ($p > 0.95$) more feed per kg of body weight gain during The 8 to 18-month test period compared to outbred peers (see Table 1). According to Carolino and Cama [10] inbred depression CONCERNING feed consumption efficiency is insignificant. At the age of 15 and 18 months, inbred bull calves also tend to have a better expression of meat forms than outbred ones by 1.3 and 2.7%, respectively. This contrasts to data obtained on THE NELORE breed in Brazil [29], [30].

Outbred bull calves have an advantage over inbred peers in pre-slaughter live weight by 9.1% ($p > 0.95$), slaughter weight by 12.3 ($p > 0.95$), and net gain by 8.9%, and slaughter yield (carcass) by 1.8 points (Table 3). Carcasses of inbred bulls have 20.5% more fat and muscle tissue cut, and they have a significantly lower coefficient of their variability.

Table 3 Traits of the slaughter of inbred and outbred bull calves.

Trait	Inbred (n = 5)		Outbred (n = 5)	
	M ±m	Cv, %	M ±m	Cv, %
Pre-slaughter live weight, kg	518 ±6.6	2.5	565 ±15.4*	5.5
Slaughter weight (carcass), kg	309 ±4.1	2.6	347 ±10.5*	6.0
Slaughter yield (carcass), %	59.7 ±1.06	3.6	61.5 ±1.11	3.6
Net gain, g	583 ±16.2	5.6	635 ±19.2	4.2
Trimming, kg	5,3 ±0.25	9.6	4.4 ±0.70	31.7
Trim, % of the half-carcass weight	3.4 ±0.21	12.1	2.6 ±0.38	29.1

Notes: *) $p > 0.95$.

Inbred bull calves are inferior to outbred peers in terms of weight of half-carcasses by 7.1% (Table 4). In absolute terms, more muscle tissue is obtained from outbred animals. Bull calves from close breeding predominate by 14.3% of outbred peers in terms of fat tissue content in the carcass. The latter feeds are used for growth, not for fat deposition. At one and a half years of age, the carcasses of inbred animals have less fat tissue under the skin. They have 3.3 times as much fat tissue deposited between the muscles. Significant accumulation of fatty tissue between the muscles in inbred cattle markedly affects their exterior, which is less angular and has better meat form development. Fat tissue between the muscles plays a significant role by shifting them slightly [31], [32].

Inbred bull calves are inferior to outbred ones in muscle content but have higher amounts of top and second-grade pulp. According to the sausage classification, second-grade beef includes a large amount of fat between the muscles not separated during trimming in inbred bull calves is higher ($p > 0.95$) by 6.3 points. Premium grade beef, including muscle tissue without fat, tendons, and ligaments, was 5.5 points higher in inbred animals ($p > 0.95$).

Fat tissue in cattle carcasses plays an important role [33], [34]. Its low content worsens the taste of beef. An excessive amount of fat tissue under the skin and between the muscles reduces the marketability of carcasses because its excess is cut off and disposed of. The formation of such carcasses requires an increase in feed consumption. A rather high proportion of fat tissue (35.9%) between muscles in inbred animals, serving as a cushion for blood vessels, nerves, and lymphatic glands, is subject TO excessive waste formation. Outbred bull calves at this age have a higher deposition of fat under the skin (19.5%).

Usually, inbred cattle have less fat under the skin and more between the muscles. In the subcutaneous tissue, reserve fat is deposited, supporting, protective, and heat-insulating function. Reserve fats in the body serve as an energy reserve and depot for water. The maximum growth of subcutaneous tissue in animals occurs in the period from 7 to 12 months, and fat tissue between muscles – between 12 and 18 months of life [35], subcutaneous fat and fat between muscles in the form of large layers appears at the age of 18 months [36].

Inbreeding of 18-month-old bull calves of the Ukrainian meat cattle breed has the maximum positive effect on the growth of fat tissue between the muscles, with the highest natural growth and the highest natural growth. Subcutaneous fat tissue, which has a relatively low nutritional value, is more depressed during inbreeding.

Table 4 Morphological composition of half-carasses of inbred and outbred 18-month-old bull calves.

Trait	Inbred (n = 5)		Outbred (n = 5)	
	M ±m	Cv, %	M ±m	Cv, %
Half-carass weight, kg	157.1 ±4.53	5.8	168.2 ±4.29	5.1
Bone weight, kg	27.6 ±0.98	7.1	27.3 ±1.25	9.2
Bone weight, %	17.6 ±0.59	6.8	16.2 ±0.66	8.2
Muscle tissue, kg	116.8 ±2.74	4.7	130.6 ±3.76*	5.8
-/-, %	74.3 ±1.57	4.2	77.7 ±0.78	2.0
including the highest grade, %	20.4 ±2.57	25.2	14.9 ±1.22*	16.4
First grade, %	37.5 ±2.99	16.0	49.4 ±1.05*	4.3
Second grade, %	42.1 ±1.15	5.5	35.8 ±1.70*	9.5
Tendons and ligaments, kg	6.3 ±0.93	29.6	4.7 ±0.21	8.8
Tendons and ligaments, %	4.0 ±0.45	21.8	2.8 ±0.08	6.1
Fat tissue in the carcass, kg	6.4 ±0.26	8.2	5.6 ±1.02	35.8
-/-, %	4.1 ±0.17	8.5	3.3 ±0.57	34.4
Including slaughter fat, kg	4.1 ±0.26	12.5	4.9 ±1.07	43.7
-/-, % to total fat	19.3 ±1.25	12.7	27.4 ±5.62	41.02
-/-, % to fat in the carcass	64.1 ±3.90	12.1	87.5 ±3.93	9.39
Including intermuscular fat, kg	2.3 ±0.35	30.6	0.7 ±0.11	26.5
-/-, % to total fat	11.0 ±2.01	36.9	4.6 ±0.58	25.1
-/-, % to fat in the carcass	35.9 ±3.9	7.8	12.5 ±4.95	68.0
Muscle-bone ratio	4.3 ±0.18	8.5	4.8 ±0.20	8.5
The muscle tissue index (MTI)	2.9 ±0.14	9.6	3.4 ±0.11	6.4

Notes: *) $p > 0.95$.

