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ASSESSMENT AND SELECTION OF COWS OF FUTURE MOTHERS OF SIMMENTAL BULLS WITH THE USE OF GENETIC MARKERS

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Abstract

There are given the results of the selection, the assessment of future mothers of bulls of the Simmental breed. The materials for the research were cows of the first, second and third lactation of the Simmental breed of the herd of the breeding farm Society of limited liability "Strapit". The studies were carried out according to the scheme developed by us according to the following parameters: origin and genetic examination; constitution and exterior, marker alleles; productivity; breeding value; genetic evaluation methods. Milk yields for 305 days of lactation on average for the population of Simmental cows amounted to 6017 kg of milk, which is by 455 kg of milk more than the average for the first lactation, the difference is significant ($P<0.005$). Alleles B_2I_1Q, I', I'Q' are markers for the Simmental breed. There were selected 4 cows as candidates for mothers of future bulls, whose productivity in terms of the highest lactation varied within 7029-8003 kg of milk.

Key words*: assessment, blood groups, female ancestors, mothers of future bulls, productivity.*

INTRODUCTION

The breeding process requires intensive use of animals with outstanding performance, repeated in subsequent generations. The identification of such animals has become possible thanks to molecular genetic methods. Due to the rapid development of genetic technologies over the past two decades, the DNA technology method has become the main method for improving the use of farm animals (Glazko et al., 2017; Kgwatalala et al., 2007).

Improvement in the methodology of biology and molecular genetics made it possible in 2010 to decipher the genome of the most important species of agricultural animals - cattle, pigs, sheep and to genotype the studied species using hundreds of DNA markers. Of the majority of genetic markers, the most informative and most convenient for practical use was SNP (Single Nucleotide Polymorphism), (Kgwatalala et al., 2007; Matukumalli et al., 2009; VanRaden et al., 2010; Tracovicka, 2015).

The development and implementation of genomic evaluation marked the beginning of a new era in dairy cattle breeding. Selection based on genomic evaluation does not take place on individual "master genes", but on the entire genome. Knowing the DNA sequence of the father and mother makes it possible to predict which parts of the genome and hereditary inclinations a descendant can receive. According to the data of the Holstein and Jersey associations, the addition of genomic information increases the reliability of the assessment of bulls for all indicators, and the accumulation of data leads to an increase in the accuracy of the "genomic prediction" (Kalashnikova, 2010).

However, the successes of molecular genetics "pushed" into the background such a section of genetic research as immunogenetic. According to Serdyuk (2018), referring to Altukhov's research, in his article notes that a similar state of affairs is erroneous, since..."Polymorphism of proteins, blood groups and DNA naturally complement each other..." (Legarova, 2010). Therefore, the use of allelic forms of genes responsible for blood groups is also very relevant.

In the Republic of Moldova, as a result of many years of research in the breeding of the Moldovan type of black-motley cattle, information has been accumulated on the blood groups of cattle of various breeds (Smirnov et al., 2007). It was created a database of the allele

pool of the EAB-locus of the Moldovan type of black-motley cattle on the basis of attestation materials for blood groups of bulls belonging to 18 lines of the Moldovan type of black-motley cattle (Foksha et al., 2008).
Alleles of the AEB locus were used in the choice and selection of bulls and breeding stock, where genetic markers of both bulls and breeding stock are taken into account (Konstandoglo et al., 2015).
Taking into account the difficulties in the development of breeding cattle in the Republic of Moldova, it is important to obtain breeding bulls and heifers to further increase the genetic progress in dairy cattle breeding.
The aim of the research was to evaluate cows of the Simmental breed (future mothers of bulls) by origin and their own productivity using blood groups, to obtain bulls from them in the future for growing on the Elever.

