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Estimated Breeding Values of Aberdeen-Angus Cattle Breed

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Abstract: The study aims to calculate the estimated breeding value of Aberdeen-Angus cattle using the BLUP method. The live weight of cattle of the Aberdeen-Angus breed was: At birth in bulls 28.25 kg and in heifers 27.18 kg; on day 210, at weaning in bulls 212.31 kg and in heifers 198.04 kg; on day 365, respectively, 328.02 kg and 304.73 kg. At the age of 5, the live weight is 897.05 kg for bulls and 552.04 kg for cows. The average values of the productivity indicators of cattle of the Aberdeen-Angus breed according to the average daily gain showed: From birth to 210 days of age in bulls -879.56 g and heifers -847.07 g; from 210 days to one year of age in bulls -767.03 g and heifers -647.62 g; from birth to one year of age in bulls -831.77 g and heifers -767.37 g. For the Aberdeen-Angus breed, the estimated breeding values in terms of live weight at birth range from -8.24 to +9.93; for live weight at weaning in the range from -42.47 to +39.07; for live weight at 12 months of age from -62.29 to +78.67; for milking capacity of cows from -47.45 to +33.15; for live weight at the age of 5 years from -117.4 to -141.16. The composition of the muscle tissue of Aberdeen-Angus bulls was with a high level of protein usefulness (protein usefulness index 0.70). This is higher than that of crossbred and Black-and-white mates by 6.1 and 4.5%.

Keywords: Beef Cattle, Aberdeen-Angus Breed, Live Weight, Estimated Breeding Value (EBV), Meat, Chemical Composition, Amino Acid Composition

Introduction

Aberdeen-Angus cattle are well adapted to grazing and consuming large amounts of roughage. The color of the cattle is black. There are animals of red color. They are on low legs and have well-defined meat forms. The cattle are hornless. This trait is well inherited: In the first generation almost 100% hornless. The cattle feed very quickly and well. Its meat is marbling. Slaughter yield -60-65%.

Modern breeds of beef cattle are very diverse both in terms of productive and biotechnological traits (Garrick and Golden, 2009; Brenneman *et al*., 2007).

To date, genes have been identified that have a pronounced effect on the phenotype of the animal. Such genes are usually called target genes and are considered DNA markers of breeding traits of agricultural animals. The introduction of these markers into breeding work makes it possible to use information about the hereditary potential of the selected animals and increases the accuracy of assessment and selection efficiency (Sasaki *et al*., 2019; Tsuchida *et al*., 2010).

Several target genes of farm animals associated with various productivity traits have been identified. Some of them are widely used in practical breeding, others are under research and testing (Ogawa *et al*., 2016).

The presence of a large number of experimental materials (DNA samples, a database of productive traits, etc.,) is a necessary condition for the development of molecular genetics and mathematical methods for calculating the estimated breeding value of farm animals (Chen *et al*., 2015).

Recently, there has been a growing interest in the genetic improvement of body measurement characteristics in farm animals. Modern research in the field of animal husbandry, in particular the study of the genetic basis for the formation of breeding traits, requires a comprehensive analysis of a large amount of information on the productivity of animals and molecular genetic data that characterize the individual characteristics of each animal (Naserkheil *et al*., 2020).

There is a growing trend towards the widespread use of molecular genetics in breed conservation programs and to improve understanding of the origin and domestication of farm animal species (De Las Heras-Saldana *et al*., 2020).

Although genomics is the new standard in breeding and genetics, there are still some issues that need to be addressed. This includes new validation procedures that are not affected by selection, parameter estimation that takes into account all genomic data used in selection, and strategies to reduce genetic bias after the introduction of genomic selection (Misztal *et al*., 2020).

Currently, there is a deficiency of dietary protein in the world, and its shortage will persist in the coming decades. The biological value of proteins significantly depends on the type of raw material, which is a determining factor in the preparation of the daily ration and justification of the consumption rates of animal and vegetable proteins.

The traditional way to increase the resources of food protein is the intensification of animal husbandry and crop production based on modern technologies for raising animals and cultivating crops. Currently, such industries as poultry farming and pig breeding are successfully developing in the Russian Federation. However, cattle breeding is developing at a slow pace, and part of the beef enters the Russian market mainly from abroad. Increasing beef production in Russia is one of the most urgent tasks of local animal breeding. The main source of beef is fattening stock from dairy herds, and in the coming years it will continue to occupy a significant share in the structure of the produced beef.

