UDK636.2.082.4

POLYMORPHISM OF SIRES OF HOLSTEIN BREED WHICH ARE USED IN UKRAINE BY KAPPA-CASEIN GENOME AND THEIR BREEDING VALUE

I. P. Chumachenko, K. A. Naidenko, L. A. Koropets, Candidates of Agricultural Sciences, M. P. Zhuravel, Candidate of Biological Sciences

Abstract. *Studied polymorphism of sires of Holstein breed used in Ukraine by kappa-casein genome on account of their linear origin and breeding values.*

Key words: sires, lines, kappa-casein, genotypes, alleles, breeding value.

An alternative to conventional breeding are DNA technology methods. The simplest one is considered to be the method of genotype identification at the DNA level using polymerase chain reaction (PCR) with subsequent analysis by restriction fragment length polymorphism (RFLP), which you can use for animals of different sexes and ages, including sires, calves, embryos, which significantly accelerates the rate of selection [1, 5].

The difficulty of obtaining a marker for characteristics of milk productivity of animals exists due to their polygenism and interaction with environmental conditions. But among the many genes controlling milk productivity it can be distinguished a group of major genes that provide the greatest contribution to the formation and operation of certain feature. These genes include άs1 - casein, k - casein, β - lactoglobulin [5].

In recent years, considerable attention is given to kappa-casein (k-Cn), allelic variants of which affect the qualitative composition and technological properties of milk. Milk of cows with AB and BB kappa-casein genotypes is characterized by a greater protein content and better coagulation when compared to other genotypes. More valuable for making cheese is considered to be milk from cows of BB genotype, which has faster coagulation under the influence of rennet; from it they receive casein clots of the best quality. When making cheese from milk of cows

with BB and AB kappa-casein genotypes, it is observed a higher degree of milk protein use than in cows of AA genotype [2, 3, 6].

Information about sire polymorphism by kappa-casein gene makes it possible to carry out more intensive breeding to increase the protein content in milk and its coagulation, to which it is not paid enough attention in Ukraine. The catalog of sires of dairy and dual cattle breeds for reproduction of breeding stock includes no data on their sire polymorphism by kappa-casein gene, although in countries from which semen is imported such studies are being conducted and widely used in the selection process.

The aim of the work was to study the polymorphism of sires of Holstein breed, which is used in Ukraine, by kappa-casein gene in view of their linear origin and breeding values.

Materials and research methods. The study includes 87 sires of Holstein breed, which are listed in the Catalogue of dairy and dual cattle breeds for reproduction of breeding stock in 2014 [4]. The semen of these sires was imported to Ukraine from Canada (the company SEMEX). Identification of sires by kappa-casein genotypes was provided by using the Internet information base. Methods of investigation provided a comprehensive analytical analysis:

- genealogical structure of sires by their belonging to the line;
- frequencies of AA, AB, BB, AE, BE and EE genotypes, as well as A, B, E allelic variants by kappa-casein in the study group of sires and individual lines;
- indicators of breeding values of sires of different genotypes by kappa-casein.

Results. Among the investigated sires most common (Table 1) are lines of Chief 1427381 - 31 animals (35.6%), Starbuck 352 790 - 20 animals (23%), Elevation 1491007 - 14 animals (16.1%), and Marshal 2290977 - 12 animals (13.8%). In addition, 10 sires (11.5%) belong to the lines of Bell 1667366 (4 animals), J. Besn 5694028588 (4 animals) and Valiant 1650414 (3 animals).

Table 1. Genealogical structure of sires by lines

Line	Animals	%
Chief 1427381	31	35.6
Starbuck 352790	20	23.0
Elevation 1491007	14	16.1
Marshal 2290977	12	13.8
Other lines	10	11.5
Total	87	100

As a result of monitoring of the genetic structure of sires by kappa-casein locus it was revealed that 40 sires (46%) are homozygous (AA and BB) by this locus, and 47 (54%) - heterozygous (AB, AE, BE).

It is noted more frequent distribution (Table 2) of AA (39.1%) and AB genotypes (37.9%). The frequency of genotype AE is 11.5%, of BE - 8.7%. The lowest frequency was obtained by BB genotype - 6.9%.