MATERIALS AND METHODS

The research was carried out in the herd of Society of Limited Liability "Strapit" (LLC "Strapit"), where Simmental animals are bred, which were imported from Austria and Germany.
The material for the research were the cows of the first, second and third lactation of the Simmental breed of the herd of the breeding farm LLC "Strapit", v. of Nitscani, district of Calarash.
Selection, testing and immunogenetic marking of mother cows- bull producers from the Simmental breed were carried out using our own elaborations (Smirnov & Konstandoglo, 2009) (Figure 1).
The research carried out was directed at the testing of Simmental breed cows (future mothers producing bulls) on genealogical indices, own production, immunogenetic testing of blood groups (n = 64). An extensive analysis of the records of the population of Simmental bulls, the register of the growth and development of young bulls, the registers of cattle appraisal, the control milking and selected according to the scheme previously developed by the laboratory collaborators, were carried out.
The collection of blood samples, the performance of testing and the study of blood groups was carried out according to the recommendations of genetic testing (1983). The frequency of antigens and alleles was calculated according to the recommendations of Mierkuriev (1983). The level of homozygosity (Cα) was calculated using the Robertson formula: $Ca = \Sigma p^2$, where Ca - the homozygosity level at one locus, p - the allele frequency at the locus.
For the studied traits, the arithmetic mean (M), the error of the mean (± m), the coefficient of variation (Cv), and the significance of the difference according to Student's criterion (P) were determined. Statistical data processing and correlation analysis were carried out according to Merkurieva & Shangin-Berezovsky (1983) using the Microsoft Excel 2010 software package.

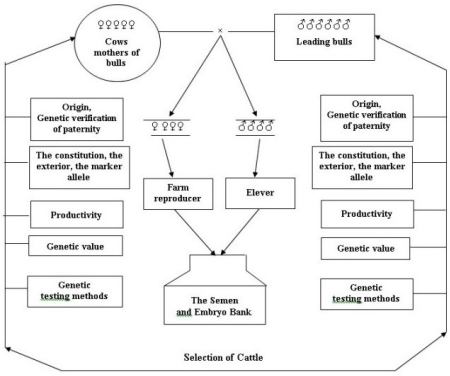

Figure 1. The scheme of selecting the cows-mothers of bulls and performing nominated pairings to obtain offspring for growth and reproduction

RESULTS AND DISCUSSIONS

The selection and evaluation of future mothers of Simmental bulls in the herd of LLC "Strapit" was carried out according to the following parameters: lineage and genetic expertise; constitution and exterior, marker alleles; productivity; breeding value; genetic evaluation methods.
Assessment and analysis of the productivity of the female ancestors of the Simmental heifers of the German selection showed that the milk yield of cow mothers averaged 7660 kg of milk with a fat content of 4.23% (Table 1).

Table 1. Productivity of female ancestors of the Simmental breed (German selection) (X ± Sx)

Indicators	Mother	C_v, %	Father's mother	C_v, %	Mother's mother	C_v, %
Milk yield, kg	7660 ± 198.1	17.3	11007 ± 239.1	15.2	8188 ± 202.0	16.9
Fat, %	4.23 ± 0.05	8.2	4.18 ± 0.07	11.3	4.10 ± 0.05	9.0
Fat, kg	323 ± 8.6	17.9	459 ± 11.4	17.4	336 ± 9.0	18.4

The milk yield of mothers and fathers according to the highest lactation amounted to 11007 kg of milk with a fat content of 4.18%.

The coefficients of variability (Cv) for milk yield were slightly above the lower limit of the norm for all analyzed groups of mothers from 15.2% (mothers of fathers) to 17.3% (mothers). In terms of fat content, the coefficient of variability was within the normal range from 8.2% (mothers) to 11.3% (mothers of fathers). As for the amount of milk fat, it should be noted that the values of this trait at mothers and mothers of fathers were below the norm, and at mothers of mothers they corresponded to the literature data (18.4%). Thus, the obtained results of the coefficients of variability and their comparison with the literature data led to the conclusion about a wide range of their variability and high genetic diversity of the analyzed population of Simmental cattle.