The meat quality is assessed by the mass and degree of fat deposition in the carcass, the yield of its cuts, morphological and chemical composition, and it depends on such factors as livestock breed, live weight, age, sex, fatness, level and usefulness of feeding. The deposition of fat is considered to be the main one, which does not fully reflect the true quality of the raw materials in accordance with the requirements of the consumer. At the same time, the system of assessment, classification of animals and their carcasses do not take into account the gross yield of edible protein and fat, the qualitative diversity of the supplied beef, and, therefore, does not provide stimulation for the growth of production and improvement of its quality. Therefore, the quality of beef is an economic factor and it should be noted that the most effective method of beef production is to improve its quality by using the gene pool of specialized beef breeds in crossing.

Aim of the Research

To calculate the estimated breeding value of Aberdeen-Angus cattle using the BLUP method. To study the nutritional and biological value of the meat of Aberdeen-Angus bulls and their crossbreeds.

Materials and Methods

Genealogical structure Aberdeen-Angus breeds presented on accessories to stud bulls EG Frontier 678 OF107, EG pound marker 612 of 415, S A V Premier 0096, S A V Viper 0986, E G pound marker 612 of 415, Buffalos final product 12, Buffalos Midlander 143, Randy's reach out 112, Buffalos king Empire 133, Buffalos CC&7 JR 118, Buffalos Surtitle 136, Buffalos SIR CC&7 18, DF total 1729, KAF N61, Schelskes K37 Aberdeen 169, Schelskes Ironwood 1380A, Schelskes K37 Aberdeen 171, Schelskes expedition 1063M, Schelskes K37 Aberdeen 164, schelskes expedition 1064M, Schelskes K37 Aberdeen 159, Schelskes K37 Aberdeen 187, Schelskes on target 1067M, Schelskes 747 Legend 134, Connealy true answer 892.

As a result of solving linear equations of animal biometric models (AM/MME) using the BLUP method on the data of zootechnic event registrations in the Information-Analytical System (IAS) for the Aberdeen-Angus breed, genetic estimates of their productivity were obtained according to economical traits: Live weight at birth; live weight at weaning; milking capacity of cows; body weight at one year of age. Also, as trial calculations, genetic assessments were carried out on average daily gains in live weight: In the period from birth to weaning (SP 0-205); in the period from weaning to a year (SP 205-12); in the period from birth to one year (SP 0-12).

The initial indicators of the live weight of young animals at birth, and at weaning were adjusted following the age of mothers, which affect the studied indicators.

Based on the results of calculations of estimated breeding value for the Aberdeen-Angus cattle breed using the BLUP method by the biometric model, tables were compiled of the frequency distribution of the obtained EBV for live weight at birth, at weaning, and at 12 months of age and adult animals, as well as for milking capacity for cows.

The number of economic entities involved in breeding the Aberdeen-Angus breed is presented in Table 1. For the calculation, data from 2106 farms engaged in breeding of Aberdeen-Angus cattle breeds were used. In 2021, there were 2,106 Aberdeen-Angus cattle in total.

The animals were fed on natural pastures, without fertilizing.

Table 1: Statistics on farms in terms of the number of Aberdeen Angus animals registered in the IAS, data on which were used to calculate the EBV

Range of the number of animals on the farm, animals	2021 the year	2022 year
Over 10,000	-	16
From 5,000-10,000	37	25
From 1,000-5,000	30	32
From 500-1,000	21	28
From 200-500	53	66
From 100-200	39	60
Less than 100	1926	2157
Total farms	2106	2384

Meat Biological Value and Productivity of Bulls of Aberdeen-Angus, Black-and-White Breeds and Their Crosses

The research was carried out in the Lekomtsev M. M. farm, the Glazovsky district of the Udmurt Republic in 2021-2022. For the experiment, three groups of bulls were selected and formed, 15 animals each, at the age of 6 months. The groups were formed according to the method of pair-analogues, taking into account the origin, age and live weight at birth. The first (control group) included Black-and-white bulls, the second (experimental group 1) crossbred bulls of the black-and-white breed with the Aberdeen-Angus breed, the third (experimental group 2) purebred Aberdeen-Angus bulls. Animals were in the same conditions of feeding and keeping. In winter, stall keeping on deep litter in sections of 7-9 animals, in summer pasture grazing. The level of feeding of experimental animals was calculated taking into consideration the physiological need to obtain an average daily gain of 900-1000 g and achieve a live weight of 480-530 kg at 18 months of age. Meat productivity was studied at the age of 18 months by control slaughter. For this, 3 bulls from each group were selected. Control slaughter was carried out in the Churinsky meat-processing shop (Chura village, Glazovsky district, Udmurt Republic). The contents of moisture, protein, fat, carbohydrates, ash, calcium, and phosphorus were determined in the average sample of the rib eye of the 9th-12th rib. The quality indicators of average samples of meat from experimental bulls were determined in the laboratory of the Udmurt veterinary diagnostic center. The amino acid composition of proteins was determined in the educational and scientific testing laboratory of the Stavropol State Agrarian University. The resulting digital material was processed using the methods of variation statistics.

