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## Growth and meat productivity of bulls depending on the similarity of their blood group B antigens with mothers

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**Abstract.** Various molecular genetic markers are used to comprehensively assess the breeding value of animals based on genetic information. Therefore, an important place in the qualitative improvement of beef cattle breeds is occupied by the improvement of methods of animal selection using the immunogenetic characteristics of their blood. The purpose of the study is to determine the dependence of weight growth and meat productivity of animals of the Ukrainian beef breed on the number of similar antigenic factors of the B blood group system in them and their mothers. After weaning, the first group contained bulls ( $n = 12$ ) who had similar antigens from 2 to 6 inclusive. The second group ( $n = 15$ ) – from 7 to 13. When studying the features of weight gain and meat productivity of bulls, it was proved that the similarity in the B system of cattle blood groups between mother and offspring is informative regarding the homo- or heterozygosity of the latter. It was found that animals with a lower amount of antigens similar to the mother outperformed (by 9.3%) homozygous peers in the test from 8 to 18 months of age in terms of average daily weight gain and had a higher live weight (by 8.0%) at 18 months, indicating their better early maturity. With lower antigenic similarity between mother and offspring, the expression of meat forms is 7.8% and 6.0% higher, respectively, at 15 and 18 months of age.

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After slaughter, there is no significant difference between homozygous and heterozygous bulls in terms of meat productivity, including pre-slaughter live and slaughter weight. When selecting offsprings with fewer antigens similar to their mother, they tend to reduce the slaughter yield (by 0.5 points) and the muscle content in carcasses (by 3.2%). The selection of bulls of Ukrainian beef breed with a smaller number of antigens of the B blood group system, similar to mothers, will help to improve their weight growth and the expression of meat forms, and will allow predicting future meat productivity

**Keywords:** breeding; live weight; average daily increment; Ukrainian beef breed; cattle breeding

## Introduction

In the genetic progress of cattle of local breeds, the substantiation of animal breeding methods is of great importance. They are selected in a variety of ways, including by telomere length measured in white blood cells, as they are associated with health, ageing, and stress (Ilska-Warner *et al.*, 2019), genomic selection (Gutierrez-Reinoso *et al.*, 2021) and epigenetic regulatory mechanisms (Wang & Ibeagha-Awemu, 2021).

The productivity of offspring depends on the compatibility of parents for antigens of the B blood group system. Studies on animals of the Ukrainian beef breed indicate ambiguous results of the relationship between the similarity of parents by blood group factors and the offspring productivity. Thus, it is proved that bulls that are descended from their parents with a larger  $r_{as}$  predominate in terms of average daily increments and have a larger live weight. If  $r_{as}$  in parents is more than 0.268, animals tend to improve their growth rate by the age of 8 months (Ugnivenko & Natalych, 2021). This trend continues after weaning. In bulls received from parents with  $r_{as}$  up to 0.267, average daily increments are better in the period from 15 to 18 months, which indicates a lower precocity. According to the index of antigenic similarity of parents over 0.268, animals are better in the expression of meat forms at the age of 15 and 18 months. At 15 months, bulls obtained from

homogeneous selection, according to  $r_{as}$ , have lower height measurements, a better developed front part of the body in terms of chest width and depth, and a longer torso and backside. According to the homogeneous selection of fathers in their offsprings, in comparison with peers from heterogeneous mating, there is a tendency to increase the content of muscle (by 4.2%), adipose tissue in carcasses (by 12.4%), including between muscles (by 1.1 points) (Ugnivenko & Natalych, 2022). Per kilogramme of bones, the boneless meat is 11.6% less, the muscle tissue index is 17.2% worse, the absolute weight of the liver is 7.8% less, the kidneys are 10.0% less, the heart is 27.8% less, the head is 2.0% worse, and the lungs are 11.6% less. In bulls from a heterogeneous selection of parents with  $r_{as}$  up to 0.267, there is 7.2% more adipose tissue in the body, including 7.8% more internal tissue, and the relative weight of bones is 0.8 points higher. For sheep of the Kazakh meat-wool semi-fine-fleeced breed, the erythrocyte antigen Ab is informative, which correlates with a large shearing of wool (Islamov *et al.*, 2020). Among sheep of wool and coarse-wool types, carriers of B-factor blood groups showed an increase in the level of wool productivity.

