ANIMAL SCIENCE AND FOOD TECHNOLOGY

Journal homepage: https://animalscience.com.ua/en
Animal Science and Food Technology, 13(1), 57-65
Received: 21.12.2021 Revised: 15.01.2022 Accepted: 08.02.2022

UDC 664.643.1
DOI: 10.31548/animal.13(1).2022.57-65

Meat Production and Growth of Internal Organs and Adipose Tissue in Bulls, Obtained from the Selection of Their Parents According to the Index of Similarity of System B Antigens of Blood Groups

Anatolii Ugnivenko*, Oleksandr Natalych

National University of Life and Environmental Sciences of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine

Abstract. During reproductive crossing, the genetic diversity of animals increases and the problem of consolidating livestock by type and productivity arises. Blood group antigens are one of the factors that indicate genetic variability, so they can be used as markers when selecting parent pairs. The purpose of this study was to analyse the meat productivity, development of internal organs and accumulation of adipose tissue in 18-month-old bulls derived from different selection of their parents according to the index of antigenic similarity (r_{as}) of the B system of blood groups at the first stages of a complex reproductive cross between Simmental and grey Ukrainian cattle with breeders of Charolais and Chianina breeds. According to the value of r_{as}, the bulls were divided into two groups. In the first – from a homogeneous selection of parents (over 0.268; n=9); in the second – from heterogeneous (r_{as} up to 0.267; n=7). After slaughtering the bulls, the meat productivity, mass, and output of the head, liver, lungs, and other organs and glands of internal secretion were determined. Intermuscular, interstitial, perirenal, pregastric, intestinal, and pericardial fat were separated and weighed. With homogeneous selection of parents, their sons, in comparison with their peers from heterogeneous mating, show a tendency to increase the content of muscles (by 4.2%), fat tissue in carcasses (by 12.4%), including between muscles (by 1.1 points). There is 11.6% less pulp per kilogram of bones, 17.2% worse muscle tissue index, 7.8% less absolute weight of liver, 10.0% of kidney, 27.8% of heart, head – by 2.0% and lungs – by 11.6%. In bulls, from the heterogeneous selection of parents with r_{as} to 0.267, there is 7.2% more fat tissue in the body, including internal fat tissue by 7.8%, the relative mass of bones is 0.8 points higher. The practical use of homogeneous selection according to antigens of blood groups of crossbreed parents allows improving the morphological composition of the carcasses of their offspring. Heterogeneous selection promotes better development of internal organs, which are less valuable slaughter products

Keywords: meat breeding, reproductive crossing, homogeneous selection, heterogeneous selection

Suggested Citation:
Ugnivenko, A., & Natalych, O. (2022). Meat production and growth of internal organs and adipose tissue in bulls, obtained from the selection of their parents according to the index of similarity of system B antigens of blood groups. *Animal Science and Food Technology*, 13(1), 57-65.

**Corresponding author*

Introduction

During the breeding of the Ukrainian beef cattle breed created by complex reproductive crossing of Chianina (3/8), Charolais (3/8), Simmental (1/8), grey Ukrainian (1/8) cattle, there is a deterioration of productivity characteristics due to lack of justification of methods of selection of parents. At the current stage, polymorphic erythrocyte antigens of the B system of blood groups are increasingly used for the selection of animals to achieve a certain level of heterogeneity of livestock, they are ambiguously related to the reproductive capacity, growth rate and viability of animals. Selection of parents with low similarity of system B blood group antigens has a positive effect on offspring. In pure-bred breeding, the use of homogeneous mating almost always leads to a negative effect – a decrease in the viability, fertility, milk yield and meat productivity of livestock. This creates prerequisites to believe that the heterogeneous selection of parents by blood group factors in breed populations will contribute to the preservation of genetic variability and higher productivity of offspring.

The meat productivity of bulls, obtained from the selection of parents based on blood group factors in cattle of Ukrainian breeds at the first stages of complex reproductive crossing, has been understudied. Many issues regarding the influence of parental selection on the growth of internal adipose tissue and organs of the offspring are still understudied as well. Therefore, it is worth investigating the influence of the selection of parental pairs according to the index of similarity (r_{as}) of antigens of the B system of blood groups on meat productivity and the growth of internal organs and adipose tissue of bulls obtained at the first stages of complex reproductive crossing, for the foremost importance of their stock in production beef.

The use of the B blood group system is currently one of the methods for predicting the productivity of cattle. Numerous studies on the Ukrainian beef cattle breed indicate ambiguous results of the relationship between blood groups and signs of its productivity. It was proved [1] the negative influence of homogeneous selection of parents after them on the sperm productivity of offspring. Thus, the volume of ejaculate is 7.4% greater in Prydniprovskyi type bulls obtained from heterogeneous selection than in peers from homogeneous selection, and by 9.1% in Chernihiv type bulls. In terms of sperm motility, animals obtained from parents with a lower index of antigenic similarity (r_{as}) outperform peers by 6.5 and 9.8%, respectively. In terms of sperm concentration – by 2.4 and 16.7%. An increase in the difference between father and mother in erythrocyte antigens increases the life expectancy of their sons. The opposite feature was obtained [2] on cows. Due to the increase in the antigenic similarity of the parents in terms of blood group factors, their daughters tend to increase in live weight and reproductive capacity.