Results and Discussion

The live weight of cattle of the Aberdeen-Angus breed was: at birth in bulls 28.25 kg and heifers 27.18 kg; on day 210, at weaning bulls 212.31 kg and heifers 198.04 kg; on day 365, respectively, 328.02 and 304.73 kg (Table 2).

At the age of 5, the live weight is 897.05 kg for bulls and 552.04 kg for cows.

The average values of productivity indicators of the Aberdeen-Angus cattle breed according to the average daily gain showed: from birth to 210 days of age in bulls -879.56 g and in heifers -847.07 g; from 210 days of age to one year of age in bulls -767.03 g and heifers -647.62 g; from birth to one year of age in bulls -831.77 g and heifers -767.37 g (Table 3).

For the Aberdeen-Angus breed, the values of the estimated breeding values in terms of live weight at birth range from -8.24 to +9.93; for live weight at weaning in the range from -42.47 to +39.07; for live weight at 12 months of age from -62.29 to +78.67; for milking capacity of cows from -47.45 to +33.15; for live weight at 5 years of age from -117.4 to -141.16 (Table 4).

Table 2: Average values of productivity indicators of cattle of the Aberdeen-Angus breed

	Live weight kg							
	At birth		When weaned on day 210		On day 365		5 Years and older	
Sex and age group	n	M ± m	n	M ± m	n	M ± m	n	M ± m
2021 год								
Bulls	38 649	28.25±0.20	29 597	212.31±1.70	18 324	328.02±2.20	2	897.05±14.1
Heifers	63 809	27.18±0.20	56 236	198.04±1.20	35 420	304.73±1.80	22	552.04±8.3.0
2022 год								
Bulls	44 577	28.56±0.22	33 367	215.00±0.17	21 908	324.27±0.26	15	838.20±19.54
Heifers	82 889	27.56±0.16	72 340	197.80±0.11	50 122	302.03±0.16	327	611.22±5.510

Table 3: Average values of the productivity indicators of cattle of the Aberdeen-Angus breed according to the average daily gain

	SP 0-210		SP 210-12		SP 0-12	
Breed, sex, and age group	n	M ± m	n	M ± m	n	M ± m
Bulls	28 691	879.56±0.767	17 978	767.03±1.677	17 732	831.77±1.076
Heifers	54 509	847.07±0.512	33 144	647.62±1.219	32 907	762.37±0.865

Table 4: Percentile distribution of calculated EBV values of productive indicators of Aberdeen-Angus animals

	EBV live weight, kg				
Percentile %	At birth	At weaning	At 12 months of age	At the age of 5	EBV for milking capacity
2021					
0	-8.24	+39.03	+78.67	+141.16	+33.15
5	-1.29	+4.85	+6.94	+8.68	+5.00
10	-0.78	+2.82	+4.05	+5.25	+3.26
20	-0.33	+0.93	+1.50	+1.98	+1.54
30	-0.13	+0.29	+0.53	+0.67	+0.64
40	-0.03	+0.06	+0.11	+0.17	+0.14
50	0.00	0.00	0.00	0.00	0.00
60	+0.05	-0.05	-0.11	-0.07	-0.00
70	+0.17	-0.22	-0.50	-0.46	-0.38
80	+0.41	-0.66	-1.43	-1.40	-0.99
90	+0.93	-2.14	-4.00	-4.41	-2.27
95	+1.46	-3.90	-6.91	-7.80	-3.69
100	+9.93	-42.47	-65.29	-117.40	-47.45
Minimum	-8.24	-42.47	-65.29	-117.40	-47.45
Maximum	+9.93	+39.03	+78.67	+141.16	+33.15
2022					
0	-9.67	+59.97	+80.51	+141.84	+33.57
5	-1.34	+5,96	+9,14	+11,31	+5.31
10	-0.82	+3.60	+5.74	+7.34	+3.51
20	-0.36	+1.47	+2.45	+3.31	+1.68
30	-0.15	+0.49	+0.91	+1.23	+0.72
40	-0.03	+0.13	+0.26	+0.37	+0.17
50	0.00	0.00	0.00	0.01	0.00
60	+0.07	-0.03	-0.07	-0.03	-0.08
70	+0.21	-0.22	-0.48	-0.43	-0,52
80	+0.48	-0.63	-1.40	-1.36	-1.26
90	+1.03	-1.92	-3.86	-4.16	-2,81
95	+1.,58	-3.35	-6.69	-7.47	-4.37
100	+21.60	-34.91	-49.07	-117.15	-50.31
Minimum	-9.67	-34.91	-49.07	-117.15	-50.31
Maximum	+21.60	+59.97	+80.51	+141.84	+33.57