According to the genetic mechanism of these relationships, alleles are influenced by the heterotic state, since the similarity between

the body of the offspring and the mother in terms of antigens affects their differences and determines the degree of compatibility or heterospecificity.

The problem of growth and meat productivity of offspring with different amounts of antigens of the B blood group system in them and mothers is not sufficiently studied. Information on the characteristics of meat productivity in bulls of local breeds that have different similarities with their mothers in terms of antigens is useful and necessary for the efficient and targeted production of beef and its valuable components. The purpose of the study is to determine the influence of the number of similar B blood group antigens in mothers and offsprings on their weight growth and meat productivity in Ukrainian beef cattle.

## Materials and Methods

The analysis of the growth and meat productivity of bulls of the Ukrainian beef breed for different amounts of antigens of the B blood group system in them and their mothers were carried out in 2021 based on the materials of breeding accounting and production activities of the breeding plant “Volya” in Cherkasy oblast. Up

to 6-7 months of age, they were reared on suckling cows. After weaning, well-developed bulls were tested for the likelihood of origin by blood type factors. For this purpose, bovine erythrocyte antigens were used according to the blood group B system published (Podoba *et al.*, 1987) in the catalogue “Blood types of breeder bulls and cows used in the breeding of dairy and beef breeds of cattle”. Bulls were selected in 2 groups. The first group included animals (n = 12) according to the number of erythrocyte antigens of the B blood group system in them and their mothers from 2 to 6. In the second group (n = 15), the number of erythrocyte antigens ranged from 7 to 13. Intensive growing of bulls was carried out from 8 to 18 months of age according to diets compiled in accordance with the norms. The tests were carried out indoors on a tethered system. The feed eaten by each bull was counted every ten days for two consecutive days, weighing before feeding the animals, and its remains – after. The actually consumed feed was used to calculate its energy value (in oat fodder units) and costs per 1 kg of live weight gain. There was no significant difference in feed consumption between the bull groups (Table 1).

**Table 1.** Feed intake from 8 to 18 months of age by bulls who have different similarities with their mothers in terms of blood group factors of the B system

Feed	Group 1		Group 2	
	fodder units	%	fodder units	%
Concentrated	1.542 ± 121.0	50.9 ± 0.98	1.468 ± 95.8	47.7 ± 0.73
Coarse	363 ± 38.4	12.0 ± 1.22	454 ± 98.5	14.1 ± 2.37
Succulent	468 ± 53.4	15.4 ± 1.88	530 ± 83.4	16.8 ± 1.84
Green	657 ± 119.6	21.7 ± 2.55	634 ± 93.8	21.4 ± 3.56
Total	3.030 ± 216.1	100.0	3.086 ± 210.3	100.0

Meat forms in animals were evaluated in accordance with guidelines (Lukash & Shevchenko, 1983). At the end of the test at the age of 18 months, two groups were formed for

animal slaughter using the balanced analogue group method. The difference between them in live weight and age did not exceed 5%. During the experiment, the animals were kept in

accordance with the requirements of the Order of the Ministry of Agricultural Policy and Food of Ukraine, No. 652 (2012) and Guide for the Care and Use of Laboratory Animals (National Research Council..., 2011) and followed ARRIVE (2010) guidelines for reporting experiments on the use of live animals.

To determine the beef productivity of bulls, they were slaughtered in the Cherkasy meat processing plant in accordance with the requirements of DSTU 4673:2006 "Cattle for slaughter. Specifications" (2008). Before slaughter, animals were weighed before and after 24-hour fasting with free access to water and a pre-slaughter live weight was established. After slaughter, the slaughter weight (paired carcass) was determined by weighing. The slaughter yield (carcass) was calculated according to the ratio of the slaughter weight to the pre-slaughter live weight. The left semi-carcasses of the slaughtered bulls were deboned. Next, the weight of bones, muscle tissue, including the highest, first, and second grades, tendons and ligaments, and adipose tissue were weighed.