An analysis of the pedigrees of breeding evidence showed that heifers of the Simmental breed of German selection were inseminated by different bulls. The largest number of offspring (4) was found at the bull of the Austrian selection Pandora AT 597742517, at the bull of the German selection Dryland DE 09 4553211 (2), the productivity of mothers of which for the highest lactation was 12117 and 13049 kg of milk, with a fat percentage of 4.59 and 4.75 respectively. The mother of the bull Ilja DE 09 42492282 has the highest fat content in milk - 5.36%, with a milk yield for the highest lactation of 8739 kg of milk, the number of daughters is - 2.

The breeding value of bulls in terms of milk productivity on average for the analyzed livestock was +640.7 kg of milk, that is, all bulls are improvers in terms of milk yield.

As for the presence in the pedigrees of bull's genotypes from different countries, it was established as a result of the assessment that the origin of the fathers - producers were from two countries: Germany (82%) and Austria (18%) (Figure 2).

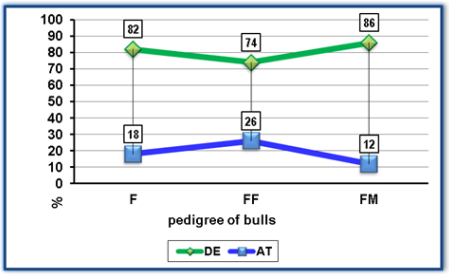

Figure 2. Genotypes from different countries as part of the parents of producers

Note: F - father; FF - the father of the father; FM - the father of the mother

In the FF and FM genotypes, there are 74 and 86% of bulls from Germany, 26 and 12%, respectively, from Austria.

The next stage of the research was to evaluate the analyzed cows of the Simmental breed according to their own productivity (Table 2).

Table 2. Characteristics of Simmental cows in terms of milk production for 305 days of lactation, (X ± Sx)

Lactation	Number of cows, n	Milk yield, kg	Cv	Fat content, %	Cv	Amount of Fat, kg	Cv
The first	10	5562 ± 179.5	9.7	3.94 ± 0.02	1.3	219 ± 7.1	9.8
The second	I23	6191 ± 106.2***	8.2	3.95 ± 0.01	1.4	249 ± 6.6	12.7
The third	19	5990 ± 212.5	15.5	3.98 ± 0.01	1.3	238 ± 8.0	14.7
Average population	52	6017 ± 102.3*	12.4	3.96 ± 0.01	1.4	240 ± 4.5	13.8

It was found that milk yield for 305 days of lactation on average for the population of Simmental cows was 6017 kg of milk, which is by 455 kg of milk more than the average for the first lactation, the difference is significant ($P<0.005$). It should be noted that the comparison of milk yields between the second and first lactations showed an increase of 629 kg of milk ($P<0.001$). Depending on lactation, the lowest coefficient of variability in milk yield per

lactation was at cows of the second lactation - it amounted 8.2%, which is by 7.3 and 4.2% less than at cows of the third lactation and on average for sample, respectively. According to the content and amount of milk fat in milk, the coefficient of variability is lower compared to the literature data.

The next stage of research is genetic marking by blood groups. It is known that the genetic information about animals, represented by blood groups, is used repeatedly, including after the disposal of the animal. Next, we present a detailed description of the antigenic spectrum, the allelophond of the AEB locus of certified Simmental animals according to blood groups.

As a result of the research, it was found that the antigenic spectrum of blood groups of the analysed animals of the Simmental breed turned out to be quite wide and is characterized by a greater saturation of antigenic factors due to the high frequency of occurrence of antigens V, H′, Z (Table 3).