The amount of adipose tissue in animals varies depending on the species [3], breed [4], age [5] and feeding [6]. The problem of the growth of internal adipose tissue in animals obtained from varied selection of parents for r_{as} is not properly covered. Fat under the skin, between the muscles and in the middle of the muscles is usually examined [7]. Information on visceral fat in different depots would be useful in explaining differences in slaughter yield (carcasses) levels. The accumulation of fat is also of significant importance due to its connection with the increase in feed consumption for live weight gain [8]. Its distribution by fat depots is simultaneously the subject of accounting for the generation of waste in cattle. About 1/4-1/3 of the main chemical components: water, protein, and fat are found in parts of the body that are not part of the carcass [3]. The importance of beef fat, which has a low nutritional value in the processing industry, is decreasing. Healthy nutrition is aimed at reducing the calorie content of products and partially replacing fats of animal origin with triglycerides with polyunsaturated fatty acids, introducing raw materials of plant origin into recipes. Beef fat in burger patties is replaced with tiger nut oil emulsion [9]. In sausages, it is replaced by jelly-containing emulsion systems, including peanut and linseed oil [10]. In cutlets – olive oil for reducing the share of internal fatty tissue in animals for slaughter [11].

By-products after animal slaughter have nutritional value. Liver, heart, tongue, kidneys are an essential source of protein, including essential amino acids, vitamins, and mineral elements [12]. Cattle liver is used as a raw material to produce pasta and pastes [13]. The kidneys, lungs, and heart contribute to increased absorption of non-heme iron [14]. In cattle of similar origin, the weight of offal is influenced by pre-slaughter live weight [15]. The total amount of edible and inedible offal substantially depends on the breed and age of animals [16]. The weight of testes depends on age and puberty and increases with intensive feeding [17].

Currently, in the Ukrainian meat breed, the coverage of the features of meat productivity, the deposition of internal adipose tissue and organs and glands in bulls from parents with different similarity index of antigens of the B system of blood groups is necessary to produce beef efficiently and purposefully with a higher yield of its valuable components. *The purpose of this study* was to determine the influence of the selection of parental pairs according to the B blood group system on the characteristics of meat productivity, the distribution of internal adipose tissue, and the growth of organs and glands of cattle obtained at the initial stages of complex reproductive crossing.

Materials and Methods

The analysis was carried out in 2021 based on the materials of the production activity and breeding records of the breeding plant "Volya" of the Zolotonoskyi district of the Cherkasy Oblast, collected in creating the Ukrainian meat breed of cattle. It was created by complex reproductive crossing of mother stock of the Simmental and grey Ukrainian breeds with Charolais and Chianina breeds. After verifying the authenticity of the origin of the bulls by blood group factors, 2 groups were formed according to the value of the antigenic similarity index of the parents: Group I – r_{as}=over 0.268 (from homogeneous selection, n=9) and Group II – r_{as}=up to 0.267 (from heterogeneous selection, n=7). At the same time, local bulls were raised in a herd. After the end of rearing, two balanced groups of animals were selected at the age of 18 months. Before slaughter, the permissible difference in live weight and age between animals did not exceed 5% (Table 1).

***Table 1**. Live weight and age of bulls from homogeneous and heterogeneous selection of parents before slaughter*

Feature	Groups of animals according to the value of the index of antigenic similarity (r_{as})			
	over 0.268 (n=9)		up to 0.267 (n=7)	
	M	lim	M	lim
Age, days	547	from 520 to 574	547	from 520 to 574
Live weight, kg	594	from 588 to 600	580	from 570 to 590

To calculate the index of antigenic similarity of the parents, erythrocyte antigens of cattle according to the B system of blood groups, published in the catalogue [18], were used. The index was calculated according to the formula cited in the paper [19]:

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

where r_{as} is the ratio of antigenic similarity of parents; S is the number of coincident antigens in the father and mother; n_1 is the total number of antigens detected in the mother; n_2 is the total number of antigens detected in the father.

The conditions for rearing bulls met the requirements of the technology of specialised meat cattle breeding. Until the age of 6-7 months, the animals were reared under suckling. After weaning from their mothers until the age of 8 months, they were accustomed to a typical diet and conditions of confinement. In the period from 8 to 18 months of age, intensive rearing of bulls was carried out. The general level of their feeding was calculated to obtain average daily gains from 1,000 to 1,200 g. The amount of feed consumed by animals was individually monitored. The list of fodder that was fed to the animals depended on the season of the year. In the spring and summer period, they fed the grass of crops according to the scheme of the green conveyor and compound feed of their production. It comprised corn grain 25%, barley – 30%, wheat bran – 25%, sunflower grist – 15%, minerals and vitamins – 4.5%, salt – 0.5%. In the autumn-winter period, a large part of the diet consisted of hay, silage, and root vegetables. The mass of fodder eaten by each bull was calculated every decade (two days in a row) by weighing the given fodder and its residues. During the period from 8 to 18 months, there was no significant difference in the consumption of all feed by the bulls (Table 2).