Table 5: Percentile distribution of calculated EBV values of productive indicators of Aberdeen-Angus cattle

	EBV average daily gain, g/ day		
Percentile%	SP 0-205	SP 205-12	SP 0-12
0	317.74	499.18	523.71
5	82.48	92.62	116.45
10	61.91	65.70	87.98
20	40.42	37.84	57.90
30	25.90	22.40	37.49
40	14.83	10.94	21.43
50	5.75	1.31	7.41
60	-2.79	-7.51	-6.23
70	-12.08	-18.29	-20.54
80	-24.00	-32.95	-38.03
9	-41.64	-60.19	-64.45
95	-57.74	-89.88	-88.99
100	-284.19	-479.91	-507.02
Minimum	-284.19	-479.91	-507.02
Maximum	317.74	499.18	523.71

For Aberdeen-Angus cattle, the estimated breeding values in terms of average daily gain from birth to 12 months of age range from -507.02 to +523.71 (Table 5).

In the process of calculating the breeding values, their accuracies were obtained, indicated in Tables 6-7.

The share distribution of accuracies for the EBV in 2021 for Aberdeen-Angus cattle productivity indicators contains zero values for the most part for cow milking capacity indicators. The general increase in the proportion of non-zero EBV accuracy values

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indicates a more complete and high-quality filling of the live weight database in recent years.

It has been established that the share distribution of accuracies for the calculated EBV in 2022 according to the productive indicators of animals born in the period 2014-2022 of the Aberdeen-Angus breeds has zero values up to 10%. A smaller number of shares of non-zero values of EBV accuracy indicates a more complete and high-quality filling of the database of the information analytical system of live weight in recent years.

One of the main indicators to determine beef taste and nutritional value is its chemical composition. Our results (Tables 8-9) show a significant impact on the chemical composition of animal meat of different breeds. At the same time, the process of accumulation of nutrients in the body of young animals of different genotypes does not occur in the same way.

Table 6: Percentile distribution of calculated accuracies for the EBV of the productive indicators of Aberdeen-Angus animals

	Live weight EBV accuracy, kg				
Percentile %	At birth	At weaning	At 12 months of age	Adult animal	Milking capacity EBV accuracy
2021					
0	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000
20	0.006	0.002	0.002	0.001	0.006
30	0.012	0.004	0.005	0.003	0.014
40	0.037	0.012	0.014	0.010	0.035
50	0.106	0.038	0.041	0.028	0.089
60	0.239	0.122	0.122	0.085	0.152
70	0.458	0.231	0.221	0.151	0.200
80	0.512	0.289	0.294	0.196	0.257
90	0.532	0.326	0.362	0.236	0.356
95	0.556	0.342	0.385	0.258	0.492
100	0.992	0.975	0.978	0.913	0.991
2022					
100	0.996	0.986	0.985	0.914	0.991
95	0.566	0.350	0.392	0.269	0.504
90	0.536	0.333	0.371	0.246	0.372
80	0.519	0.301	0.315	0.213	0.280
70	0.481	0.260	0.255	0.174	0.220
60	0.339	0.182	0.179	0.123	0.173
50	0.159	0.065	0.076	0.051	0.118
40	0.049	0.019	0.020	0.013	0.054
30	0.020	0.007	0,007	0.005	0.021
20	0.008	0.003	0.003	0.002	0.008
10	0.002	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000
0	0.000	0.000	0.000	0.000	0.000

Table 7: Percentile distribution of calculated accuracies for EBV of productivity indicators of Aberdeen-Angus animals

	EBV accuracy of average daily gain, g/day		
Percentile%	SP 0-205	SP 205-12	SP 0-12
0	0.000	0.000	0.000
5	0.388	0.140	0.115
10	0.416	0.167	0.154
20	0.443	0.196	0.204
30	0.460	0.218	0.247
40	0.474	0.238	0.275
50	0.485	0.256	0.298
60	0.499	0.272	0.319
70	0.510	0.288	0.340
80	0.520	0.303	0.358
90	0.530	0.319	0.373
95	0.544	0.331	0.384
100	0.980	0.943	0.957