During the statistical processing of data, the average values ( $M$ ) for groups, the statistical error of the average ( $\pm m$ ), the difference between the means and its probability were determined according to the methods given in the paper (Osadcha, 2021). To characterise the variability of features, the variability coefficient ( $Cv$ , %) was calculated as the ratio of the mean square deviation to the average value for the group.

## Results and Discussion

Bulls with different antigenic similarities with their mother did not differ in growth rate until 8 months of age. This was due to the milk consumed from their mothers, which offset the effect of selection by antigenic similarity on the growth rate of offspring during the suckling period. After weaning in different age periods, bulls tended to predominate in the number of similar antigens between them and mothers from 2 to 6 (from 4.6 to 15.3%) in terms of average daily increments over peers with 7 or more similar antigens (Table 2).

**Table 2.** Average daily increments of bulls with different numbers of similar antigens between them and mothers

Average daily increment for the period: from – to	Group 1			Group 2		
	<i>n</i>	$M \pm m$	<i>Cv</i> , %	<i>n</i>	$M \pm m$	<i>Cv</i> , %
0-8	12	912 ± 39.7	14.4	15	914 ± 29.7	12.2
8-12	12	1.221 ± 75.8	20.6	15	1.145 ± 42.3	13.8
12-15	12	1.266 ± 92.0	24.1	13	1.210 ± 71.3	20.4
8-15	12	1.246 ± 51.6	13.7	13	1.185 ± 43.0	12.6
15-18	7	1.140 ± 118.5	25.5	9	988 ± 119.7	34.2
8-18	7	1.258 ± 61.4	12.0	9	1.151 ± 37.1	9.1

A decrease in the number of erythrocyte antigens that the mother has in the offspring from 2 to 6 – with age increased the average daily increments in bulls compared to their peers with more than 7. At the age from 8 to 12

months, this difference was 6.6%, from 15 to 18 months – 15.3%.

Bulls with less similarity of antigenic factors of blood groups with their mother had greater variability in average daily increments

compared to their peers. This indicates that they do not adapt equally to environmental conditions, both before and after weaning. According to the coefficient of variation of the average daily weight gain, bulls between groups in all age periods did not have a significant difference. Heterozygous bulls in Group 1 grew faster for a longer time, maintaining a fairly high growth rate until the age of 18 months. Slowing of the growth rate from 15 to 18 months in homogeneous animals of Group

2 is associated with an increase in their precocity. A decrease in the differences between the mother's body and the offspring from 2 to 6 antigens accompanied an increase in live weight in bulls after weaning (Table 3). Thus, those with a number of antigens similar to the mother in the range from 2 to 6 tended to be 2.0% superior to their peers with the number of such antigens exceeding 7 by live weight at 12 months of age, 4.6% at 15 months of age, and 8.0% at 18 months of age.

**Table 3.** Live weight of bulls, with a different number of antigens similar to their mothers

Live weight by age: months	Group 1			Group 2		
	<i>n</i>	<i>M</i> ± <i>m</i>	<i>Cv</i> , %	<i>n</i>	<i>M</i> ± <i>m</i>	<i>Cv</i> , %
newborns	12	33.7 ± 0.66	6.5	15	32.4 ± 0.72	8.3
8	12	256 ± 9.7	12.6	15	255 ± 7.6	11.2
12	12	402 ± 13.7	11.3	15	394 ± 8.9	8.4
15	12	521 ± 11.4	7.3	14	498 ± 10.6	7.7
18	7	633 ± 17.3	6.7	10	586 ± 11.4	5.8

