



Journal homepage: <https://animalscience.com.ua/en>

Animal Science and Food Technology, 12(4), 78-86

Received: x.xx.2021 Revised: x.xx.2021 Accepted: x.xx.2021

UDC 636.2.081.2:[612.12+636.2-044.88]

DOI: 10.31548/animal2021.04.008

Influence of methods of selection of parents by the index of similarity of antigens in blood groups on weight and linear growth of bulls

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Abstract. In solving the problem of qualitative improvement of meat breeds, an important place is occupied by the improvement of methods of practical use of existing methods of selection of parental pairs using histocompatibility antigens, polymorphic proteins and blood group systems. The purpose of the work is to determine the effect of homogeneous and heterogeneous selection of parental pairs by blood group factors on the weight and linear growth of Ukrainian beef bulls. Ukrainian meat breed is bred using four breeds and is characterised by high variability in polymorphic traits. The type of selection of parents was determined by the index of antigenic similarity (r_{as}) of antigens of the B blood group system of cattle. To calculate the index of antigenic similarity of parents, the formula of D.A. Zhivotovskiy and A.M. Mashurov was used. The selection was considered homogeneous if the parents' $r_{as} \geq 0.268$, and heterogeneous if $r_{as} \leq 0.267$. It is proved that bulls that come from parents with higher r_{as} prevail in the test by average daily gain and have a higher live weight. For r_{as} in parents over 0.268, animals tend to improve growth rate by 8 months of age. This trend continues after weaning. Bulls sired by parents with r_{as} up to 0.267 have better average daily gains in the period from 15 to 18 months, which indicates their lower precocity. According to the index of antigenic similarity of parents over 0.268, animals are better in terms of meat forms at the age of 15 and 18 months. At 15 months of age, bulls obtained from homogeneous selection for r_{as} have smaller height measurements, the better developed front part of the body in terms of chest width and depth, and longer torso and hindquarters. Homogeneous

Suggested Citation:

Ugnivenko, A., & Natalych, O. (2021). Influence of methods of selection of parents by the index of similarity of antigens in blood groups on weight and linear growth of bulls. *Animal Science and Food Technology*, 12(4), 78-86.

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selection of parental pairs according to the index of similarity of antigens of the B blood group system improves the weight growth and expressiveness of meat forms in bulls of the Ukrainian beef breed

Keywords: selection, antigenic similarity, live weight, average daily gain, measurements, beef cattle breeding

Relevance

In the genetic progress of beef cattle, the rationale for the selection of parental pairs is of great significance. With a significant (about 90%) use of natural mating during its breeding, inbreeding is inevitable, which can increase homozygosity for recessive non-functional alleles, which can increase embryonic mortality (Upperman *et al.*, 2019) and reduce animal productivity. Currently, a growing problem in the Ukrainian meat breed is the decline in animal productivity. In females, it is manifested by weight growth, reproductive capacity and milk production. Therewith, the methods of selection of parents in local breeds of beef cattle are not sufficiently justified, which is a problem. Parental pairs are selected in different ways, regardless of the degree of their kinship. Therefore, inbred depression is manifested, particularly in local breeds.

One of the genetic methods that allow increasing the variability of traits in offspring is using antigens of the B blood group system during the selection of parents. They are protein or polysaccharide compounds that result in the development of antibodies. According to I.Y. Gorbatenko, and M.I. Gil (2006), antigens of erythrocytes and some proteins are used to determine the origin of animals, evaluate the gene pool of breeds and account for productivity indicators after the selection of parental pairs. Immunobiological features of blood groups,

based on immunogenetic analysis by the index of antigenic similarity, allow predicting of the results of parental selection by the features of its selection.

Therefore, it is essential to explore the weight and linear growth of beef bulls in the local Ukrainian beef breed, under the influence of the selection of parental pairs that have a different index of similarity of antigens (r_{as}) of the B blood group system.

Analysis of Recent Studies and Publications

One of the methods for assessing the genetic potential of animal productivity currently using the system of B blood groups is still. It combines relative simplicity of implementation on large livestock, with rather high results (Chizhova *et al.*, 2015). Despite the ambiguous results obtained when studying the relationship between blood groups and animal performance traits, research in this area continues, thanks to data obtained on cattle (Bukarov, 1995), sheep (Kopylov, 2019) and pigs (Goncharenko, 2009).