***Table 2**. Feed consumption by bulls from 8 to 18 months of ageter*

Feed	r_{as} 0.268 or more	r_{as} up to 0.267
	M ± m	M ± m
Concentrated, feed units	1480±31,5	1407±58,5
Concentrated, %	49,5±0,85	46,8±0,64
Rough, feed units	482±53,7	493±52,8
Rough, %	15,7±1,57	15,9±1,41
Juicy, feed units	543±35,9	554±60,4
Juicy, %	17,9±1,00	18,1±1,59
Green, feed units	536±41,7	568±57,0
Green, %	17,4±1,69	19,2±2,09
Total, feed units	3032±77,6	3017±124,7
Per 1 kg of weight gain, feed units	8.9±0.44	9.3±0.67

To determine the meat productivity of the animals, they were slaughtered at the Cherkasy meat processing plant per the requirements of DSTU 4673:2006 [20] and DSTU 3938-99 [21]. Before that, they were weighed before and after a 24-hour fasting period with free access to water (pre-slaughter live weight). After slaughter, the slaughter weight (of a pair of carcasses) was determined. According to its relation to the pre-slaughter live weight, the slaughter yield (carcasses) was calculated. Net weight gain (Ng) for each day of life was determined per the ICAR requirements [22] according to the formula (2):

$$Ng = \frac{slaughter\ weight\ (carcass), kg \times 1000}{age\ at\ slaughter,\ days} \quad (2)$$

After cleaning the carcasses, the absolute mass of trimmings and their share of the slaughter weight (carcass) were determined. The left half-carcasses of the bulls were buried. Subsequently, the mass of bones, muscle tissue, including higher, first, second grade, tendons and ligaments, and fat tissue was weighed. Adipose tissue was weighed and divided into subcutaneous (subcutaneous) and intermuscular fat per DSTU 3938-99 [21]. Perirenal fat was separated from the kidneys from the inner side of the lower back and pelvis. The fat covering the stomach was separated from the internal omentum, and the fat surrounding the intestine and deposited in the mesentery was also separated. The mass of total adipose tissue was calculated as the sum of internal fat and fat from the carcass.

After deboning, the muscle-bone ratio was determined as the ratio of muscle tissue to bones [3]. The index of muscle tissue was determined by the ratio of muscle tissue to the mass of bones, fat tissue, and tendons and ligaments [23]. After slaughter, the mass of offal was determined, including head with horns, liver, lungs, heart, kidney, brain, and testicles and their ratio (%) to pre-slaughter live weight.

After slaughter, the weight of a pair of skins was determined on the scales without the remains of muscle and fatty tissue (if their weight did not exceed 500 g), blood clots and impurities and "bulk". The length of the skin was measured along the spine from the upper edge of the neck midway between the horns to the line connecting the ends of the buttocks. Width was measured along the line located in the middle third of the skin. Before measuring, the skin was spread out on the table, folds and other irregularities were smoothed out without stretching it in length and width.

During the statistical processing of the data, the average values (M) by group, the statistical error of the average (±m), the difference between the averages and its probability were determined. To characterise the degree of variability of signs, the coefficient of variability (Cv, %) was calculated as the ratio of the mean square deviation to the average value for the group.

Results and Discussion

Under homogeneous selection of parents according to the index of antigenic similarity, their sons have a tendency to increase live weight and weight after starvation, compared to peers born from ancestors under heterogeneous selection (Table 3). Due to the heterogenous selection, the bulls have somewhat more (by 7.1%) adipose tissue, including internal (by 7.8%). The obtained data indicate a tendency to precocity in animals under the influence of heterogeneous selection of parents by blood group factors. Precocious animals are prone to early obesity [24].

***Table 3**. Slaughter signs of bulls at the age of 18 months, obtained from varied selection of parents by r_{as}*

Feature	over 0.268			up to 0.267		
	n	M±m	Cv, %	n	M±m	Cv, %
Live weight, kg	9	594±16.5	7.9	7	580±24.1	10.2
Live weight after 24-hour starvation, kg	9	562±14.8	7.4	7	559±19.0	8.3
Slaughter weight (carcass), kg	9	342±12.6	10.4	7	341±13.5	9.7
Slaughter yield (carcasses), %	9	60.8±0.77	3.6	7	61.0±0.91	3.6
Net increase, g	7	597±24.6	10.1	7	594±27.0	8.2
Total adipose tissue, kg	7	20.9±2.96	7.2	4	22.4±2.75	4.8
Internal adipose tissue, kg	9	14.1±1.34	26.9	7	15.2±1.46	23.6
Internal adipose tissue to total, %	9	67.5±0.23	26.4	7	67.9±0.23	20.6

This leads to a 4.5% increase in feed consumption (feed unit) per kilogram of live weight gain (Table 2). More intense deposition of fat is associated with an increase in precociousness, which is combined with a decrease in the size of animals. Relatively more precocious cattle for beef production are less efficient due to reduced meat productivity and higher feed costs per unit of production. For the formation of adipose tissue, animals spend more feed nutrients than for the formation of the muscle part of the carcass.

