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MILK PRODUCTIVITY AND REPRODUCTIVE ABILITY OF COWS OF UKRAINIAN BLACK AND WHITE DAIRY BREED OF DIFFERENT GENOTYPES BY KAPPA-CASEIN LOCUS

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It was investigated the genetic structure of cow herd of a breeding farm using DNA diagnostics for kappa-casein gene. On the basis of indicators of milk productivity, as well as some indicators of herd reproduction, it was made their comparative analysis, depending on cow genotype by kappa-casein gene locus.

Breed, milk productivity, breeding, genotype, protein content of milk, kappa-casein, service period, the rate of reproductive capacity

Due to significant advances in breeding of dairy cattle, especially in the use of animals of the Holstein breed - the global leader in milk productivity, the parent form of which significantly participated in the creation of new breeds, including the Ukrainian black and white dairy breed, resulted in obtaining animals with high genetic potential for milk productivity.

The extensive use of Holstein cattle gene pool, unfortunately with not always desirable breeding values, led to the fact that by some economically useful traits animals of created breed do not fully meet the requirements of dairy farming intensification level. One of these traits is the most important one - protein content of cows' milk, which in its genetic characteristics of formation belongs to the complex selection process that requires an in-depth study of the latter.

Research of the mass fraction of protein in milk and its structure proved that according to the ratio, the main and specific milk protein is casein (complex composition), which accounts for about 80% of the total protein content [5]. Casein complex consists of several fractions; the most desirable of them is kappa-casein. The content of the latter in milk affects the quantitative characteristics of protein content, technological properties of milk in the manufacturing protein-milk products and their taste, so, there is a direct relationship between the content of kappa-casein in milk and above-mentioned parameters [3, 5].

Increased production of protein products from dairy cattle is possible in terms of use advanced genetic techniques of animal breeding. Thus, in recent decades there is a growing use of information on allelic variants of genes responsible for encoding the synthesis of milk protein in dairy cattle breeding. Among the allelic variants of genes most studied and available for production implementation is kappa-casein gene. Currently they are set 10 allelic variants of the latter in cattle. The most common of these genetic variants are A and B, the frequency of which is different for various breeds [4, 5].

Considering the importance of allelic variants of kappa-casein genes in animal breeding to increase protein content, the aim of this paper is to investigate milk production and reproductive ability of cows of Ukrainian black and white dairy breed of different genotypes by kappa-casein locus in the herd of breeding farm "Agronomic Research Station", the separated subdivision of the National University of Life and Environmental Sciences of Ukraine.

Materials and research methods. To investigate the frequencies of genotypes and alleles of kappa-casein gene they were used blood samples obtained from 196 cows of Ukrainian black and white dairy breed with the completed second lactation.

The study of blood samples was conducted in the Department of Molecular Biology of Ukrainian Laboratory of Quality and Safety of Agricultural Products of NULES of Ukraine. For this samples of 1.5-2.0 cm^3 volume in Eppendorf tubes with the addition of EDTA as coagulant, in the day of obtaining were sent to the

lab. According to methods of DNA diagnostics genomic DNA was determined by polymerase chain reaction (PCR) with subsequent analysis by restriction fragment length polymorphism (RFLP). For each cow with a known genotype by the kappa-casein locus were accounted the following indices: yield (kg), fat content (%), protein content (%), the amount of milk fat (kg) and milk protein (kg) for the first and the second lactation; indices of reproductive capacity – the age of fruitful insemination of heifers (months) and their live weight at this age (kg), length of service period, calving interval (days) and coefficient of reproductive ability (CRA) of cows determined by the formula: **CRA = 365: CI** where 365 – the number of days in the calendar year, CI – the duration of calving intervals, days. Biometric data processing was performed by using mathematical statistics using statistical functions of MS Excel.

Results. Of the total number of the investigated cows the herd by the genetic structure of genotypes is represented by two groups of animals – homozygous AA and heterozygous AB by the kappa-casein gene locus (Table 1).

Table 1. The frequencies of genotypes and alleles of the kappa-casein gene in herd cows

Breed	Index	Genotype			Allele	
		AA	AB	BB	A	B
Ukrainian black and white dairy	Animal units	170	26	0	183	13
	%	86.7	13.3	-	-	-
	frequency	0.868	0.132	0	0.93	0.07

They were found no animals of homozygous genotype BB in the herd. The group of cows of genotype AA includes 170 units (86.7%) and the group of AB – 26 units (13.3%). Respectively, the share of frequencies of genotypes AA and AB is 0.868 and 0.132. The frequency of distribution in the herd of allele A variant corresponds to 0.93, and B allele variant – only 0.07. This distribution of allelic variants of kappa-casein genes and animal genotypes points to the use of Holstein bulls in the herd for a long time, the vast majority of homozygous (AA) by the kappa-casein gene, and more seldom – heterozygous (AB) and it exists the possibility of complete absence of use of homozygous (BB) bulls, resulting in the

existing ratio of genotypes AA and AB in the herd. A similar distribution of allelic variants of genes in the herd was got while research by V. A. Malienko et al. in 2008 [1].