Table 3. Antigenic spectrum of blood groups of Simmental cows, LLC "Strapit"

No	Locuses	Antigens	n	Frequency of antigens	No	Locuces	Antigens	n	Frequency of antigens
1.	**A**	A_2	45	0.6923	25.	**C**	C_1	34	0.5231
2.		Z'	1	0.0154	26.		C_2	34	0.5231
3.	**B**	B_2	35	0.5385	27.		E	45	0.6923
4.		G_2	30	0.4615	28.		R_1	4	0.0615
5.		G_3	32	0.4923	29.		R_2	30	0.4615
6.		I_1	24	0.3692	30.		W	63	0.9692
7.		I_2	19	0.2923	31.		X_1	9	0.1385
8.		O_2	18	0.2769	32.		X_2	38	0.5846
9.		P_2	3	0.0432	33.		C′	10	0.1538
10.		Q	20	0.3077	34.		L′	25	0.3846
11.		T_1	8	0.1231	35.	**F-V**	F	65	1.0000
12.		T_2	7	0.1077	36.		V	40	0.6154
13.		Y_2	22	0.3563	37.	**J**	J_2	30	0.4615
14.		D'	12	0.1846	38.	**L**	L	26	0.4000
15.		E'_2	23	0.3538	39.	**M**	M	8	0.1231
16.		G'	27	0.4154	40.	**S**	S_1	47	0.7231
17.		I'	24	0.3692	41.		U	2	0.0308
18.		J'_2	2	0.0308	42.		H′	63	0.9692
19.		O'	21	0.3231	43.		U′	9	0.1385
20.		P'	15	0.2308	44.		H″	7	0.1077
21.		Q′	36	0.5538	45.		U″	23	0.3538
22.		Y′	4	0.0615	46.	**Z**	Z	58	0.8923
23.		B″	3	0.0462	Average frequency or saturation of antigenic factors				0.2974 29.7%
24.		G″	21	0.3231					

The high frequency of occurrence of antigens A_2, E, W, V, S_1, H′, and Z should be noted. Similar results were obtained in studies of Austrian breeding Simmental cows (Sakhautdinov et al., 2011), where a high frequency of occurrence of the above antigens was also revealed.

For the AEA locus, both antigens were identified, the frequency of occurrence of which is 0.6923 (antigen A_2) and 0.0154 (antigen Z′).

All antigens were identified for the AEB locus out of 22 studied. In the tested population of animals, the most common antigens were B_2, G_2, G_3, I_1, Y_2, G', Q' (Figure 3).

Our data confirm studies (Gumerov, 2009; Didyk, 1987), the authors identified similar antigens of the AEC locus with a high frequency of occurrence inherent to the Simmental breed.

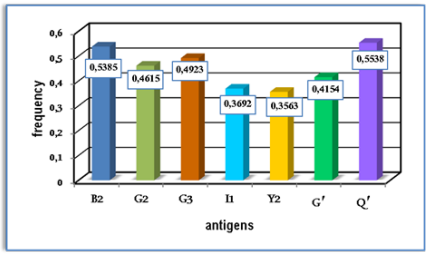

Figure 3. Frequency of occurrence of AEB locus antigens

The obtained results are consistent with the results of studies in the population of Simmental cattle in the herd of Technologically Experimental Station "Maksimovka" (Konstandoglo & Foksha, 2008), as well as the previously obtainned results of testing the Simmental population of the analyzed herd (Konstandoglo et al., 2016). The frequency of occurrence of antigens I_2, O_2, Q, Y_2, D', O', P' varied from 0.1846 (D' antigen) to 0.3563 (Y_2 antigen). Further, the antigens T_1 and T_2 were distributed in descending order with a frequency of occurrence of 0.1231 and 0.1077, respectively. The most common among animals of the Simmental breed on the AEC locus turned out to be antigens C_2, E, W, X_2, which are characteristic of this breed.

According to the F-V- locus, both antigens were detected in the entire analyzed population of animals. The frequency of occurrence of antigen F was 1.0, antigen V - 0.6154.

In one-factor AEJ-, AEL-, AEM-, AEZ-loci, all studied antigens were revealed. The frequency of occurrence of antigens J_2 and Z is high and is 0.4615 and 0.8923, respectively. Carriers of antigen M among the tested animals are more than 12%, the frequency of which is 0.1231.