In the bulls from heterogeneous selection, there is a tendency towards weight decrease (by 2.5%) of half-carcasses compared to peers from homogeneous selection (Table 4).

***Table 4**. Morphological composition of half-carcasses of bulls obtained from varied selection of parents by r_{as}*

Feature	Over 0.268			Up to 0.267		
	n	M±m	Cv, %	n	M±m	Cv, %
Half-carcass weight, kg	7	174.5±5.78	14.2	7	170.3±6.87	16.8
Bones, %	8	16.2±0.23	0.6	7	17.0±0.46	1.1
Muscle tissue, kg	8	133.2±4.60	12.2	7	127.8±4.55	11.1
Muscle tissue, %	8	76.3±1.17	3.1	7	76.0±1.62	4.0

Table 4, Continued

Feature	Over 0.268			Up to 0.267		
	n	M±m	Cv, %	n	M±m	Cv, %
Including high grade, %	8	19.9±2.35	6.2	4	20.4±3.08	5.3
First grade, %	8	41.1±3.18	8.4	5	43.0±9.05	18.1
Second grade, %	8	39.0±1.72	4.5	4	38.2±2.94	5.1
Tendons and ligaments, %	8	3.7±0.41	1.1	7	3.8±0.59	1.4
Adipose tissue of the carcass to the total, %	6	32.5±0.84	1.9	4	32.1±0.35	0.6
Including subcutaneous fat to total, %	8	22.5±2.81	7.4	4	23.2±3.32	5.7
Fat between the muscles, %	6	10.0±1.65	3.7	4	8.9±2.70	4.7
Trimmings, kg	4	4.9±0.33	12.0	3	4.6±0.97	30.0
Crops, %	4	0.9±0.08	16.0	3	0.8±0.17	30.2
Musculoskeletal ratio	6	4.7±0.12	0.3	4	4.2±0.21	0.4
Index of muscle tissue	6	3.2±0.19	0.4	4	2.9±0.19	0.3

They are inferior in the content of muscle tissue, but they tend to increase the relative amount of pulp of the highest and first grades and to decrease the amount of the second grade. For beef of the highest grade, which includes muscle tissue without fat, tendons, and ligaments in animals from heterogeneous selection, it is 0.5 points more. Beef of the second grade, which according to the sausage classification includes a large amount of fat between the muscles, which was not separated during ageing, has 0.8 points more in bulls from homogeneous selection.

Buckeyes obtained from parents by homogeneous mating prevail by 12.4% of their peers from heterogeneous origin in terms of the content of fatty tissue between the muscles in the carcass. Fat between muscles leads to their displacement [3]. Therefore, more accumulation of this fat in cattle due to homogeneous selection has a noticeable effect on the expressiveness of its meat forms, which is characterised by less angularity and better development. A greater proportion of adipose tissue between muscles in homozygous animals is also subject to excessive waste formation from them. In the carcasses of animals from homogeneous selection, fatty tissue under the skin is worse (by 0.7%). In it, reserve fats, which perform supporting, protective, and heat-insulating functions in the body, and energy reserves and water depots are deposited less.

The most active accumulation of adipose tissue under the skin in cattle occurs in the period from 7 to 12 months of life, and between the muscles – from 12 to 18 months [5]. Homogeneous selection of parents by r_{as} in the Ukrainian beef cattle breed has the maximum positive effect on the normal growth of fat tissue of 18-month-old bulls between the muscles, which improves the nutritional properties of beef, due to its much higher growth rate during this period. With a homogeneous selection of parents, a decrease in the accumulation of subcutaneous adipose tissue can be observed in sons. According to data [7], homozygosity is negatively related to fat and its thickness in the back of the body. Evaluation [25] in pure-bred populations of Charolais, Limousin, Simmental, Hereford, and Angus beef cattle also proved that homozygous animals have a lower fat mass in the carcass. The analysis of the yield and quality of beef according to muscle tissue indices and the muscle-bone ratio shows a pronounced tendency towards the improvement of the listed traits in bulls due to homogeneous selection. For each kilogram of bones, they have more pulp. These cattle also have a better index of muscle tissue.

Due to heterogeneous selection, the level of deposition of internal adipose tissue is 7.8% higher in bulls (Table 5). They have a higher percentage of fat around the kidneys and from the intestines, but less from the foreskin and pericardium.

***Table 5**. The output of internal fat in 18-month-old bulls obtained from varied selection of parents by r_{as}*

Feature	Over 0.268			Up to 0.267		
	n	M±m	Cv, %	n	M±m	Cv, %
Live weight after starvation, kg	9	562±14.8	7.4	7	559±19.0	8.3
Internal adipose tissue, kg	9	14.1±1.34	26.9	7	15.2±1.46	23.6
Internal adipose tissue, % to pre-slaughter live weight	9	2.5±0.23	26.4	7	2.7±0.23	20.6
Including fat from stomachs, kg	8	4.0±0.60	41.3	4	4.2±1.01	40.3
Fat from stomachs, %	8	28.4 ±1.56	21.1	4	27.6±2.75	24.9
Pericardial fat, kg	8	1.0±0.12	33.7	4	0.8±0.28	59.7
Pericardial fat, %	8	7.1±0.70	37.0	4	5.3±1.96	81.2