Table 8: Chemical composition of meat in the average sample of the rib eye

Indicator	Group / Control / Average sample X ± m	Cv, %	Lim (min-max)	Experimental 1 X ± m	Cv, %	Lim (min-max)	Experimental 2 X ± m	Cv, %	Lim (min-max)
Moisture content, %	72.82±1.3100	3.12	70.28-74.560	68.66±1.9600	4.95	65.82-72.43	67.25±1.12*	3.03	64.25-70.670
Mass fraction of protein, %	20.31±1.0200	8.49	18.51-21.950	19.78±0.7300	6.41	18.38-20.85	19.12±0.7100	5.25	18.01-19.940
Mass fraction of fat, %	4.78±0.2400	8.82	4.31-5.1200	9.42±2.19*	40.32	5.14-12.39	11.74±0.75***	7.45	10.13-13.210
Mass fraction of carbohydrates, %	0.91±0.2800	8.28	0.83-0.9700	0.87±0.3800	25.78	0.81-1.03	0.83±0.2100	6.47	0.77-0.9400
Mass fraction of ash, %	0.84±0.0800	16.63	0.71-0.9900	0.85±0.1000	20.33	0.71-1.04	0.99±0.0700	14.08	0.88-1.0800
Mass fraction of calcium, %	0.037±0.003	7.12	0.031-0.042	0.031±0.003	18.70	0.027-0.038	0.037±0.004	8.36	0.031-0.045
Mass fraction of phosphorus, %	0.223±0.011	6.51	0.208-0.224	0.213±0.012	11.11	0.186-0.228	0.211±0.009	6.13	0.182-0.219

Note: *p<0.05; **p<0.01; *** p<0.001; The first (control group) included Black-and-white bulls, the second (1 experimental group) - crossbred bulls obtained by crossing the Black-and-white breed with the Aberdeen-Angus breed, the third (2 experimental group) - purebred Aberdeen-Angus bulls breeds

Table 9: Chemical composition of meat in the sample of the rib eye

Indicator	Group / Control / Muscle tissue X ± m	Cv, %	Lim (min-max)	Experimental 1 X ± m	Cv, %	Lim (min-max)	Experimental 2 X ± m	Cv, %	Lim (min-max)
Moisture content, %	76.23±1.0500	2.39	74.19-77.690	75.90±0.16	0.37	75.58-76.070	75.35±0.73	2.03	74.0-76.7000
Mass fraction of protein, %	21.23±0.9300	7.61	21.10-21.620	21.37±0.84	1.17	21.12-21.620	20.93±0.98	9.44	20.63-21.250
Mass fraction of fat, %	0.64±0.06000	15.09	0.55-0.7400	1.21±0.27**	39.01	0.92-1.7500	1.41±0.11***	12.8	1.24-1.62000
Mass fraction of carbohydrates, %	1.06±0.12000	15.94	0.95-1.1500	1.02±0.21	12.06	0.92-1.2800	0.93±0.08	7.21	0.84-0.99000
Mass fraction of ash, %	0.77±0.05000	18.08	0.64-0.8800	0.92±0.03*	5.56	0.88-0.9800	0.96±0.04*	6.22	0.89-1.03000
Mass fraction of calcium, %	0.031±0.0030	11.21	0.028-0.035	0.030±0.003	10.07	0.027-0.033	0.038±0.002	7.32	0.037-0.0390
Mass fraction of phosphorus, %	0.235±0.0040	2.77	0.228-0.241	0.223±0.01	7.66	0.205-0.239	0.229±0.007	2.85	0.224-0.2350

Note: *p<0,05; **p<0,01; *** p<0,001; The first (control group) included Black-and-white bulls, the second (1 experimental group) - crossbred bulls obtained by crossing the Black-and-white breed with the Aberdeen-Angus breed, the third (2 experimental group) - purebred Aberdeen-Angus bulls breeds

The study of the chemical composition of meat samples (rib eye) of experimental animals indicates the existing differences in the main components taken into account, due to the fact that the process of accumulation of nutrients in the body of bulls of different genotypes occurred in different ways. The water content was the highest in the meat of Black-and-white bulls. Compared with the meat of crossbred animals and purebred Aberdeen-Angus breed, the moisture content in the meat of Black-and-White bulls was higher by 4.16 and 5.57% (p<0.05) in the rib eye sample, and in the muscle tissues by 0.33 and 0.88%, respectively, with an insignificant difference. It should be noted that the high-water content in meat reduces its nutritional value.

The meat of bulls of the 1st and 2nd experimental groups contained more ash compared to the meat samples obtained from purebred black-and-white bulls by 0.01, 0.15 and 0.15% (p<0.05), 0. 19% (p<0.05), respectively. Meat carbohydrates are represented by glycogen, called animal starch. Its optimal level in meat is 0.6-0.8% and on average about 1%. In muscle tissue, glycogen is present both in the free state and in the protein-bound state. In the muscles of fattened and well-fed animals, there is somewhat more glycogen than in emaciated, tired and sick individuals. After the slaughter of an animal, glycogen decomposes to form mainly lactic acid, the content of which determines many processes that indirectly affect the texture and taste of meat. In addition, the acidic environment due to the accumulation of lactic and phosphoric acids prevents the development of putrefactive microflora. According to the mass fraction of carbohydrates in the average sample and in the muscle tissue of the rib eye, no significant differences were found between the analyzed groups, and the difference varied from 0.04-0.08% and from 0.04-0.13%, respectively. At the same time, a higher content was found in the meat of black-and-white bulls.