According to Zhao, et al. [5], homozygosity is significantly negatively associated with slaughter fat and its thickness in the back of the barrel. However, fat tissue between the muscles improves the nutritional value of beef and is not delayed in development due to a significantly higher growth rate.

The results of this study were compared with those reported by Carolino & Cama [10]. Carolino & Cama [10] evaluated the effect of inbreeding depression using carcass information collected through the Carnalentejana, DOP certification program on 7701 animals slaughtered between 1995 and 2004 under the certification program. The retail meat yield as a percentage of carcass weight and percentage of meat cuts, including rump steak, were taken into account. The results clearly show an adverse effect of inbreeding on most meat cattle traits.

The aimed at the quantitative evaluation of the effect of inbreeding on carcass quality, growth rate, and conformation characteristics in purebred Charolais, Limousin, Simmental, Hereford, and Angus meat cattle populations based on Irish commercial and breeding herds. Inbred animals have lower carcass weight and fat in it. The effects of inbreeding are more expressed in British breeds. The effect on carcass weight ranges from -0.87 kg (Charolais) to -1.90 kg (Hereford), with a 1% increase in inbreeding. Continental animals suffer more from inbreeding due to the expression of meat forms and conformation of carcasses than British ones. Inbred animals are smaller and narrower due to poorly developed muscles. Inbreeding increases the viscosity of meat but does not significantly affect other meat qualities or carcass traits [37], [38], [39], [40].

In our study, the relative bone weight in the carcasses of inbred animals is higher by 1.4 points. The beef yield and quality analysis by muscle tissue index and muscle-bone ratio show a pronounced tendency to improve these traits in outbred bull calves. For every kilogram of bones, they have 11.6% more pulp. Outbred cattle have a 17.2% better MTI than inbred cattle.

From animals of both groups, heavy hides with a large area are obtained (Table 5). Inbred bull calves have a shorter length of 26.3% ($p > 0.99$) and an area of 7.0% ($p > 0.95$). The size of the hide was also affected by measurements of the exterior of the animals. Inbred bull calves are shorter and more rounded. Inbred bull calves also have a 15.3% lighter hide ($p > 0.95$).

Thus, one of the most important problems in the Ukrainian meat cattle breed with its small population size is reducing genetic diversity and the occurrence of inbred depression and traits of meat productivity. This has also been confirmed in small populations as well as in breeds with large numbers. In commercial herds, it is recommended to avoid mating close animals [8], [6]. It is important to intensively use many young sires of high breeding value [13]. A special feature of stock breeding in commercial herds should be grouped or line-group selection, with strict adherence to the cross of the highest producing lines to prevent inbreeding during further breeding [41], [42].

Table 5 Hide sizes in inbred and outbred bull calves.

Hide traits	Inbred (n = 5)		Outbred (n = 5)	
	M±m	Cv, %	M±m	Cv, %
Weight, kg	44.5 ±1.45	5.7	51.3 ±2.44*	8.2
-"-, % of fat weight	8.6 ±0.31	6.2	9.0 ±0.30	5.9
Length, m	1.9 ±0.03	2.5	2.4 ±0.07**	5.2
Width, m	2.2 ±0.08	6.2	1.9 ±0.06*	5.4
Area, m ²	4.3 ±0.06	2.2	4.6 ±0.05*	1.8

Notes: *) $p > 0.95$; **) $p > 0.99$.ffff.

Selection begins with an "ordering" of sires. When making a plan for their use, the improvement type of selection is taken as the basis. When making a line-group selection plan in commercial herds, there is no need to consider the mothers' origin of each dam, as a large group is assigned to one sire. With this approach, the origin of the breeding stock is taken into account according to the ancestors of the parents and the pedigree on both sides. This is done by determining the close relations between the bulls, who have offspring in the herd. They are common ancestors for most dams and occur in various combinations in their pedigrees.

CONCLUSION

Inbreeding reduces the meat productivity of bull calves compared to outbreeding. It contributes to the appearance of animals prone to higher fat deposition in the carcass, obtaining higher grades of muscle tissue from them, leading to increased feed consumption for gain. Inbred bull calves tend to increase the cut-off of slaughter fat and meat from carcasses. Preference should be given to outbred cattle with a higher and more stable growth rate from 8 to 18 months. Animals of this type have a longer, higher-legged barrel and a higher final live weight. They maintain high gain rates for a long time and reach the maximum live weight later than inbred ones.

Inbred animals tended to have a growth rate of 10.2% from birth to 8 months of age. Afterwards, their average daily gain in live weight decreases sharply compared to outbred peers, who grow faster over a more extended period. From 8 to 18 months of age, it is probably ($p > 0.95$) higher by 27.3% compared to inbred animals. Inbred bull calves have higher variability (Cv, %) in average daily gains. This indicates different adaptations to the environment during the suckling period and after weaning.

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The authors have no conflicts of interest.

Ethical Statement:

According to Protocol No. 10 of 18.04.2020 at the meeting of the Ethics Commission of the Faculty of Livestock Raising and Water Bioresources, National University of Life and Environmental Sciences of Ukraine, Act No. 3 and 4 were signed during the experimental research, i.e. in the process of the slaughter of cattle "all the rules of the current legislation of Ukraine were observed, following DSTU 4673: 2006.

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