Thus, in the Ukrainian beef breed, the selection of heterozygous bulls with less similarity with mothers in terms of blood group factors led to an improvement in their average daily live weight gain. Similar features of the growth of homozygous and heterogeneous cattle by antigens of blood group factors were established by L.A. Koropets (2004). The level of similarity between the father and mother in terms of antigens affects the differences in them between the offspring and the body of the latter and determines one or another degree of their compatibility. It was found that an increase in differences between the mother's body and the offspring by blood group factors accompanies an increase in the live weight of bulls. Thus, in the group of bulls with the number of antigens absent from the mother in the range of 6-8, there was an increase ( $P > 0.95$ ) in live weight by 9.1% at 18 months of age compared to their

peers with the number of antigens absent from the mother from 0 to 3. The comparison of indicators of signs of sperm productivity of bulls with heterospecificity by blood group factors indicates that an increase in the number of antigens in the offspring that are absent from the mother accompanies an improvement in the volume of ejaculate, sperm motility and its concentration.

The meat forms of bulls are different due to the unequal antigenic similarity between them and their mothers. In an animal with a larger value of this internal trait, the expression of meat forms at the age of 15 and 18 months is worse by 7.8% and 6.0%, respectively (Table 4). A smaller number of similar antigens between mother and offspring contributed to an increase in the propensity of offspring to early growth cessation and precocity, increased feed consumption for live weight gain by 12.7% from 8

to 18 months of age. Relatively more precocious cattle are less efficient for beef production due

to reduced meat productivity and higher energy costs for its production.

**Table 4.** The expression of meat forms and feed costs for live weight gain in bulls that have different antigenic similarities with their mothers

Meat forms (points) by age, months.	Group 1		Group 2	
	n	$M \pm m$	n	$M \pm m$
15	10	55.0 ± 0.86	9	51.0 ± 1.63
18	6	56.4 ± 0.99	9	53.2 ± 1.26
Feed costs per 1 kg of growth from 8 to 18 months, fodder units	7	7.9 ± 0.60	9	8.9 ± 0.90

In bulls with lower antigenic similarity with mothers compared to peers with greater

similarity, a slightly larger (by 1.1%) live weight was observed after a period of fasting (Table 5).

**Table 5.** Signs of slaughter and morphological composition of semi-carcasses in 18-month-old bulls that have different antigenic similarities with their mothers

Trait	Group 1			Group 2		
	n	$M \pm m$	Cv, %	n	$M \pm m$	Cv, %
Live weight after 24-hour fasting, kg	4	560 ± 24.2	7.5	5	554 ± 20.3	7.3
Slaughter weight (carcass), kg	4	350 ± 18.7	9.2	5	349 ± 13.5	7.7
Slaughter yield (carcass), %	4	62.5 ± 1.16	3.2	5	63.0 ± 0.74	2.3
Semi-carcass weight, kg	3	167 ± 11.9	10.1	4	165 ± 7.1	7.5
Bones, %	4	16.7 ± 0.64	6.7	4	16.6 ± 0.09	0.9
Muscle tissue, %	4	80.6 ± 1.37	3.0	4	80.4 ± 0.45	1.0
Including the highest grade, %	4	14.0 ± 1.84	17.0	4	18.8 ± 2.04	30.3
First grade, %	4	47.7 ± 2.33	10.9	4	43.0 ± 4.59	20.1
Second grade, %	4	38.3 ± 2.35	11.6	4	38.2 ± 2.45	13.9
Tendons and ligaments, %	4	2.7 ± 0.15	9.8	4	3.0 ± 0.18	12.0

Heterozygous bulls tended to increase (by 1.2%) the weight of semi-carcasses compared to homozygous peers. They were 4.8 points behind in terms of the content of the highest-grade muscle tissue, which does not include fat, tendons and ligaments. But they show a tendency to increase the relative amount (by 4.7 points) of first-grade boneless meat. In terms of the content of second-grade beef, which according to the sausage classification includes fat between muscles that is not separated during venation, there were no differences in bulls of different groups.

The influence of differences between the mother and offspring on the implementation of genetic information in the ontogenesis of the latter is attributed (Podoba, 1997) to the integral properties of the genome, which determine the effect of heterosis, non-specific resistance, and age-related changes (Shakhbazov, 1981). Within the pre-existing population, it was confirmed that bulls with less similarity to their mothers outperformed their peers with more similar antigens in terms of performance, due to the greater variability in variations of antigens received from the father.