The cooking and taste qualities of beef are determined by the content of adipose tissue and its localization in different parts of the carcass. We have studied the chemical composition of calves' meat and determined in which calves of what genetic origin the most energy-intensive adipose tissue is synthesized to a greater extent in the process of their intensive fattening. The more balancing the content of fat that accumulates between muscle fibers or inside them, the more valuable the breed for the production of marbled beef.

In the average rib eye sample of crossbred and purebred Aberdeen-Angus bulls, the fat content was almost 2 times or more higher (4.64%, $p<0.05$) and 6.96% ($p<0.001$), respectively, compared with mates of control group. The accumulation of adipose tissue between and within the muscles indicates the "marbling" of the beef. The fat content in the muscle tissue of the analyzed groups varied from 0.64-1.41% with a significant superiority of animals 1 (by 0.57%) ($p<0.05$) and 2 (by 0.77%) ($p<0.01$) of the experimental groups compared with their mates in the control group.

The biological value of meat is characterized by the amount of protein that the human body can digest when eating a particular product. The higher this number, the more valuable and useful food. The results of our studies did not reveal significant differences in protein content both in the average sample of the rib eye and in the muscle tissue of bulls of different origin. The difference varied from 0.53-1.19% and from 0.14-0.44%, respectively. It should be noted that the protein content in the meat samples of experimental animals was quite high, which is evidence of a balanced feeding of animals during the intensive fattening period.

We have studied the biological value of the protein by analyzing the amino acid composition of the meat of the experimental bulls (Table 10).

The biological value of meat is primarily determined by the amount of complete protein, since a complete protein contains a balanced amount of all amino acids, in which the biological "indicator" is the amount of essential amino acids. The largest amount of essential amino acids identifies raw meat as biologically more complete.

To study the amino acid composition of meat, we analyzed the biological value of the longissimus dorsi muscle (rib eye) of purebred and crossbred animals.

Table 10: Indicators of the amino acid composition of bulls, g/100 g of protein

	Group								
	Control			Experimental 1			Experimental 2		
Amino acids	X ± m	Cv, %	Lim (min-max)	X ± m	Cv, %	Lim (min-max)	X ± m	Cv, %	Lim (min-max)
Essential amino acids									
Lysine	1.79±0.03	3.17	1.73-1.84	1.80±0.02	2.25	1.75-1.82	1.80±0.04	4.32	1.71-1.86
Leucine	1.62±0.03	2.78	1.58-1.67	1.74±0.02*	2.07	1.70-1.77	1.77±0.01*	1.17	1.75-1.79
Isoleucine	0.91±0.02	3.37	0.88-0.94	0.93±0.02	2.84	0.90-0.96	1.02±0.03*	5.56	0.96-1.07
Valine	0.99±0.01	2.02	0.97-1.01	0.99±0.01	1.54	0.98-1.01	1.07±0.04	5.99	1.00-1.12
Methionine	0.79±0.02	3.88	0.76-0.82	0.78±0.02	3.69	0.75-0.80	0.81±0.03	5.59	0.76-0.85
Threonine	1.01±0.02	2.97	0.98-1.04	1.08±0.02	2.84	1.05-1.11	0.93±0.02*	3.79	0.89-0.96
Phenylalanine	0.75±0.01	2.05	0.73-0.76	0.83±0.01*	1.39	0.82-0.84	0.82±0.02*	3.94	0.78-0.84
Tryptophan	0.15±0.01	3.77	0.15-0.16	0.15±0.01	3.77	0.15-0.16	0.14±0.01	4.22	0.13-0.14
Sum of essential amino acids	8.05±0.08	3.21	7.78-8.24	8.30±0.05*	2.71	8.10-8.47	8.36±0.06*	4.12	7.97-8.63
Non-essential amino acids									
Aspartic acid	1.91±0.02	1.84	1.88-1.95	2.04±0.03*	2.59	1.98-2.08	1.82±0.04	4.13	1.74-1.89
Glutamic acid	3.43±0.03	1.47	3.38-3.48	3.55±0.08	3.68	3.41-3.67	3.53±0.06	3.12	3.42-3.64
Serine	0.82±0.03	5.48	0.78-0.82	0.87±0.01	0.66	0.87-0.88	0.81±0.02	4.94	0.77-0.85
Histidine	0.80±0.01	1.90	0.79-0.82	0.82±0.01	1.41	0.81-0.83	0.83±0.02	4.34	0.79-0.86
Glycine	0.95±0.01	1.61	0.93-0.96	0.99±0.01**	2.53	0.97-1.02	0.87±0.02	4.60	0.83-0.91
Arginine	1.23±0.01	1.70	1.21-1.25	1.30±0.02*	2.77	1.26-1.33	1.26±0.04	5.15	1.20-1.33
Alanine	1.16±0.02	2.28	1.14-1.19	1.29±0.02*	2.33	1.26-1.32	1.17±0.04	5.24	1.10-1.22
Tyrosine	0.72±0.02	4.26	0.69-0.75	0.78±0.01*	3.24	0.75-0.80	0.70±0.02	5.75	0.66-0.74
Cystine	0.15±0.01	10.41	0.13-0.16	0.14±0.01	4.22	0.13-0.14	0.17±0.01	9.17	0.15-0.18
Proline	0.81±0.01	1.89	0.79-0.82	0.84±0.03	6.53	0.78-0.88	0.79±0.02	4.43	0.76-0.83
Sum of non-essential amino acids	11.98±0.05	4.82	11.72-12.20	12.62±0.07**	4.17	12.22-12.95	11.95±0.06	5.24	11.42-12.45
Protein usefulness index	0.67±0.003	2.34	-	0.66±0.004	2.03	-	0.70±0.005***	3.04	-