All antigens were identified for the AES locus, the most common were antigens S_1, H', U″. The frequency of occurrence of the H' antigen is quite high and amounts to 0.9692.

An assessment of the saturation of the analyzed animals with antigenic factors showed that at the animal population of the Simmental breed it is 29.7%. As it is known, the alleles of the AEB locus to a greater extent reflect the hereditary characteristics of animals and characterize their genetic diversity.

As a result of the studies, 66 alleles were identified of AEB-locus of the Simmental breed (Table 4).

Table 4. Genetic structure of the Simmental breed of AEB locus

No	Alleles	Number of alleles	Frequency	No	Alleles	Number of alleles	Frequency
1.	B_2G_2	11	0.0846	34.	$Y_2D'E'_2Y'$	1	0.0080
2.	$B_2G_2I_1Q$	2	0.0154	35.	$Y_2G'IQ'$	1	0.0080
3.	$B_2G_2I_1O_2QT_1$	1	0.0080	36.	$Y_2G'IQ'G'$	1	0.0080
4.	$B_2G_2O_2$	1	0.0080	37.	$Y_2E'_2G'I'O'P'G''$	1	0.0080
5.	$B_2G_2O_2T_1$	1	0.0080	38.	$Y_2E'_2G'I'O'Q'G''$	1	0.0080
6.	$B_2G_2O_2P_2Q$	1	0.0080	39.	$Y_2E'_2I'O'Q'$	1	0.0080
7.	$B_2G_2P_2Q$	1	0.0080	40.	Y_2G'	1	0.0080
8.	$B_2G_2T_1$	1	0.0080	41.	$Y_2G'I'$	1	0.0080
9.	$B_2G_2I'OT_1$	1	0.0080	42.	Y_2I'	2	0.0154
10.	$B_2G_3I_1$	1	0.0080	43.	$Y_2I'P'Q'$	2	0.0154
11.	$B_2G_3T_1$	2	0.0154	44.	$Y_2I'P'Y'$	1	0.0800
12.	B_2I_1	1	0.0080	45.	$Y_2I'Q'$	4	0.0308
13.	$B_2I_1P_2Q$	1	0.0080	46.	$D'E'_2G'O'G''$	1	0.0080
14.	$B_2I_1O_2Q$	1	0.0080	47.	$D'E'_2G'O'P'G''$	1	0.0080
15.	B_2I_1Q	6	0.0461	48.	$D'E'_2I'J'_2O'$	1	0.0080
16.	B_2O_1Q	1	0.0080	49.	$D'G'I'Q'G''$	1	0.0080
17.	$B_2O_2Y_2E'_3G'Q'G''$	1	0.0080	50.	$D'G'J'_2P'$	1	0.0080
18.	B_2QG'	1	0.0080	51.	$E_2'G'I'O'$	1	0.0080
19.	G_2	2	0.0154	52.	$E_2'G'I'O'G''$	3	0.0230
20.	G_2I_1	1	0.0080	53.	$E_2'G'I'O'P'G''$	2	0.0154
21.	$G_2O_2T_1$	2	0.0154	54.	$E_2'G'I'O'Q'G''$	2	0.0154
22.	G_2T_2	2	0.0154	55.	$E_2'G'O'P'G''$	1	0.0080
23.	G_2Y_2	1	0.0080	56.	$E_2'G'O'P'Q'G''$	1	0.0080
24.	I_2	3	0.0230	57.	$E_2'G'O'G''$	1	0.0080
25.	I_1Q	1	0.0080	58.	$E_2'I'$	1	0.0080
26.	O_1I'	1	0.0080	59.	$E_2'I'O'Q'$	1	0.0080
27.	O_2	9	0.0692	60.	$G'I'$	2	0.0154
28.	Q	3	0.0231	61.	$G'O'G''$	1	0.0080
29.	Y_2D'	1	0.0080	62.	I'	7	0.0538
30.	$Y_2D'G'I'Q'Y'B''$	1	0.0080	63.	$I'Q'$	9	0.0692
31.	$Y_2D'G'Q'Y'B''$	1	0.0080	64.	Q'	9	0.0692
32.	$Y_2D'E'_2I'O'Q'$	1	0.0080	65.	G''	1	0.0080
33.	$Y_2D'E'_2I'P'$	1	0.0080	66.	"b"	1	0.0080

The most common alleles were B_2G_2, B_2I_1Q, O_2, I′, I′Q′, Q′. It should be noted that the alleles B_2I_1Q, I′, I′Q′ are markers for the Simmental breed.