The data of studies (Nazarenko, 1986; Tyutyunnikov, 1995; Ivanova and Rossokha, 1996) indicate the relationship between blood groups on the one hand and some traits of cattle productivity, which have an essential role in cattle breeding, on the other hand, it

was established (Tyutyunnikov, 1995) that the lower the index of antigenic similarity of father and mother by blood group antigens, the higher the fertility of their daughters. After mating of cows and bulls at a low (up to 0.20) coefficient of antigenic similarity, the fertility of cows is higher by 5.7%, the number of walks, respectively ($p>0.999$) is lower by 0.14, and the service period is shorter by 21.6 days (Nazarenko, 1986). The most productive were identified (Ivanova & Rossokha, 1996) pairs “cow-bull” with a low degree (from 0.10 to 0.39) of antigenic similarity.

The opposite feature was obtained (Ugnivenko and Nosevych, 2014a) in females of the Ukrainian beef breed at the initial stages of complex reproductive crossing for reproductive traits. As the degree of antigenic similarity of parents by blood group factors increases, the average milk yield and lifetime milk yield per 1 day of the life of their daughters tend to increase (Uhnivenko and Nosevych, 2014b).

Thus, the purpose of the study was to determine the influence of the selection of parents by the index of antigenic similarity (r_{as}) of cattle of local Ukrainian beef breeds on the traits of weight and linear growth of their sons and to substantiate its optimal options for complex reproductive crossing.

Materials and Methods of Research

The research was performed on bulls in the breeding plant “Volia”, Zolotonosha district, Cherkasy region. Animals up to 6-7 months of age were raised near cows on suckling. After weaning, well-developed bulls were selected for the group and tested for the probability of origin by blood group factors. Until 8 – months of age, they were accustomed to a typical diet and conditions of detention. Intensive rearing was performed from 8- to 18-months of age. The general level of feeding was calculated to obtain an average daily gain of 1000 to 1200 g. During this period, the animals were fed with the fodder of their products according to the rations established by the standards. The mass of fodder eaten by each bull was calculated every ten days (two days in a row) by weighing the given fodder and its residues. Based on the consumed fodder, their energy value (in oat feed units) and costs per 1 kg of live weight gain were determined. Bulls were examined indoors with a tethered keeping system. Each time before giving a new portion, the fodder that remained in the feeder was weighed and determined how much it was consumed by the animals. There was no significant difference in its consumption between the bulls of the groups (Table 1).

Table 1. Fodder consumption from 8 to 18 months of age by bulls obtained from a different selection of parental pairs by the index of antigenic similarity (r_{as}), $M\pm m$

Fodder	r_{as} above 0.268 (n=15)		r_{as} up to 0.267 (n=11)	
	fodder unit	%	fodder unit	%
Concentrated	1480±31.5	49.5±0.85	1407±58.5	46.8±0.64
Rough	482±53.7	15.7±1.57	493±52.8	15.9±1.41
Juicy	543±35.9	17.9±1.00	554±60.4	18.1±1.59
Greens	536±41.7	17.4±1.69	568±57.0	19.2±2.09

Table 1. Continued

Fodder	r_{as} above 0.268 (n=15)		r_{as} up to 0.267 (n=11)	
	fodder unit	%	fodder unit	%
Total	3032±77.6	100.0	3017±124.7	100.0
Per 1 kg of growth	8.9±0.44	-	9.3±0.67	-

To calculate the index of antigenic similarity of parents, erythrocyte antigens of bovine blood groups according to the B system were used. It was determined by the formula of Zhivotovsky-Mashurov (1974):

$$r_{as} = \frac{S}{n_1 + n_2 - S}, \quad (1)$$

where r_{as} – index of antigenic similarity of parents; S – the number of antigens that coincide in the father and mother; n_1 – the total number of antigens detected in the mother; n_2 – the total number of antigens detected in the father.

To analyse changes in weight and linear growth of bulls, they were grouped by the value of the index of antigenic similarity of parents: Group I – r_{as} over 0.268 and Group II – r_{as} up to 0.267. Meat forms in animals were evaluated according to the guidelines (Prakhov *et al.*, 1972). The obtained data were processed using the methods of variation statistics. To

determine the degree of variability of traits, its coefficient (Cv, %) was calculated by the ratio of the standard deviation to the average value for the group.

Research Results and their Discussion

Animals with an index of antigenic similarity (r_{as}) in parents of 0.268 and more tend to deteriorate the growth rate up to 8-months of age. Perhaps it is due to the worse milk productivity of their mothers, which offsets the positive effect of homogeneous selection on the growth rate of offspring in the suckling period. After weaning, it mainly tends to prevail over the indicators of peers from parents with r_{as} up to 0.267 (Table 2). It contradicts the data (Romanov *et al.*, 1984), according to which the place has a better growth rate in animals obtained from heterogeneous selection for r_{as} .