Table 5, Continued

Feature	Over 0.268			Up to 0.267		
	n	M±m	Cv, %	n	M±m	Cv, %
Perirenal fat, kg	8	3.1±0.89	78.6	4	3.6±0.92	42.6
Perirenal fat, %	8	22.0±1.89	36.3	4	23.7±2.97	31.3
Fat from intestines, kg	8	6.0±0.39	17.5	4	6.6±0.69	17.6
Fat from intestines, %	8	42.5±3.26	26.8	4	43.4±2.99	16.3

Perirenal fat is formed early, later – subcutaneous and other fats [5; 6]. Perirenal fat contains the least amount of moisture and protein, and the highest percentage (about 90%) of extracted fat [3]. Adrenal fat has the lowest value. Therewith, it is associated with increased feed costs during animal rearing. One of the disadvantages of excessive deposition of internal adipose tissue is its negative correlation with the content of fat inside the muscles [26]. In animals prone to accumulation of internal fat, the degree of marbling of beef will decrease. Thus, this fat not only does not have an exceptional value, but factually requires added costs for its production and is unprofitable. A considerable amount of the homogenous selection of pericardial fat in bulls can be explained by the propensity of some such individuals to excessive obesity and the manifestation of heart failure, which is often observed during intensive breeding of cattle for meat [27]. Excessive deposition of fat on the omentum in cattle under the same conditions of its maintenance is caused by genetic loci [28]. The genes involved in proteolysis, transcription, transport, and immune functions, and oxidative processes differ among cattle at different live weight gains and feed consumption [29].

The homogenous selection of parents in bulls leads especially to a pronounced suppression of the growth of internal organs: liver by 7.8%, kidneys – by 10.0%, heart – by 27.8%, head – by 2.0%, lungs – by 11.6% (Table 6). Worse development of the lungs leads to a decrease in redox reactions.

***Table 6**. The mass of organs and tissues that are not part of the carcass in bulls obtained from varied selection of parents by r_{as}*

Organ	Over 0.268			Up to 0.267		
	n	M±m	Cv, %	n	M±m	Cv, %
Head, kg	9	19.6±0.87	12.6	4	20.0±1.16	10.0
Head, %	6	3.3±0.11	7.7	4	3.4±0.11	5.5
Liver, kg	6	6.4±0.26	9.2	4	6.9±0.62	15.7
Liver, %	6	1.2±0.05	9.1	4	1.2±0.06	8.1
Lungs, kg	6	4.3±0.15	7.5	4	4.8±0.83	30.1
Lungs, %	6	0.8±0.02	7.3	4	0.8±0.14	30.3
Kidneys, kg	6	1.0±0.13	29.6	4	1.1±0.11	18.2
Kidneys, %	6	0.2±0.04	49.0	4	0.2±0.03	28.6
Intestines, kg	4	8.0±0.52	11.3	3	8.4±0.33	5.6
Intestines, %	4	1.4±0.14	17.5	3	1.5±0.11	10.4
Spleen, kg	4	1.3±0.28	36.8	3	1.2±0.29	35.2
Spleen, %	4	0.2±0.06	39.9	3	0.2±0.04	29.0
Abomasum + Rumen, kg	4	12.0±0.39	5.7	3	13.1±0.52	5.6
Abomasum + Rumen, %	4	2.2±0.10	8.1	3	2.3±0.02	1.4
Tongue, kg	4	1.5±0.07	8.3	3	1.6±0.24	21.1
Tongue, %	4	0.3±0.01	3.5	3	0.3±0.03	15.6
Heart, kg	4	1.8±0.08	8.0	3	2.3±0.27	16.4
Heart, %	4	0.3±0.02	9.2	3	0.4±0.03	9.5

Bulls from parents with r_{as} up to 0.267 have a better developed tongue, intestines, abomasum, and rumen. Animals from homogeneous selection have a tendency to decrease the absolute and relative mass of the head, which may be conditioned upon the ossification of the skull in the early stages of ontogenesis. Due to earlier ossification of cartilage, these animals have a shorter head, thinner and lighter bones, which is reflected in their mass. Regardless of the composition of the carcasses, the increase in offal and internal fat adversely affects the yield of the carcass. Therefore, it is important to find an opportunity to change this ratio in the desired direction, since the cost of by-products is substantially inferior to the price of the carcass.

The largest rate of accumulation of adipose tissue from the large and small omentaries and around the kidneys in bulls occurs in the period from 7 to 12 months [5]. Fat is most intensively deposited around the heart from 12 to 18 months of life of animals. According to the data obtained in the study, the mass of the heart decreases in bulls due to homogeneous selection, and the amount of fat deposited around it is greater. This is compensated by an active reduction in the amount of fatty tissue in the intestine and around the kidneys.