Примечание: *p<0,05; **p<0,01; *** p<0,001; The first (control group) included black-and-white bulls, the second (1 experimental group) crossbred bulls obtained by crossing the black-and-white breed with the Aberdeen-Angus breed, the third (2 experimental group) purebred Aberdeen-Angus bulls breeds

The calculation of the protein usefulness index, defined as the ratio of essential amino acids to non-essential amino acids in the total volume, is a more objective indicator, since the assessment of usefulness includes the maximum number of amino acids, in contrast to the protein-quality indicator determined by the ratio of tryptophan to hydroxyproline. Thus, the calculation of the content of essential amino acids in the proteins of rib eye showed that Aberdeen-Angus bulls differed in the highest value of this indicator -8.36 g/100 g, which is higher than the indicator of crossbred bulls by 0.7% (0.06 g/100 g) and significantly higher than Black-and-White bulls by 3.70% (0.31 g/100 g). The crossbred stock of bulls "inherited" an intermediate amount of essential amino acids, it is significantly higher than that of purebred black-and-white mates by 3.01% (0.25 g/100 g).

According to the research results, it was revealed that the content of essential amino acids in groups of animals was unequal, so the breed (breeding method) did not have a definite effect on the following amino acids: Lysine (necessary for the formation of all protein structures in the body, the amino acid determines the biological value of the protein) content by groups ranged from 1.79-1.80 g/100 g of protein; valine (has a stimulating effect, is necessary to maintain the nitrogen balance in the body) from 0.99-1.07 g/100 g; methionine (a sulfur-containing amino acid that provides the body with available sulfur) - from 0.78-0.81 g/100 g, tryptophan (is the main essential amino acid in muscle tissue, which serves to determine the Protein Quality Index (PQI) from 0.14-0.15 g/100 g.

The research results determined a significant effect of the origin of bulls on the content of such amino acids as leucine and isoleucine, which play a major role in gluconeogenesis, the synthesis of many essential amino acids, hemoglobin, and maintaining muscle metabolism. The amount of these amino acids in the protein of the rib eye in purebred Aberdeen-Angus bulls is significantly ($p<0.05$) higher by 9.2% (0.15 g/100 g) and 12.1% (0.11 g/100 g), respectively, than in purebred black-and-white bulls and by 1.7% (0.03 g/100 g) and 9.7% (0.09 g/100 g), respectively, than in crossbred mates.

The content of the essential amino acid phenylalanine was significantly ($p<0.05$) higher in purebred Aberdeen-Angus and crossbred young animals by 9.3% (0.07 g/100 g) and by 10.7% (0.08 g/100 g) than in purebred black-and-white peers. A significantly high content of threonine was noted in crossbred and purebred black-and-white bulls, which is higher than in Aberdeen-Angus bulls by 16.1 and 8.6%.

Non-essential amino acids can be synthesized in the body. But due to endogenous synthesis, only the minimum needs of the body are provided. Satisfaction of the body's need for essential amino acids is carried out due to their intake in food as part of proteins.

Non-essential amino acids perform quite significant functions in the body, in some of them they play the physiological role no less than essential amino acids.

The calculation of the amount of non-essential amino acids in the proteins of the rib eye showed that the maximum amount is contained in the proteins of the muscle tissue of crossbred animals - 12.62 g/100 g, which is significantly higher ($p<0.05$) than in Aberdeen-Angus bulls by 5.6% and black-and-white bulls by 5.3%.