Table 2. The frequencies of k-C_n genotypes in sires of different lines

Line	Index	genotype k – C_n genotype				
		AA	AB	BB	AE	BE
Chief 1427381	animals	18	9	4	-	-
	%	58.1	29.0	12.9	-	-
Starbuck 352790	animals	8	6	-	5	1
	%	40.0	30.0	-	25.0	5.0
Elevation 1491007	animals	4	6	-	3	1
	%	28.6	42.9	-	21.4	7.1
Marshal 2290977	animals	2	8	-	1	1
	%	16.7	66.7	-	8.3	8.3
Total	animals	34	33	6	10	4
	%	39.1	37.9	6.9	11.5	8.7

Sires of individual lines differ significantly in kappa-casein gene polymorphism. AA genotypes are more common in the lines of Chief (58.1%) and Starbuck (40.0%), AB - in lines of Marshall (66.7%) and Elevation (42.9%), BB is found

only in line of Chief (12 9%), AE - in lines of Starbuck (25.0%) and Elevation (21.4%). AE and BE genotypes among sires of Chief line are not found.

For all investigated sires (table 3) it was found the highest frequency of allele A spread - 0.638, the lowest - allele E - 0.080. The frequency of allele B is 0.282, which is typical for the Holstein breed [1, 6].

Table 3. The frequencies of k - C_n alleles in sires of different lines

Line	k – C_n allele		
	A	B	E
Chief 1427381	0.726	0.274	-
Starbuck 352790	0.675	0.175	0.150
Elevation 1491007	0.607	0.250	0.143
Marshal 2290977	0.542	0.375	0.083
Total	0.638	0.282	0.080

In terms of individual lines allele A is more common among sires of lines of Chief - 0.726 and Starbuck - 0.675, allele B - in the lines of Marshall - 0.375 and Chief - 0.274, allele E - in the lines of Starbuck - 0.150 and Elevation - 0.143. The greatest value for getting milk able to coagulate represent sires of Marshall line, which is marked by a relatively high frequency of B allele and Chief line where they were found sires with BB genotype.

The breeding value of the sires is the main criterion for effectiveness of their use in the selection process. Indices of breeding values of studied sires (Table 4) by milk productivity are in the range of 1108 kg (BB genotype) to 859 kg (AB genotype), fat content in milk from + 0.10% (AB genotype) to 0.01% (AA genotype), protein in milk - from + 0.08% (AB genotype) to -0.04% (BB genotype). The best averages of breeding values by milk fat (44.2 kg) and protein (+ 38.9%) are characterized AB genotype sires. Possible difference among indices of breeding values of sires was obtained in milk fat between AB and BB genotypes ($p < 0.05$) and in protein content in milk between genotypes AB and AA, AB and BB ($p < 0.01$).

Table 4. Indices of breeding values of sires of different genotypes by k - C_n, M±m

Genotype	n	Breeding value				
		yield, kg	milk fat		milk protein	
			%	kg	kg	%
AA	34	911±110	0.01±0.04	34.8±3.5	-0.01±0.02	30.3±2.6
AB	33	859±98	0.10±0.03	44.2±4.0	0.08±0.02	38.9±3.7
AE	10	899±129	0.08±0.01	41.6±5.1	0±0.04	29.2±4.1
BB	6	1108±138	0.02±0.03	41.5±6.2	-0.04±0.03	31.5±5.4
BB*	30	909±111	0.08±0.04	41.0±4.2	0.08±0.02	37.6±3.1

* Sires, sperm of which is proposed for implementation by SEMEX.

The negative value of the average indices of breeding value of BB genotype sires by protein content in milk (-0.04%) is due to their genetic potential and calls into question the use of sires to improve protein contest of cow milk. For comparison, in Table 4 are included 30 indices of breeding values of bulls with BB genotype, represented by SEMEX on the internet for the implementation of semen. Average rates of breeding values of sires are indicated by the fat and protein in milk +0.08%, which is bigger than in sires, semen of which is imported into Ukraine, respectively by 0.06% ($p < 0.05$) and 0.12% ($p < 0.01$).