Table 2. Average daily gain of bulls obtained with different indexes of antigenic similarity (r_{as}) of parents

Average daily increase for the period: from-to	r_{as} over 0.268			r_{as} to 0.267		
	<i>n</i>	<i>M</i> ± <i>m</i>	Cv, %	<i>n</i>	<i>M</i> ± <i>m</i>	Cv, %
0-8	33	872±21.6	14.0	35	906±20.3	13.1
8-12	34	1128±36.4	18.5	35	1075±37.8	20.5
12-15	32	1188±50.2	23.5	32	989±56.1	31.6
8-15	32	1144±33.3	16.2	32	1051±38.5	20.4
15-18	27	903±57.2	32.3	21	932±87.6	42.1
8-18	28	1084±26.0	12.5	21	1032±37.2	16.1

In bulls obtained from parents with r_{as} up to 0.267, the average daily gains are better in the period from 15 to 18 months (Table 2), which indicates their lower precocity. Due to faster growth in the suckling period, outbred animals

at the age of 8 months tend to increase their live weight. The higher growth rate of bulls from parents with r_{as} over 0.268 during these periods contributes to an increase in their live weight (Table 3).

Table 3. Live weight of bulls obtained with different index of antigenic similarity (r_{as}) of parents

Live weight at age: month	r_{as} over 0.268			r_{as} to 0.267		
	<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	35	32.5±0.60	10.8	35	32.5±0.58	10.5
8	35	247±5.4	12.8	35	253±5.1	11.6
12	34	384±7.0	10.5	35	383±6.7	10.2
15	32	490±9.6	10.9	33	472±9.4	11.2
18	28	574±10.3	9.3	21	558±11.5	9.2

The tendency for the advantage in the live weight of animals from heterogeneous selection begins to appear at 15 months of age. Heterogeneous bulls have greater variability in average daily gain compared to homogeneous bulls. It indicates their unequal adaptation to environmental conditions, both during the suckling period and after weaning. The coefficient of variation of live weight obtained from a homogeneous and heterogeneous selection of bulls in all age periods have no difference.

Bulls from homogeneous and heterogeneous selection for r_{as} maintain a fairly high growth rate until 18 months of age. The offspring of parents with similar antigens grow faster for a longer time. Their average daily live weight gain from 8 to 18 months is higher compared to their peers from the heterogeneous selection. Thus, at the first stages of the establishment of the Ukrainian beef breed, a homogeneous r_{as} selection of parents improved the average daily weight gain of bulls.

Homogeneous mating increases the tendency of animals to stop growing early and increases feed costs for growth.

The results of this study were compared with those obtained on Aberdeen Angus (Romanov *et al.*, 1984) and Red Steppe (Nazarenko & Voronenko, 1986) breeds. According to L.M. Romanov and colleagues (1984), the group of bulls and heifers born from parents with a high (more than 0.308) index of antigenic similarity are smaller. Growth retardation in young animals was observed in the following age periods. At the age of 12 months, the difference is significant. The difference in body weight between heifers from parents with low and high similarity index at 15 months of age was 13 kg ($P<0.999$), and at 18 months – 16 kg ($P>0.999$) in favour of the first ones (Nazarenko & Voronenko, 1986).

The Ukrainian beef breed was established by complex reproductive crossbreeding of Kian (K 3/8), Charolais (Ch 3/8), Simmental (S 1/8),

Grey Ukrainian (GU 1/8) cattle (Ugnivenko *et al.*, 2008). Homogenealogical selection of animals of four initial breeds with large differences in their pedigrees results in heterosis by average daily gain and live weight after 8 months at the first stages of complex reproductive crossing. Probably, the adverse effects of heterogeneous selection on the index of antigenic similarity regarding the growth of bulls in the initial stages of breeding are levelled by the genetic background of significantly different crossbreds. The best average daily gains from

birth to 8 months of age are the result of better milk production of cows, which, in combination with the bulls matched to them, had a low index of similarity for blood group factors.

Meat forms of bulls obtained from parents with different r_{as} are different. Animals with a higher index of antigenic similarity are better in the expression of meat forms at 15 and 18 months (Table 4). Breeding cattle for better-expressed meat forms contributes to obtaining from it a higher growth rate up to 18 months of age and reducing feed costs for growth.