38 significant single-nucleotide polymorphisms that influence the weight of internal organs have been established [30], which indicates the genetic condition of the output of by-products in animals, which can manifest as a result of the concentration of similar genes and the reduction of their diversity. These data confirm the possible dependence of the development of the organs of bulls on the selection of parents. The mass of the glands of internal secretion is also greater in bulls from parents with a ratio of antigenic similarity (r_{as}) up to 0.267, which indicates the specific features of the secretory activity of these glands in them (Table 7). An enlarged thyroid gland leads to a weakening of the constitution of animals.

***Table 7**. The mass of the glands of internal secretion of bulls, obtained from varied selection of parents by r_{as}*

Gland	Over 0.268			Up to 0.267		
	n	M±m	Cv, %	n	M±m	Cv, %
Pancreas, g	4	321±26.7	46.3	3	323±4.1	5.8
Brain, g	7	392±22.2	54.4	4	447±53.6	92.8
Testicles, g	4	609±37.0	64.1	3	660±88.6	125.3
Thyroid, g	4	25.2±4.50	30.9	3	28.1±3.34	16.8
Pituitary gland, g	3	2.4±0.30	17.5	3	2.6±0.11	6.0

Heavy and large skins are obtained from animals of both groups (Table 8). Bulls, obtained from the selection of parents with a lower index of antigenic similarity, have a greater mass and width of the skin and a slightly shorter length than those of the same age.

***Table 8**. Sizes and weight of skins in bulls, obtained from varied selection of parents by r_{as}*

Indicator	Over 0.268			Up to 0.267		
	n	M±m	Cv, %	n	M±m	Cv, %
Skin, kg	6	49.2±2.29	10.4	4	52.3±2.04	6.8
Skin, % of pre-slaughter live weight	6	8.7±0.20	5.2	4	9.1±0.23	4.5
Length of the skin, m	6	2.1±0.12	12.9	4	2.0±0.14	11.5
Width of skin, m	6	2.1±0.09	9.1	4	2.2±0.11	9.1

Therefore, the great similarity in blood group factors in the genotypes of animals originating from different breeds leads to a desirable increase in the level of heterozygosity by origin with an increase in the number of erythrocyte alleles, which is the reason for the increase in the meat productivity traits of the offspring. At the first stages during the creation of the Ukrainian beef cattle breed using the homogeneous selection of parents according to the index of antigenic similarity, one of the important issues in their sons was a decrease in the weight of the liver, lungs, heart, kidneys, and glands of internal secretion.

Pairing of animals related by genotype, but not similar in phenotype and genealogically, counteracts the growth of homozygosity. Therefore, the probability of depression decreases. Preservation of heterozygosity according to type of body structure and origin during homogenous mating for r_{as} is explained by the presence among homozygous animals of individuals with satisfactory meat productivity. All other things being equal, such individuals, formally homozygous but biologically the most heterozygous, factually retain their advantages. Notably, the parents of the bulls under study were hybrids, which are described by great genetic variability. The results of homogeneous and heterogeneous selection based on the index of antigenic similarity of parents during pure-bred breeding may substantially differ from those obtained in this study.

Conclusions

Bulls obtained from homogeneous selection of parents according to antigens of the B system of blood groups show a tendency to increase pre-slaughter live weight, as well as increase the content of muscle and fatty tissue in carcasses. Due to the heterogenous selection of parents in the carcasses, bulls have more adipose tissue in the body and a greater relative mass of bones. They have a better developed number of internal organs.

Thus, in the first stages of complex reproductive crossing, greater similarity in blood group factors in the genotypes of parents who come from different breeds leads to a decrease in the level of heterozygosity in erythrocyte antigens of the B system of blood groups, which is associated with an improvement in the meat productivity of the offspring. During the selection of inbred parents, a heterogeneous selection based on blood group factors should be carried out to reduce the amount of adipose tissue scraps from carcasses, increase the weight of the head, liver, lungs, heart, kidneys and endocrine glands, or homogeneous selection to improve the morphological composition of the carcasses.

The prospect of further research lies in the comparison of the performance and interior indicators of crossbred and pure-bred animals obtained under the same variant of parent selection according to ratios of antigenic similarity. This will expand the knowledge of selection methods in genetically diverse and relatively homogeneous cattle populations.

References

[1] Ugnivenko, A.M., & Koropets, L.A. (2005). Justification of the characteristics of the selection of bulls of meat breeds. *Agrarian Science and Education*, 6(3), 72-80.

[2] Ugnivenko, A.M., & Nosevych, D.K. (2014). Reproductive ability of beef females depending on the selection of parents by blood group factors: Agriculture. *Scientific Papers Sworld*, 2(27), 78-83.

[3] Berg, R.T., & Butterfield, R.M. (1976). *New concepts of cattle growth*. Sydney: Sydney University Press.

[4] Casas, E., Thallman, R.M., Kuehn, L.A., & Cundiff, L.V. (2010). Postweaning growth and carcass traits in crossbred cattle from Hereford, Angus, Brangus, Beefmaster, Bonsmara, and Romosinuano maternal grandsires. *Journal of Animal Science*, 88(1), 102-108. doi: 10.2527/jas.2009-2271.