Genetic variations in maternal and foetal loci affected placental formation, thereby determining the likelihood of a successful pregnancy outcome or the development of associated complications (Yeung & Dendrou, 2019). The mother's pregnancy affected their immune system and the foetus and the associated effects on stimulating its development. However, it was found that the different antigenic similarity between mothers and their offspring does not play a big role during the suckling period and before weaning. Bulls with genes involved in proteolysis, transcription, transport and immune functions, and oxidative processes differ in terms of live weight gain and feed intake (Lindholm-Perry *et al.*, 2017). This is comparable to the greater or lesser similarity of animals and their mothers in this experiment, which also affected average daily increments and feed consumption.

In the qualitative improvement of local cattle breeds, the practical use of interior features occupies an important place. Erythrocyte and white blood cell antigens, polymorphic systems, and DNA genome polymorphism are used to assess their breeding value based on genetic information that correlates with certain genes. Molecular genetic markers of an individual are formed during the embryonic period and do not change during its life, regardless of sex and age, physiological state, and are inherited according to Mendel's laws. Since the markers passed on to the offspring are closely interrelated with the loci that characterise performance traits, this allows labelling indicators. The priority area of research in the selection of beef breeds of cattle was to improve methodological approaches to the analysis of group factors to identify the features of their gene pool. Using B blood group factors, G.A. Tsilyuko (1987) evaluated the similarity and differences of structural units of the Ukrainian beef breed, determined the degree of

similarity between its successors and ancestors of lines, found out the relationship of immunogenetic markers with productivity, objectively evaluated the distribution of conditional frequencies of heredity of the original breeds in crossbreeds.

Due to the fact that mostly DNA markers are currently being studied in Ukraine, the use of blood group factors is experiencing a crisis. In recent years, studies have not found a significant link between beef cattle performance and blood group factors. For the most part, these results do not provide a large-scale improvement in the level of meat productivity of animals by breeding methods. The economy of cattle breeding is affected by the business output of offspring from mothers at the time of weaning 5 times more than the growth and 10 times more than the quality of carcasses (Minish & Fox, 1982). The mechanisms of formation of meat productivity in offspring under the influence of the mother's body at the molecular level are poorly studied. The application of conventional approaches using the antigenic similarity index of parents ( $r_{as}$ ) does not fully provide solutions to problems related to the economy of beef cattle breeding. In this regard, the possibility of increasing beef production at the expense of the mother body, based on an understanding of the biological features of the inheritance of blood group factors of system B from cows by offspring, was of theoretical and practical importance. According to V.G. Nazarenko (1986), increasing the differences between the mother's body and the offspring in terms of red blood cell antigens reduces the embryonic period. Antigens absent in the mother, which characterise their incongruity with those present in the foetus, reflect certain trends in changes in the individual development of calves that are more heterozygous for this indicator (Tsilyuko *et al.*,

2000). In this study, it is manifested in the fact that bulls whose similarity to the mother was in the range of 2 to 6 antigens tended to prevail in live weight and meat forms over bulls whose similarity to their mothers was higher.

In this paper, cows and their offsprings were typed during weaning according to the factors of the B blood group of cattle to investigate the degree of similarity between them and its influence on the latter's productivity. A small similarity (from 2 to 6) in this trait between the genotypes of mothers and their offsprings descended from different bulls leads to an increase in the latter's level of heterozygosity by origin. This is the reason for the tendency to increase weight growth after weaning and signs of meat productivity in the offspring. Consolidation of animals closely related to their ancestors leads to a significant reduction in livestock biodiversity (Calabrese *et al.*, 2011), which was confirmed by this study as well. Mating of animals related by blood group factors, but not similar in phenotype and genealogy, counteracts the growth of homozygosity. Therefore, the probability of deterioration in productivity in offspring with low (from 2 to 6) similarity decreases. The preservation of heterozygosity by origin during such homogeneous mating should be explained by the presence of individuals satisfactory in terms of meat productivity among homozygous animals. In most cases, animals with heterozygous genotypes predominate homozygous in terms of meat productivity, which was confirmed in this study.