Table 4. Expression of meat forms and measurements of bulls obtained with different indexes of antigenic similarity (r_{as}) of parents

Feature	r_{as} over 0.268		r_{as} up to 0.267	
	<i>n</i>	<i>M</i> ± <i>m</i>	<i>n</i>	<i>M</i> ± <i>m</i>
Meat forms (points) at age: 15 months	19	54.1±0.93	14	52.8±0.97
Meat forms (points) at age: 18 months	15	55.6±0.79	11	53.8±1.07
Measurements at the age of 15 months, cm.				
Height at the withers	3	126.7±4.32	5	127.2±3.51
Height at the sacrum	3	137.3±4.32	5	138.0±3.89
Breast depth	3	68.7±0.41	5	66.4±1.60
Breast width	3	46.3±1.78	5	46.2±1.19
Width in clusters	3	45.0±1.41	4	46.3±2.02
Oblique length of the body (stick)	3	152.7±5.21	4	145.5±3.35
Oblique rear length	3	52.0±2.55	4	50.5±2.13
Chest girth	3	188.0±3.08	4	190.0±3.24
Heel girth	3	20.8±0.20	4	20.8±0.35

At 15 months of age, bulls with a higher index of antigenic similarity (r_{as} more than 0.268) have smaller height measurements, the better developed front part of the body in terms of chest width and depth, and longer torso and rear and heel girth. Animals from parents with a lower index of

antigenic similarity (r_{as} up to 0.267) are relatively taller, with wider clusters and larger chest girth.

Conclusions and Perspectives

Selection of parents with a high (homogeneous) index of antigenic similarity (r_{as} more than 0.268)

for erythrocyte antigens of the B blood group system with large differences in their genealogies increases the average daily gain and live weight of sons and improves the expression of meat forms.

References

- [1] Bukarov, N.G. (1995). Ispol'zovaniye polimorfizma antigenov eritrotsitov i glavnogo kompleksa tkanevoy sovmestivosti v razvedenii i sovershenstvovanii krupnogo rogatogo skota [The use of polymorphism of erythrocyte antigens and the main complex of tissue compatibility in the breeding and improvement of cattle]. Dubrovitsy, 34. (in Russian).
- [2] Goncharenko, G.M. (2009). Struktura populyatsiy sel'skokhozyaystvennykh zhivotnykh v zapadnoy Sibiri po geneticheskim markoram i ikh ispol'zovaniye v selektsii [The structure of populations of farm animals in western Siberia by genetic markers and their use in breeding]. Russian Academy of Agricultural Sciences. Novosibirsk, 254. (in Russian).
- [3] Horbatenko, I.Yu., & Hyl', M.I. (2006). Biologiya produktyvnosti sil's'kohospodars'kykh tvaryn. Navchal'nyy posibnyk [Biology of productivity of farm animals. Textbook]. Mykolaiv. 218. (in Ukrainian).
- [4] Zhivotovskiy, D.A., & Mashurov, A.M. (1974). Metodicheskiye rekomendatsii po statisticheskomu analizu immunogeneticheskikh dannykh dlya ispol'zovaniya v selektsii zhivotnykh [Methodical recommendations for the statistical analysis of immunogenetic data for use in animal breeding]. Dubrovitsy. 29. (in Russian).
- [5] Ivanova, N.V., & Rossokha V.I. (1996). Immunogeneticheskaya geterogennost' kak oposredovannyi faktor regulirovaniya protsessa vosproizvodstva [Immunogenetic heterogeneity as an indirect factor in the regulation of the reproduction process]. Molecular genetic markers of animals. Kiev. 55-60. (in Russian).
- [6] Kopylov, I.A. (2019). Sovershenstvovaniye porody sovet'skiy merinos na osnove genofonda avstraliyskoy selektsii i immunogeneticheskikh markerov [Improvement of the Soviet Merino breed based on the gene pool of Australian breeding and immunogenetic markers]. All-Russian Research Institute of Sheep and Goat Breeding. Stavropol. 114. (in Russian).
- [7] Nazarenko, V.G. (1986). Ispol'zovaniye immunogeneticheskikh markerov dlya uluchsheniya reproduktivnoy funktsii krupnogo rogatogo skota. Molekulyarno-geneticheskiye markory zhivotnykh [Use of immunogenetic markers to improve the reproductive function of cattle]. Molecular genetic markers of animals. Kiev: Agrarna nauka. 62-63. (in Russian).
- [8] Prakhov, L.P. (1972). Otsenka bykov myasnykh porod po kachestvu potomstva i ispytaniye bychkov po intensivnosti rosta, oplate korma, myasnym formam [Evaluation of bulls of beef breeds by the quality of offspring and testing of bulls by the intensity of growth, payment for feed, meat forms]. Moskva: Pechatno-mnozhitel'naya grupa VNIIMS. 18. (in Russian).
- [9] Romanov, L.M., Balakhnin, I.A., & Ugnivenko, A.M. (1984). Regulirovaniye vosproizvodstva u skota myasnykh porod [Regulation of reproduction in beef cattle]. Livestock raising. 11. 60-62. (in Russian).