Alleles B_1I_1Q, I_1Q, O_1I', Q, I′Q′, Q′ "b" are common for breeds of "pale-motley" root - Sychevskaya, Charolais, Pinzgau.

The objective genetic characteristics of the analyzed animals of the Simmental breed are also reflected by such indicators as the homozygosity coefficient (Ca), the number of effective alleles (Na) (Table 5).

Table 5. Genetic variability of the Simmental cattle population

No	Indicators	Quantitative value
1.	Total explored, heads	65
2.	Number of established alleles: - total - main - rare	128 84 44
3.	Total allele frequency: - basic - rare	0.6461 0.3385
4.	Homozygosity coefficient, Ca	0.0351
5.	Number of effective alleles, Na	28.5

As it can be seen, the concentration of the main alleles for the Simmental breed in the herd of LLC "Strapit" was 64.6%. The homozygosity coefficient in the analyzed population is low and amounts to 3.5%, which indicates a high genetic diversity of this population of Simmental cattle. As it is known, the state of the allelophond of the breed in terms of the level of homozygosity is reflected in the indicator of the number of effective alleles. Research have established that in the population of animals of the Simmental breed of the herd of LLC "Strapit", the number of effective alleles reaches 28, which corresponds to the maximum possible "homozygous" structures in the herd and reflects the state of heterozygosity for this locus.

In general, the allelophond of the examined animal population of the Simmental breed is dominated by marker allele's characteristic of the Simmental cattle of Austrian and German breeding, and the identified differences.

Thus, as a result of assessing the of Simmental cows by origin (productivity of female ancestors, breeding value of bulls) and their own productivity, as well as certification by blood groups (detailed characteristics of the antigenic spectrum and allelophond of the AEB locus), 4 cows were selected, which we offer candidates for future bull-producing cows (Table 6).

Table 6. Characteristics of selected cows as mothers of future bulls

No	Number	Lactation	Milk yield, kg	Fat content, %	Amount of fat, kg	Alleles of the AEB locus
1.	MD 76405	The third	8003	3.94	315.3	$B_2O_2Y_2E'_3G'Q'G''/E'_2G'I'O'$
2.	MD 76399	The second	7029	3.86	271.3	$G_2Y_2/Y_2I'P'Y'$
3.	MD 8125	The third	7285	3.93	286.3	$Y_2G'I'Q'/G''$
4.	MD 22729	The second	7465	3.9	291	$B_2G_2/E'_2G'O'G''$

As it can be seen, all the candidates for mothers of future bulls are the same age, the productivity of which, according to the completed highest lactation, varied within 7029-8003 kg of milk. The selected cows are marked with alleles of the AEB locus and are valuable in obtaining bulls with a high genetic potential, well adapted to the breeding conditions of the Republic of Moldova.

CONCLUSIONS

1. Milk yield for 305 days of lactation on average for the analyzed population of Simmental cows amounted to 6017 kg of milk, which is by 455 kg of milk more than the average for the first lactation, the difference is significant ($P<0.005$).

2. Alleles B_2I_1Q, I′, I′Q′ are marker alleles for the Simmental breed.

3. Candidate cows in mothers - producers of bulls have the average milk production during the highest lactation in the range of 7029-8003 kg milk per lactation, are genetically marked and show value for obtaining autochthonous bulls of high genetic value well adapted to the pedoclimatic conditions of Republic of Moldova.

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