Thus, a comprehensive study and application of the compatibility of B blood group factors between mother and offspring, combined with productivity, will allow its further use for breeding heterozygous animals in herds of cattle of the Ukrainian beef breed and the provision of high-quality beef to the population.

## Conclusions

Selection of bulls with a lower (from 2 to 6) similarity of erythrocyte antigens of the B blood group system between mother and offsprings compared to their peers with greater differences (7 to 13) leads to a tendency to increase heterozygosity in the latter and improve average daily increments and live weight after weaning from 2.0 to 8.0%, the severity of meat forms at 15 and 18 months, respectively, by 7.8 and 7.0%, and an increase in muscle content and the proportion of bone in the carcass. Compatibility between the genotypes of mother and son by antigenic factors decreases as their intake from the father's body increases and indicates an increase in the heterozygosity of the offspring. The lower similarity of the offspring by the antigens of erythrocytes of the B blood group system with the maternal genotypes, which leads to an increase in the level of heterozygosity in the offspring and to the improvement of their meat productivity, including the morphological composition of carcasses, indicates the expediency of using these immunological relationships in breeding. When selecting offspring for fattening, their similarity to the mother's genotype by blood group factors of System B should be taken into account, which will lead to an increase in their heterogeneity and contribute to an improvement in their live weight and average daily increments.

The prospect of further study is to investigate meat productivity, including offal, in animals obtained from different similarities in antigens with the maternal genotype, which would deepen knowledge about the methods of selection by origin in populations of beef cattle that are genetically diverse in pedigree and relatively homogeneous in internal characteristics. They will be relevant and timely, as they would allow identifying genetic and biological reserves for increasing the beef productivity of cattle with the rational use of its genetic potential.

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None.

**Conflict of Interest**

None.

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## **Ріст і м'ясна продуктивність бугайців залежно від подібності їх антигенів системи В груп крові з матерями**

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**Анотація.** Для всебічного оцінювання племінної цінності тварин на основі генетичної інформації використовують різноманітні молекулярно-генетичні маркери. Тому, важливе місце у якісному поліпшенні м'ясних порід великої рогатої худоби посідає удосконалення методів добору тварин за використання імуногенетичних характеристик їх крові. Метою роботи є визначення залежності вагового росту і м'ясної продуктивності тварин української м'ясної породи від кількості подібних антигенних факторів системи В груп крові у них та матерів. Після відлучення у першу групу включили бугайців (n = 12), у яких було подібних антигенів від 2 до 6 включно. У другу (n = 15) – від 7 до 13. Під час вивчення особливостей вагового росту і м'ясної продуктивності бугайців, доведено, що подібність за системою В груп крові великої рогатої худоби між матір'ю і приплодом є інформативною щодо гомо- чи гетерозиготності останніх. Встановлено, що тварини за меншої кількості подібних із матір'ю антигенів переважають (на 9,3 %) на випробуванні від 8- до 18-місячного віку гомозиготних ровесників за середньодобовими приростами і мають у 18-місяців більшу (на 8,0 %) живу масу, що свідчить про їх кращу скороспілість. За меншої подібності антигенів між матір'ю і приплодом у нього у віці 15 та 18 місяців кращою є вираженість м'ясних форм відповідно на 7,8 % та 6,0 %. Після забою між гомозиготними і гетерозиготними бугайцями вірогідної різниці немає за м'ясною продуктивністю, у.т.ч. передзабійною живою і забійною масою. За добору синів із меншою кількістю подібних із матір'ю антигенів у них проявляється тенденція до зменшення (на 0,5 пункти) забійного виходу та (на 3,2 %) вмісту м'язів у тушах. Добір бугайців української м'ясної породи за меншої кількості антигенів системи В груп крові, подібних з матерями сприятиме поліпшенню їх вагового росту та вираженості м'ясних форм і надасть можливість прогнозувати майбутню м'ясну продуктивність

**Ключові слова:** селекція; жива маса; середньодобовий приріст; українська м'ясна порода; скотарство