Among 30 sires they were found only 7 sires with a negative index of breeding value by fat and protein in milk, whereas among 6 sires - 5 lead to worsening of fat and 4 - of protein content in milk (Table 5), at the same time, they have high rates of breeding value by milk productivity.

An exception is a sire O.Steard 7746123, which is characterized by the negative index of breeding value by milk production (-170 kg) and relatively high breeding value by fat (+0.59%) and protein (+0.09%) in milk.

Table 5. Indices of breeding values of BB genotype sires, sperm of which is imported to Ukraine

Name, identification № of a sire	Breeding value				
	yield, kg	Milk fat		Milk protein	
		%	kg	kg	%
H. Lomaks 048202138	946	-0.09	24	+0.08	40
M. Impression 66382657	1216	-0.04	39	-0.09	29
P. Hilmoro 137244467	1497	-0.11	43	-0.04	44
S. Steard 77466123	-170	+0.59	55	+0.09	5
R. Marker 96671643	1659	-0.16	43	-0.09	44
V.R. Nba 03650	1495	-0.09	45	-0.19	27

During the breeding sires to a breeding stock it is important, first of all, to consider the direction of improving herd by defined criteria. If the selection is to increase the protein content in milk and milk coagulation ability it necessary to increase the frequency of allele B in terms of intensive use of bulls with BB and AB genotypes, bearing in mind that the rate of selection is determined primarily by indices of breeding values of sires.

Conclusions

1. Most numerous among the investigated sires are lines of Chief 1427381 - 31 animals (35.6%), Starbuck 352 790 - 20 animals (23%), Elevation 1491007 - 14 animals (16.1%) and Marshall 2,290,977 - 12 animals (13.8%).

2. Genetic structure of sires by kappa-casein gene is characteristic for Holstein breed: the frequency of AA genotypes is 39.1%, and AB - 37.9%, AE - 11.5% and BB - 6.9% at a frequency of allele A - 0.638, B - 0.282 and E - 0.080.

3. The greatest value for coagulated milk represent sires of Marshal 2290977 line which is marked by relatively high frequency of allele B - 0.375 and Chief 1427381 line sires with BB genotype.

4. Sires of BB genotype have the highest average breeding value by milk production (+1108 kg). The best indices of breeding value by content of fat (+

0.10%) and protein (+ 0.08%) in milk, milk fat (44.2 kg) and milk protein (38.9 kg) showed AB genotype sires.

5. Due to the importance of improving protein content of milk and production of milk able to coagulate, as well as considering the experience of countries with developed dairy cattle breeding quite topical is introduction into breeding programs for the improvement of livestock breeds in Ukraine of identification of cattle by kappa-casein gene.

6. When importing sire sperm it should be taken into account the priority direction of development of dairy cattle that must be supported by the genetic structure of sires and their breeding value by the defined indices of milk productivity.

References

1. Glazko V. I. DNA technologies and bioinformatics in solving problems of mammal biotechnology / V. I. Glazko, E. V. Shul'ga, T. N. Dyman, G. V. Glazko. - Belaia Tserkov', 2001. - P.84-88.

2. Kalashnikova L. A. Effect of kapa-casein on milk quality and its coagulation ability / L. A. Kalashnikova // Dairy and beef cattle breeding. - 2004. - №8. - P. 24-25.

3. Kalashnikova L. A. Using DNA diagnostics to improve the quality of milk of cows of black-motley breed / L. A. Kalashnikova, A. Sh.Tinaev, E. A. Denisenko // Guidelines. - M. VNIIplem, 2008. - 28 p.

4. Catalog of sires of dairy and dual cattle breeds for reproduction of breeding stock in 2014 / composite author- K.: P. 10 – 69

5. Kopylova K. V. Molecular and technological markers in the system of safe of farm animal biodiversity / K. V. Kopylova // Author. Dis. Doc. sciences: 03.00.15 Institute of Animal Breeding and Genetics of NAAS. - vil. Chubinske, 2012. - 34 p.

6. Pryhodko M. F. Directions of cattle breeding by casein fractions of milk / M. F. Pryhodko // Bulletin of SNAU. - 2004. - Vol. 5. - P. 123-128.