- [10] Tyutyunnikov, A.V. (1995) Vosproizvoditel'naya sposobnost' krupnogo rogatogo skota v svyazi s polimorfizmom grupp i belkov krovi [Reproductive ability of cattle due to polymorphism of blood groups and proteins. Biological science at the service of animal husbandry]. Nauka. 60-64. (in Russian).
- [11] Ugnivenko, A.M., Koropets', L.A., & Nosevych D.K. (2008). Ukrayins'ka m"yasna poroda velykoyi rohatoyi khudoby. Monohrafiya [Ukrainian meat breed of cattle. Monograph]. Kyiv. Kyivska Pravda. 130. (in Ukrainian).
- [12] Ugnivenko, A.M., & Nosevych, D.K. (2014). Vidtvoryuval'na zdattist' m"yasnykh samyts' velykoyi rohatoyi khudoby zalezhno vid pidboru bat'kiv za faktoramy hrup krovi [Reproductive capacity of beef females depending on the selection of parents by blood group factors]. Agriculture. Scientific tr. Sworld. 2(27). 78-83. (in Ukrainian).
- [13] Ugnivenko, A.M., & Nosevych, D.K. (2014). Molochnist' m"yasnykh koriv zalezhno vid typu pidboru bat'kiv za faktoramy hrup krovi [Milk yield of beef cows, depending on the type of selection of parents by blood group factors]. Agriculture. Scientific tr. Sworld. 2(27). 83-87. (in Ukrainian).
- [14] Upperman, L.R., Kinghorn, B.P., MacNeil, M.D., & Van Eenennaam, A.L. (2019). Management of lethal recessive alleles in beef cattle through the use of mate selection software. Genetics Selection Evolution, 51(1), 1-16.
- [15] Chizhova, L.N. Shumayenko, S.N., Barnash, Ye.N., & Sharko, G.N. (2015). Geneticheskaya sochetayemost' roditel'skikh par v ovtsevodstve i produktivnost' potomstva [Genetic compatibility of parental pairs in sheep breeding and productivity of offspring. Innovations and modern technologies in agriculture]. 53-56. (in Russian).

Вплив способів підбору батьків за індексом подібності антигенів системи В груп крові на ваговий і лінійний ріст бугайців

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Анотація. У розв'язанні проблеми якісного поліпшення м'ясних порід важливе місце посідає удосконалення способів практичного використання наявних методів підбору батьківських пар за використання антигенів гістосумісності, поліморфних білків та систем груп крові. Метою роботи є визначення впливу гомогенного і гетерогенного підбору батьківських пар за факторами груп крові на ваговий і лінійний ріст бугайців української м'ясної породи. Українська м'ясна порода виведена з використанням чотирьох порід і характеризується високою мінливістю за поліморфними ознаками. Тип підбору батьків визначали за індексом антигенної подібності (r_{as}) антигенів системи В груп крові великої рогатої худоби. Для розрахунку індексу антигенної подібності батьків використали формулу Д. А. Животовського і А. М. Машурова. Гомогенним вважали підбір за r_{as} батьків $\geq 0,268$, а гетерогенним при $r_{as} \leq 0,267$. Доведено, що бугайці, які походять від батьків за більшого r_{as} переважають на випробуванні за середньодобовими приростами і мають більшу живу масу. За r_{as} у батьків понад 0,268 тварини мають тенденцію до поліпшення швидкості росту до 8-місячного віку. Після відлучення ця тенденція зберігається. У бугайців, отриманих від батьків із r_{as} до 0,267 середньодобові прирости кращі у період від 15 до 18 місяців, що свідчить про меншу їх скороспілість. За індексу антигенної подібності батьків понад 0,268 тварини кращі за вираженістю м'ясних форм у віці 15 та 18 місяців. У 15 місяців бугайці, отримані від гомогенного підбору, за r_{as} мають менші висотні проміри, краще розвинену передню частину тулуба за шириною і глибиною грудей, довший тулуб і зад. Гомогенний підбір батьківських пар за індексом подібності антигенів системи В груп крові призводить до поліпшення у бугайців української м'ясної породи вагового росту та вираженості м'ясних форм

Ключові слова: підбір, антигенна подібність, жива маса, середньодобовий приріст, проміри, м'ясне скотарство