[5] Shevchenko, N.I. (1968). Adipose tissue of cattle at some stages of ontogenesis. Scientific basis of beef production. *Papers of the Experimental Station of Beef Cattle Breeding. Scientific Bulletin of the Ukrainian Agricultural Academy*, 11, 79-83.

[6] Svechin, K.B., & Shevchenko, N.I. (1964). *Fat deposits in the body of cattle depending on their age and level of feeding*. Kyiv. Harvest.

[7] Zhao, G.Y., Zhang, T.L., Liu, Y.Q., Wang, Z.Z., Xu, L., Zhu. B., Gao, X., Zang, L.P., Gao H.J., & Liu, G.E. (2020). Genome-wide assessment of runs of homozygosity in Chinese wagyu beef cattle. *Animals*, 10(8), article number 1425. doi: 10.3390/ani 10081425.

[8] Taussat, S., Saintilan, R., Krauss, D., Maupetit, D., Fouilloux, M.N., & Renand, G. (2019). Relationship between feed efficiency and slaughter traits of French Charolais bulls. *Journal of Animal Science*, 97(6), 2308-2319. doi: 10.1093/jas/skz108.

[9] Carvalho Barros, J., Munekata, P.E., de Carvalho, F.A., Pateiro, M., Barba, F.J., Domínguez, R., Trindade, M.A., & Lorenzo, J.M. (2020). Use of tiger nut (*Cyperus esculentus* L.) oil emulsion as animal fat replacement in beef burgers. *Foods*, 9(1), 44.

[10] Öztürk-Kerimoğlu, B., Kavuşan, H.S., Gürel, D.B., Çağindi, Ö., & Serdaroğlu, M. (2021). Cold-set or hot-set emulsion gels consisted of a healthy oil blend to replace beef fat in heat-treated fermented sausages. *Meat Science*, 176, article number 108461. doi: 10.1016/j.meatsci.2021.108461.

[11] Serdaroğlu, M., Nacak, B., & Karabiyikoğlu, M. (2017). Effects of beef fat replacement with gelled emulsion prepared with olive oil on quality parameters of chicken patties. *Korean Journal for Food Science of Animal Resources*, 37(3), 376. doi: 10.5851/kosfa.2017.37.3.376.

[12] Kakimov, A., Suychinov, A., Tsoy, A., Mustambayev, N., Ibragimov, N., Kuderinova, N., & Yessinbekov, Z. (2018). Nutritive and biological value of liver and blood of various slaughtered animals. *Journal of Pharmaceutical Research International*, 22(3), 1-5. doi: 10.9734/JPRI/2018/41448.

[13] Guo, Z., Yu, Q., Han, L., Lin, L., Zhang, W., & Zhao, S. (2018). Study on processing technology of bovine liver paste. *Food and Fermentation Industries*, 44(10), 175-182.

[14] O'Flaherty, E.A., Tsermoula, P., O'Neill, E.E., & O'Brien, N.M. (2019). Co-products of beef processing enhance non-haem iron absorption in an *in vitro* digestion/caco-2 cell model. *International Journal of Food Science & Technology*, 54(4), 1256-1264. doi: 10.1111/jfs.14049.

[15] Shakhmurzov, M., Shevkhuzhev, A., Pogodaev, V., Yuldashbaev, Y., & Kherremov, S. (2021). Body types of Aberdeen Angus bulls and their relationship with meat production. In *E3S Web of conferences* (pp. 262-270). doi: 10.1051/e3sconf/202126202023.

[16] Musa, A.A., Mummed, Y.Y., Kurtu, M.Y., & O'Quinn, T.G. (2021). Carcass and meat characteristics of bulls from Arsi, Boran, Harar and Holstein Frisian crosses cattle breeds finished under similar level of concentrate supplementation. *Open Journal of Animal Sciences*, 11(1), 11.

[17] Britto, L.F. (2021). Sexual development and puberty in bulls. In *Bovine reproduction* (pp. 58-78). Hoboken: John Wiley & Sons. doi: 10.1002/9781119602484.ch6.

[18] Podoba, B.E., Tsiluyko, G.A., & Danilkiv, E.M. (1987). *Blood types of sires and cows used in breeding dairy and beef cattle*. Kyiv: Harvest.

[19] Ugnivenko, A.N., & Natalych, A.V. (2021). Influence of parent selection methods by B antigen similarity index in the blood groups on weight and linear growth of bulls. *Animal Science and Food Technology*, 12(4), 78-86. doi: 10.31548/animal2021.04.008.

[20] DSTU 4673:2006 "Cattle for slaughter. Specifications". (2008). Kyiv. State Standards of Ukraine.

[21] DSTU 3938-99 "Meat industry. Livestock slaughter products. Terms and definitions". (1999). Kyiv: State Standards of Ukraine.