The content of non-essential amino acids in the samples of the rib eye of bulls varied due to their different origin. Thus, the genotypic features of young animals did not have a significant impact on the content of some amino acids and the indicators varied within the following limits: Glutamine from 3.43-3.55 g/100 g, serine from 0.81-0.87 g/100 g, histidine from 0.80-0.83 g/100 g, cystine from 0.14-0.17 g/100 g and proline from 0.79-0.84 g/100 g.

At the same time, crossbred bulls had a significantly higher content of the following non-essential amino acids: Asparagine (a semi-essential amino acid involved in the formation of urea) the content is higher ($p<0.05$) than in Aberdeen-Angus bulls by 13.8% (0.22 g/100 g), Black-and-white bulls by 6.8% (0.13 g/100 g), and the content of glycine also revealed a similar pattern - higher by 12.1% (0.12 g/100 g) and 4 .2% (0.04 g/100 g). According to the content of arginine, alanine and tyrosine, crossbred bulls also surpass their mates in the control and two experimental groups on average from 3.2-11.2%.

The protein usefulness index showed that the most biologically complete protein is the meat of Aberdeen-Angus bulls, the indicator was 0.70, respectively, the meat of crossbred bulls and black-and-white bulls is less biologically complete -0.66 and 0.67, respectively.

The research results showed a certain influence of the breed and genotype of animals on the consumer and taste qualities of beef, which largely depend on the content of adipose tissue and its localization. In the meat of Aberdeen-Angus bulls, the highest content of fat and dry matter was noted with a relatively lower protein content. The highest protein content was in the sample of the rib eye (21.23%) and the average sample of the meat of the rib eye (20.31%) of black-and-white bulls.

The presence of dry matter in animal meat is mainly determined by the protein and fat accumulation. Their ratio in the average sample of meat of the longest muscle of the back varied within 1.63 - 4.25:1, with the maximum value of this parameter in Black-and-white bulls.

The ratio of protein to fat in the longissimus dorsi muscle (rib eye) was at the level of 14.84 - 33.17:1 with a maximum in Black-and-white bulls. A significantly higher fat content was found in the rib eye of Aberdeen-Angus bulls (by 0.77 p.p.) and crossbred mates (0.57 p.p.).

The total proportion of essential amino acids in 100 g of the protein of the rib eye of Aberdeen-Angus bulls was 8.36 g, crossbred mates -8.30 g, black-and-white -8.05 g.

The muscle tissue of the experimental bulls was featured by relatively high sum of non-essential amino acids. Their highest content in 100 g of protein of rib eye was noted in crossbred bulls (12.62 g).

The composition of the muscle tissue of Aberdeen-Angus bulls was characterized by the highest level of protein usefulness, which is higher than that of crossbred and black-and-white mates by 6.1 and 4.5%, respectively.

The obtained results are consistent with the research of scientists who conducted research and production experiments on the study of meat productivity and the biological value of beef obtained from bulls of purebred meat breeds such as Hereford, Aberdeen-Angus, Kalmyk, Limousin, as well as the effectiveness of their use in industrial crossing (Mironova *et al*., 2021).

Conclusion

The scientific value of the conducted research lies in the fact that Aberdeen-Angus beef cattle bred in Kazakhstan were studied for the first time. The obtained data on the breeding and genetic evaluation of animals will serve as the basis for the formation of the domestic breeding base for beef cattle breeding.

The methodology for calculating the estimated breeding values of Aberdeen-Angus cattle using the BLUP AM statistical method with the construction of a genetic model of the animal was developed and the breeding values were calculated for 6 productive indicators: Live weight at birth, at weaning, at 12 months of age, adult animal (5 years old), milking capacity of cows, average daily gain. Breeding values were calculated for 117,226 Aberdeen Angus animals. Aberdeen-Angus breed, as a specialized beef cattle breed, having high parameters of meat productivity and biological value of meat, had a certain impact on the level of quantitative and qualitative indicators of beef obtained from crossbred animals. Purebred breeding of beef cattle and the use of Aberdeen-Angus and other beef bulls for industrial crossbreeding in regions with intensively developed dairy cattle will help to maximize the production of high-quality beef.

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Author's Contributions

Anuarbek Temirbekovich Bissembayev: Head of research and responsible executor, experimental part of the research. Share of implementation and contribution to the preparation of the article 15%.

Alzhan Smailuly Shamshidin, Askhat Erbosynovich Chindaliyev and Stepan Dmitrievich Batanov: Share of implementation and contribution to the preparation of the article 10%.

Zhanat Maratovi Kasenov, Olga Stepanovna Starostina, Irina Andreevna Baranova and Altai Batyrkhanovich Nazarbekov: Experimental part of the research 10%.

Dastanbek Asylbekovich Baimukanov: Author of the idea, analysis and generalization of the data obtained. Share of implementation and contribution to the preparation of the article 15%.

Ethics

When doing research, all principles of scientific ethics are observed. There is no conflict of interest.

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