The absence in the herd of homozygous BB animals, which phenotypically provide greater protein content in milk, is explained by the fact that the frequency of spread of the desired C-allele of kappa-casein in Holstein breed is rather low. Importantly, the studied herd has a great number of cows of the Holstein breed as it was among the first in the country after Holsteinization, which contributed to some extent to existing distribution of allelic variants of A and B kappa-casein.

Analyzing the facts it should be mentioned that among five indices of milk production, which were subjects of the study, the latter ones have a certain level of their variation both in the age dynamics and between groups of genotyped cows (Table 2).

Studies indicate that the yield of homozygous (AA) cows was 5623 kg for the first lactation and 6284 kg for the second one, and for heterozygous (AB) cows 5880 and 6691 kg of milk respectively. For both groups of cows characteristic is the increase in yields in the age dynamics - yield of cows of AA genotype for the second lactation when compared to the first one increased by 661 kg (11.2%) and for cows of AB genotype - by 811 kg (11.4%).

The higher yield in the group of heterozygous cows when compared to the homozygous animals, indicates the general tendency to increase this index and the between-group difference is statistically likely value that is 257 kg (I lactation, $p < 0.05$), 407 (II lactation, $p < 0.001$) and 307 kg of milk (an average of two lactations, $p < 0.01$).

According to the content fat in milk, despite some advantages of heterozygous cows from 0.05 to 0.06%, the likely difference is not installed. A somewhat different result was obtained in the analysis of protein content in milk. Homozygous group of cows is much inferior to heterozygous group, and a difference in protein content between the two groups ranged from 0.14 to 0.15% ($p < 0.001$).

Table 2. Milk productivity of cows according to their genotype by the kappa-casein locus, M ± m

Lactation	Index	Cow genotype		Difference	P
		AA	AB		
The first	Yield, кг	5623 ± 98	5880 ± 124	257	<0.05
	Fat content,%	3.68 ± 0.02	3.73 ± 0.05	0.05	>0.05
	Milk fat, kg	207.2 ± 4.7	220.5 ± 5.1	13.3	<0.01
	Protein content, %	3.02 ± 0.01	3.16 ± 0.04	0.14	<0.001
	Milk protein, kg	170.4 ± 3.3	186.1 ± 4.1	15.7	<0.001
The second	Yield, кг	6284 ± 103	6691 ± 131	407	<0.001
	Fat content,%	3.65 ± 0.04	3.71 ± 0.07	0.06	>0.05
	Milk fat, kg	230.2 ± 3.8	248.3 ± 4.6	18.01	<0.001
	Protein content, %	3.04 ± 0.01	3.19 ± 0.04	0.15	<0.001
	Milk protein, kg	192.0 ± 2.4	213.5 ± 3.8	21.5	<0.001
In average	Yield, кг	5950 ± 92	6287 ± 128	337	<0.01
	Fat content,%	3.66 ± 0.02	3.72 ± 0.05	0.06	>0.05
	Milk fat, kg	216.9 ± 4.2	233.9 ± 4.9	17.0	<0.001
	Protein content, %	3.03 ± 0.01	3.17 ± 0.05	0.14	<0.001
	Milk protein, kg	179.5 ± 2.7	199.4 ± 4.8	19.9	<0.001

In terms of both milk fat and milk protein heterozygous (AB) cows highly probably ($p < 0.001$) dominated over homozygous (AA) cows.

For a more complete description of the influence of animal genotype in addition to productive ones it was carried out the evaluation of reproductive ability of cows (Table 3).

Table 3. Reproductive ability of cows of different genotypes by kappa-casein gene locus, M ± m

Index	Genotype	
	AA	AB
Age of fruitful insemination of heifers – the future cows, months	17.8 ± 0.3	16.3 ± 0.5
Live weight of heifers at fruitful insemination, kg	372 ± 4.4	354 ± 5.7
The duration of the service period, days	128 ± 3.2	112 ± 5.9
Duration of calving interval, days	412 ± 4.1	395 ± 6.4
The coefficient of reproductive ability (CRA)	0.88	0.92

The evaluation found that between the ages of fruitful insemination of replacement heifers, their live weight, duration of service period, calving interval and coefficient of reproductive ability of cows there is no possible differences in

compared groups of animals. At the same time, the best combination of these characteristics is common for the group of heterozygous cows. Similar results were obtained in studies by O. E. Pokusai [6]. Thus, different genotypes of kappa-casein cows do not affect their reproductive ability

Conclusions

1. On the basis of the identification of cows of cattle breeding farm by kappa-casein gene locus it was found that the presence of A and B allele frequencies in the herd is 0.93 and 0.07 at a spread frequency of homozygous (AA) and heterozygous (AB) animals 0.868 and 0.132 respectively. Homozygous animals of BB genotype, causing higher protein content in milk, are absent in the herd.

2. According to the evaluation of level of milk production, the best combination in terms of possible difference were obtained by milking, protein, fat and protein contents from heterozygous cows.

3. There was not found any proved influence of genotype by kappa-casein locus on the indices of reproductive capacity of animals in the herd.

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