[22] International Committee for Animal Recording (ICAR). (2009). International agreement of recording practices. Approved by the General Assembly held in Niagara Falls, USA, on 18 June 2008, 91-189.
[23] Tkachuk, V.M. (2000). Muscle tissue index as a criterion for assessing the meat of animals. *Scientific Bulletin of the National Agrarian University*, 2, 106-111.
[24] Shevchenko, D.I., & Shevchenko, N.I. (1978). Features of the development of adipose tissue in Aberdeen Angus and white-headed Ukrainian cattle under conditions of similar feeding. Raising cattle for meat. *Papers of the Experimental Station of Beef Cattle Breeding. Scientific Bulletin of the Ukrainian Agricultural Academy*, 218(9), 42-46.
[25] Mc Parland, S., Kearney, J.F., MacHugh, D.E., & Berry, D.P. (2008). Inbreeding effect on post weaning production traits, conformation and calving performance in Irish beef cattle. *Journal of Animal Science*, 86(12), 3338-3347. doi: 10.1016/SO031-6226(01)00295-0.
[26] Yamada, T., Kamiya, M., & Higuchi, M. (2020). Fat depot-specific effects of body fat distribution and adipocyte size on intramuscular fat accumulation in Wagyu cattle. *Animal Science Journal*, 91(1), article number 13449. doi: 10.111/asj.13449.
[27] Krafsur, G.M., Neary, J.M., Garry, F., Holt, T., Gould, D.H., Mason, G.L., Thomas, M.G., Enns, R.M., Tuder, R.M., Heaton, M.P., Brown, R.D., & Stenmark, K.R. (2019). Cardiopulmonary remodelling in fattened beef cattle: A naturally occurring large animal model of obesity-associated pulmonary hypertension with left heart disease. *Pulmonary Circulation*, 9(1), 1-13. doi: 10.1177%2F2045894018796804.
[28] Melendez, P., Poock, S.E., Pithua, P., Pinedo, P., Manriquez, D., Moore, S.G., Neal, J.D., & Taylor, J.F. (2019). Genome-wide study to detect single nucleotide polymorphisms associated with visceral and subcutaneous fat deposition in Holstein dairy cows. *Animal*, 13(3), 487-494. doi: 10.1017/S1751731118001519.
[29] Lindholm-Perry, A.K., Cunningham, H.C., Kuehn, L.A., Vallet, J.L., Keele, J.W., Foote, A.P., Cammack, K.M., & Freetly, H.C. (2017). Relationships between the genes expressed in the mesenteric adipose tissue of beef cattle and feed intake and gain. *Animal Genetics*, 48(4), 386-394. doi: 10.1111/age.12565.
[30] An, B, Xia, J., Chang, T., Wang, X., Miao, J., Xu, L., & Gao, H. (2018). Genome-wide association study identifies loci and candidate genes for internal organ weights in Simmental beef cattle. *Physiological Genomics*, 50(7), 523-531. doi: 10.1152/physiologenomics.00022.2018.

М’ясна продуктивність та ріст внутрішніх органів і жирової тканини у бугайців, отриманих від підбору їх батьків за індексом подібності антигенів системи В груп крові

Анатолій Миколайович Угнівенко, Олександр Володимирович Наталич

Національний університет біоресурсів і природокористування України
03041, вул. Героїв Оборони, 15, м. Київ, Україна

Анотація. Під час відтворювального схрещування зростає генетична різноманітність тварин і постає проблема консолідації худоби за типом і продуктивністю. Антигени груп крові є одним з факторів, які вказують на генетичну мінливість, тому можуть бути використані як маркери під час підбору батьківських пар. Метою даного дослідження було проаналізувати м’ясну продуктивність, розвиток внутрішніх органів і накопичення жирової тканини у 18-місячних бугайців, що походять від різного підбору їх батьків за індексом антигенної подібності (r_{as}) системи В груп крові на перших етапах складного відтворювального схрещування симентальської і сірої української худоби із плідниками порід шароле та кіанської. За величиною r_{as} бугайців розподілили у дві групи. У першу від гомогенного підбору батьків (понад 0,268; n=9); у другу від гетерогенного (r_{as} до 0,267; n=7). Після забою бугайців визначали м’ясну продуктивність, масу і вихід голови, печінки, легень та інших органів і залоз внутрішньої секреції. Відокремлювали і зважували жир міжм’язовий, полив, навколонирниковий, із передшлунків, із кишківника та навколосерцевий. За гомогенного підбору батьків у їх синів, порівняно з ровесниками від гетерогенного споровування, проявляється тенденція до підвищення вмісту м’язів (на 4,2 %), жирової тканини у тушах (на 12,4 %), у тому числі між м’язами (на 1,1 пункти). На кілограм кісток припадає м’якуша менше на 11,6 %, гірший на 17,2 % індекс м’язової тканини, абсолютна маса печінки менша на 7,8 %, нирок – на 10,0, серця – на 27,8, голови – на 2,0 і легень – на 11,6 %. У бугайців від гетерогенного підбору батьків із r_{as} до 0,267 на 7,2 % більше жирової тканини у тілі, у тому числі внутрішньої на 7,8 %, відносна маса кісток більша на 0,8 пункти. Практичне використання гомогенного підбору за антигенами груп крові помісних батьків дозволяє поліпшити морфологічний склад туш їх потомків. Гетерогенний підбір сприяє кращому розвитку внутрішніх органів, які є менш цінними продуктами забою

Ключові слова: м’ясне скотарство, відтворювальне схрещування, гомогенний підбір, гетерогенний підбір